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THE JOURNAL OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

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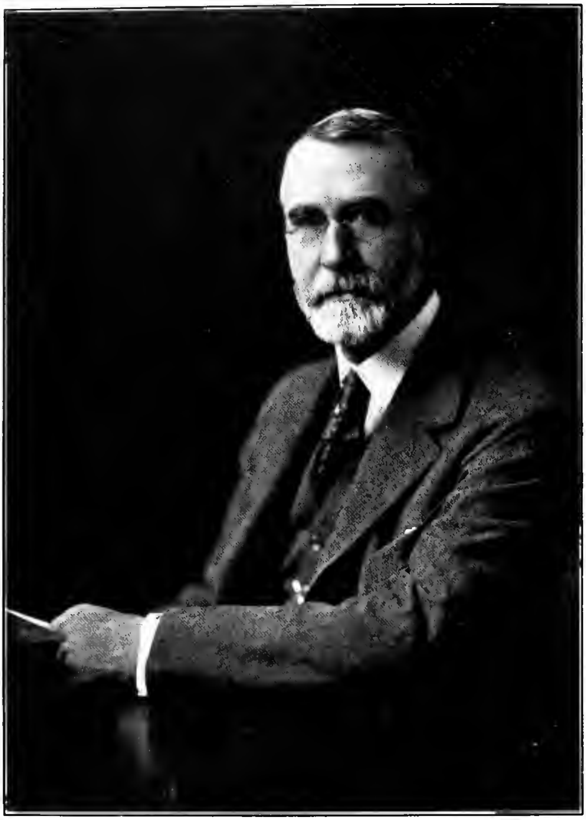

CHARLES THOMAS MAIN

PRESIDENT 1918

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

THE JOURNAL OF

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THE ANNUAL MEETING

SOME of the general meetings of the Society have excelled in the number of members and guests in attendance, some in the notable speakers and papers, some in the activity of the discussions, some in the timeliness of the topics on the program, some in the distinguished receptions held by the Society and some in the signal advances in the Society's policies; but the 38th Annual Meeting held in the Engineering Societies Building from December 4 to 7, 1917, will go down in the annals of the Society as having excelled in all of these, and in one other—the outspoken patriotism evoked by the nation's crisis in which engineers are playing no small part.

The note of patriotism sent forth by Dr. Ira N. Hollis, President of the Society for 1917, at the opening session was echoed again and again throughout the meeting and imparted to the entire proceedings the nature of a War Convention, which is likely to have a far-reaching effect upon the relations of the engineer to the Government in this emergency.

Opening Session

At the beginning of the session on Tuesday evening, President Hollis said it had been decided to omit the regular presidential address in order that there might be time to listen to one who had been honored by this nation, Hon. William H. Taft, Ex-President of the United States; and to confer Honorary Membership on one who had constructed the greatest engineering work on earth, Major-General George W. Goethals. Continuing, Dr. Hollis said:

"The Committee on Meetings decided in the late summer to change the character of our convention this year on account of the exceptional conditions in which we find ourselves. It is our first annual meeting held during a war in which we are participants. Many of our members have gone already, and many are going to voluntary service in the earnest hope of making themselvea useful to their country. Three of the Council are officers in the army: Major John H. Barr, Major William B. Gregory and Major Max Toltz; and others are serving well in civilian capacities. So much time is given by the engineers to invention, research, and manufacture for war purposes, that we could not, if we wished, conduct the usual technical program. Thus, by force of circumstances, as well as by the cheerful acquiescence of the Council and members, we turn our thoughts to public service and to discussion that will help us to see our way more clearly through this black calamity that has overtaken all the world.

"As American citizens, we hold our country to be the asylum for the oppressed, the home of opportunity for the lowly, and the land of faith in honor, truth and justice among nations, as well as among individuals.

"As engineers, our creed knows no compromise between might and right. It knows no pacifism that requires us to turn the other cheek to the assassin of all that humanity has held dear. The right to live was given to us by the Almighty, and we believe that 'they who take the sword shall perish with the sword.' Unhappily, all who are led by them share the same fate. We also believe in the justice of that penalty. We now hold the sword of the Lord and of Gideon in our hands, to use with all our strength against the barbarians of this twentieth century, so that science may be made safe for all mankind. And we have

"'Never doubted clouds would break,
Never dreamed, though right were worsted, wrong would triumph.'

"We have asked one who has held the highest office in this country, and another who has completed the greatest engineering feat on earth, to assist us in giving ourselves anew to the service of our country; but I should fail my purpose if I did not call attention to one aspect of the war.

"What are we to get out of this war? Not land, not booty, not empire, for we have disclaimed all these. We have gone in for humanity, making the great sacrifice of ourselves in the hope that the next generation may find itself the better for our share in this struggle. Our resources will be wasted on the unessentials of civilization; the blood of our young men will be shed on many battlefields, and our old people will spend their declining years in sorrow, some even in misery, as a consequence of our participation in this war. What, then, are we to get out of it?

"When we stop to think of the willingness with which thousands of men and women are working under hard conditions to train themselves for war, we find a new dignity in labor, and we gather from it a new force that can be made to supply the solvent of future struggles between capital and labor. There are many employers serving now on the battle line and many more employees serving under them, where the hardships and the deadly routine are infinitely greater than in any of the old industries. Yet the suspicions and the bitter antagonisms are gone. The relation between a good commander and his soldiers is exactly what we should have between employer and employee. Those who have been involved in a

common risk and a common service in face of death, will find a new conception of industrialism after the war is over.

"Can the virtues of war, the comradeship of the battlefield, not be made to survive in the peace that will come some day? Is it not possible to learn from this struggle that the age-long war between employer and employee never was necessary and never should have existed? Is it not possible to learn that all mankind are involved in a common fate made happier and better by mutual understanding and mutual service? Is it not possible to learn further that the power of wealth can be enjoyed only through the use to which it is put? If not, our country is sentenced to militarism for generations to come, and democracy will never be safe for any nation.

"I have been struck by a description that should stand to us as the pattern by which we may well hope to plan our lives. It is that of The Beloved Captain in one of the war books, whose career on the battle front carries a lesson to all who are leaders of other men.

'He came in the early days when we were still at recruit drills. Tall, erect, smiling, so we first saw him, and so he remained to the end. He had a smile for almost everyone, but we thought he had a different smile for us. We looked for it, and we were never disappointed. It meant that we were his men and that he was proud of us and sure that we were going to do well, and it made us determined that we would. No trouble of ours was too small for him to attend to. When we started route marches, for instance, and our feet were blistered and sore, as they often were at first, you would have thought that they were his own feet, from the trouble he took. He came into our rooms and if anyone had a sore foot, he would kneel down on the floor and look at it as carefully as if he had been a doctor. Then he would prescribe, and the remedies were ready at hand, being borne by the sergeant. There was no affectation about this, no striving after effect. It was simply that he felt that our feet were important and that he knew that we were pretty careless. Nevertheless, there was, in our eyes, something almost religious about this care for our feet. It seemed to have the touch of Christ about it and we loved and honored him the more. We knew that we should lose him, and so it proved. If ever there were a moment of danger, he was on the spot. No one would shirk if he were there. There was not one of us but would gladly have died for him. One day a torpedo fell into the trench and buried some of our chaps. The fellows next to them ran to dig them out. Of course, he was one of the first; and then came another torpedo in the same place. That was the end.

'Somehow he lives, and we who knew him do not forget. We feel his eyes are on us. We still work for that wonderful smile of his. There are not many of the old lot left now, but I think that those who "went West" have seen him. When they got to the other side, I think they were met. Some one said, "Well done, good and faithful servant," and, as they kneeled before that gracious, pierced Figure, I reckon they saw nearby the captain's smile. Anyway, in that faith let me die, if death should come my way, and so I think I shall die content.'

"Donald Hankey, who wrote that, had his wish. He joined his beloved captain when he was killed on the western front October 26, 1916.

"The best that we have survives in such memories. They are worth all the triumphs in politics, business and war. The truest measure of George Washington's greatness is not found in the surrender of Cornwallis, but in the tears of his officers when he gave up the command of the American Army. And Abraham Lincoln will last through the centuries, not as the President of a triumphant Union, but as the man who freed the slaves, and who in one short speech at Gettysburg dedicated this nation for all time to the freedom and brotherhood of man. The noble gentleman who is sitting here on the stage with us will be remembered by our children not on account of his great acts while President, but for the faith and love his gentle, generous kindness have inspired in the heart of every American citizen.

"Is there any man in this room who does not envy the beloved captain? There are few employers in America who would not exchange places with him, who would not willingly trade that memory for a thousand victories in the strikes that have wasted energies. There are few men in the unions who would not surrender to an employer like that. The poorest inheritance of the war will be material gain and the pride that glories in greater wealth and greater power. Its most precious heritage will be the memories that teach the value of work well done in behalf of those in our command. That I believe to be fundamentally the faith of the American engineer, and that I hope may become the practical ideal of every captain of industry. There are many such men in America, and if this war only reveals them to us, we may find some compensation for the lives that we must give.

"We all know men who are, under the right conditions, capable of becoming beloved captains. In their unselfish modesty we sometimes forget the qualities they possess, and the power of expressing to them our understanding is often denied us.

Introduction of the President-Elect

At the conclusion of these remarks, Dr. Hollis introduced to the membership President-Elect Charles T. Main, who was then escorted to the platform. In presenting him to the audience Dr. Hollis said:

"Happily, my opportunity has come tonight in presenting to this company one who in another year will be known to our whole family, as he is already known and understood by a few of us. I could not have hoped for a better fate than to have my year of service buttressed up by two such men as the quiet, unassuming gentleman who preceded me in office, and the next President of The American Society of Mechanical Engineers, Charles T. Main."

In acknowledging the introduction, the President-Elect thanked the members of the Society for conferring upon him such a great honor of leading the Society through a period of great effort and responsibility. He continued:

"During the past year, under the leadership of our beloved captain, many things have been accomplished, but far less than he has wished could have been done. I shall endeavor to maintain and uphold the traditions of our Society and to carry on his good work, but nothing worthy of mention will be accomplished without the support of the whole membership. The work of one man, or the life of one man, is a mere drop in the bucket in the great work which we have to do for the cause of humanity.

"The record of the engineering profession and the work which it has done in the past year is worthy of mention, but I feel that we have hardly begun to bear the full measure of the work which we should do, and I trust that in the next year we may do something which is commensurate with our responsibilities.

"This is not a time to discuss future policies, and it would be impossible to do so owing to the rapidly changing conditions. But there is, however, one ruling and central motive which every member of this Society and every citizen of this country should set up, the concentration of intellect, strength, resources and life, if necessary, to a satisfactory ending of this great war."

Honorary Membership for General Goethals

Following the introduction of Mr. Main was the conferring of Honorary Membership upon Major-General George W. Goethals. In presenting Major-General Goethals Dr. Hollis very happily recalled a little personal incident:

"A few years ago I spent a week on the Isthmus with our newest member. He had as butler a conglomerate wreck of all the Latin races, named Benoit. Whatever happened to the organization of the Canal, Benoit went with the house of the commanding officer. He held his office against all comers by means of a carving knife, and the Colonel could not discharge him. In fact, it lay between the two which would discharge the other. That was the one weakness of the Canal administration. I reveal this now lest you think him more than human.

"We who see him here know his stronger side, and we welcome him as a brother engineer in whose great accomplishment we take a pride. He belongs peculiarly to us, for his talents have been expended on the essentials of modern civilization rather than on the destructive elements of war.

"Honorary membership expresses for the members of our Society the highest gift we can bestow, and we give it to George W: Goethals in recognition of his great work as an engineer and of his fearless execution of duty in carrying the Panama Canal to its completion."

Major-General Goethals, in accepting the honor, said:

"Mr. President, Ladies and Gentlemen: It is generally believed that I built the Panama Canal. That is a mistake. The man who dug it claims to have built it, his successor in office claims to have built it, and I claim to have been one of fifty thousand men who built it. I learned exactly where I came in, in a trip that I took across the Canal in a Panama Railroad train, when a foreman describing the Canal to a visitor led the visitor to understand that he was doing pretty much all of it. The visitor finally turned to him and said, 'What is the old man, as you call him, doing?' The foreman replied, 'Oh, he comes around, and sees us doing it, jollies us a bit, and then goes back and sits in the office and entertains visitors.'

"Those of you who visited the Canal during the construction period must have appreciated the part performed by the mechanical engineers in the machinery that we used for the work, and must have appreciated the mechanical work done in the states in order that we might carry it forward. Those of you who have visited the Canal since its completion, and have seen the satisfactory working of the machinery of the locks, the dredging equipment used in the removal of the slides, and the various other appliances, must have appreciated the work of the mechanical engineers in the designing and construction of that machinery; and, realizing the assistance that they gave in the work, during its constructive period, and appreciating this assistance in its operative period, you may perhaps form some idea of the appreciation I have for the honor that this Society has conferred upon me, by electing me an honorary member, and I want to thank you heartily for this honor."

Spirit of the Annual Meeting

There is one ruling and one central motive which every member of this Society and every citizen of this country should set up, the concentration of intellect, strength, resources and life, if necessary, to a satisfactory ending of this great war.

Mr. Charles T. Main

In the changes that are coming, the engineer can no longer dwell within his technical shell, and he must prepare himself to become a citizen of the world upon whose shoulders great economic and social burdens are placed.

Dr. Ira N. Hollis

If we have not at this moment a clear vision of whither we are tending, now is the time of all times to take stock of ourselves and to redirect our course, whether this course is in conformity with time-honored definitions or not. Change is not necessarily synonymous with progress, but there is no progress without change. No one can doubt that the scientist and the engineer are to be the most important industrial figures of the near future. If we are faithful to our duties we shall be of greater importance politically and socially, but to accomplish this we must broaden our vision and get about our business, which is the industrial organization of our country.

Prof. Dexter S. Kimball

You engineers, all, constitute one of the two professions that are indispensable to the country in the carrying on of the struggle to which the people of the United States are about to devote themselves, yours and the medical profession. . . . the engineer students and the medical students should be required to go on and complete their preparation as engineers and physicians, so that they may become engineers and doctors, and then be gathered into the service of the Government in this war. . . .

Hon. William H. Taft

Address by Ex-President Taft

In introducing Hon. William H. Taft, Ex-President of the United States, who delivered a stirring address on the nation's call to the professional man, published in full in this issue, Dr. Hollis could not resist relating a little personal experience, saying:

"Last year I came to the annual session fresh from a meeting in Worcester, which I attempted to attend with our ex-president, by way of a freight elevator. The elevator went down, not up, and we stuck until we had unloaded a few of the heavy men into a dark cellar. I was there struck with the admirable good nature of this evening's speaker in assisting to tide over the embarrassment of the elevator man, and of his escort to the platform. His wide sympathies cover a vast range, from the administration of a nation's business to the simplest affairs of daily life. He is equally at home with a school boy on the train as with the representative of a great empire. He can say, in the words of Terence, '*Homo sum, et humani a me nil alienum puto*,' a free translation of which: 'I am a man, and nothing that relates to man can be foreign to my heart,' expresses him exactly.

"We welcome him here as one of ourselves, as an agent of mercy in this war, and as the finest example of citizenship in a republic, Mr. William H. Taft."

Before beginning his address, Mr. Taft said: "I find that I have come to the meeting of this Society to hear a good deal that I have to defend myself against. This suggestion that the elevator went down because I was in it is not correct—that

is not the reason — that elevator was in the region where the collegiate institution, that fine school over which your President presides, conducts instruction in the matter of mechanical engineering (loud laughter) — he just had not calculated the load, that was all."

The Engineer and the War

On Wednesday began the professional sessions of the meeting, starting with the all-day war session, at which was given a series of remarkable addresses on the great engineering problems of the war. The opening address by President Hollis on Universal Public Service in Peace and War sounded the keynote. The large audience was responsive to the point of enthusiasm, and reflected the fine spirit of patriotism which was so strongly characteristic of the opening session on the previous evening.

Several of the sessions throughout the convention were inspired by the conditions existing in this time of crisis. In fact, the first meeting, that of the Gage Committee, on Tuesday afternoon, was of this character. Many delegates were in attendance representing departments of the Government, gage manufacturers, manufacturers of munitions in this country and Canada, the Canadian Munitions Board, etc. Questions of the certification of gages and the maintenance of standards in order to promote rapid and accurate manufacturing methods were thoroughly discussed.

One session under the direction of the Sub-Committee on Machine Shop Practice was devoted to the question of Inspection, with particular reference to the manufacture of munitions. Another session dealt with new problems of management incident to the war—namely, the employment of women in the skilled industries, and particularly in machine shops; and the training of crippled soldiers, preparations for which are now being made by the Government, in order that maimed or crippled men returning from the front may continue to be useful, self-supporting elements in society.

Professor Kimball's Address

The character of the whole convention was strikingly summarized by Prof. D. S. Kimball in his address on The Relation of Industrial Management to Engineering, who at the luncheon said that "engineering was broadening to include fields formerly not considered related to the profession, and its ramifications are now so extensive that redefining the aims of the Society would be appropriate."

In speaking of the broadening scope of mechanical engineering, and of engineering in general, Professor Kimball mentioned various subjects which cannot be placed in any definite department, but, nevertheless, must be dealt with by engineers as such. He said he would like to have an inquiry made into the aims and objects of our Society . . . in a statesmanlike manner without reference to persons or groups of persons, but with the sole object of finding out what is best for the Society and what will insure to it an enduring future.

"There will never be a better or more opportune time to consider this subject. Every loyal American is now asking himself what are his duties and responsibilities. Every technical body is facing a reorientation of its purposes and aims. As a nation we are facing a period of self analysis that may result in changing some of our fundamental policies. I am not so sure, for instance, that we shall continue to be a 'refuge for the oppressed of the earth' unless we are quite sure that the aforesaid oppressed are really in pursuit of the liberty and happiness that we all hold so dear. Americanization may indeed be a part of the work of all organized bodies that are interested in the existence of the Republic."

General Sessions

At the Business Meeting, President Hollis's address dealt with the activities of the Society for 1917, and was in the nature of a report. Following it was the presentation by Mr. W. M. McFarland of a bust of Rear-Admiral B. F. Isherwood, late Honorary Member of the Society. Amendments to the Constitution and By-Laws were presented and voted on for issue in letter-ballot, and other business transacted as recounted elsewhere in this number.

Besides these distinctly war sessions there were technical sessions of the usual high order of merit on the Power Plant, Textile Subjects, the Protection of Industrial Workers, and general topics. In fact, there has never been so wide a diversity of subjects discussed at a convention, and subjects of so great importance, as at the meeting just closed.

On Friday the sessions were fittingly brought to a close by the beginning of one of the most important undertakings in the history of the Society. This was the public hearing of the Power Test Committee, attended by official representatives from various engineering societies, college laboratories, governmental departments, railroads and manufacturing firms. The present Power Test Codes of the Society were discussed and suggestions offered for their comprehensive revision.

Entertainment Features

The entertainment features of the convention consisted of a "get-together" meeting for members, at which the members did as they were instructed—forgot the cares of life and joined in general good-fellowship. Past-President John R. Freeman held the interest of the audience by his amusing and enlightening anecdotes of his trip to the Orient last winter. There were other entertaining features provided by the New York Committee. On Thursday evening, Dr. John A. Brashear gave his remarkably fine lecture on the Science of the Beautiful in Commonplace Things, which was followed by a reunion and dance, at which everyone thoroughly enjoyed himself. This lecture was accompanied by many striking demonstrations which appealed strongly to the sense of the beautiful, and which will long be remembered by the large audience of personal friends who greeted "Uncle John." There was also a ladies reception and tea on Wednesday afternoon.

Registration

The total registration was 1965, of which 1115 were members and 850 were guests. This registration exceeded last year's by 88, and was representative of all parts of the country. The national character of the Society, however, was quite as strongly emphasized by the delegates present from the various Local Sections of the Society, of which 19 had representatives in attendance. Important features of the meeting were a Sections' Session, a Sections' luncheon and a Sections' conference.

In this number of The Journal will be found an account of the sessions devoted to subjects relating to the war, including the address by Ex-President Wm. H. Taft; the business transactions; Sections' Sessions, and Entertainment Features. The address by Prof. Kimball and the account of the strictly technical sessions and of the Power Test hearing will be given in the next issue.

ADDRESS OF HON. WM. H. TAFT

Delivered at the Opening Session of the 38th Annual Meeting and Setting Forth to the Professional Men of America What the Country is Fighting For

IT is a great honor and pleasure to be here in this company to take part, if I may so say, in your act of recognition of one of the world-reputed members of the general profession of engineering. Major Goethals, as he was when I first knew him, did build the Panama Canal, whatever he says and whatever he claims. I am able to testify to it, because I was there for eight years and saw him do it, and I know the trouble he had. I know the struggle he had. I know the power of the man in meeting difficulties. I know his tenacity of purpose. I know from its results, not from my professional knowledge, but from its results, his wonderful ability as an engineer in all the fields of engineering, because that task commanded a knowledge of every branch of engineering. I know his power for managing men. I know of his genius of common sense, without which it would have been impossible for him, in face of the difficulties, to discharge the task which he did discharge, and I may say, because an ex-President out of office can say anything—so long as it is truthful—that I am profoundly regretful that the United States and the people of the United States in this great juncture, in this great crisis, have not the benefit of the great ability and great experience of General Goethals. (Loud applause.)

I was a lawyer and I was a Judge, and I was sent to the Philippines. I was sent there—well, I don't know why, but there was more excuse for sending a man there who did not know anything about the subjects with which he was to deal in the Philippine Islands, because there were very few men who did, than there is for putting any man in a position now who does not know a great deal about the subject in respect to which he is to discharge his functions. But, as I say, I went to the Philippines, and while there it fell to my lot to be responsible for some engineering tasks.

We had to do a good deal of engineering in the Philippines, and I came in contact with that very distinguished body of men who have vindicated their existence many a time, and have inspired great confidence in them on the part of the people of the United States—the Engineers of the United States Army (applause), of which General Goethals is a world leader.

And then, when I came here as Secretary of War it fell to my lot to be associated with engineers, civil engineers, who were called in to assist in the determination of a problem that had to be met and solved in the construction of the Canal, and I look back upon my association with men like Alfred Noble; Stearns, of Boston; Freeman, of Providence; Randolph, of Chicago; Parsons, of New York, who is now at the front, and other engineers, with profound satisfaction. (Applause.)

Engineers and Medical Men Indispensable

Now, you engineers, all, constitute one of the two professions that are indispensable to the country in the carrying on of the struggle to which the people of the United States are about to devote themselves, yours and the medical profession; you as the constructors of all the material and all the equipment of which so much is needed now in modern warfare to make effective the work of our boys at the front, and the medical profession to furnish, so far as may be, the aid in restoring to the ranks those whom the fortunes of war disable.

We have a conscription law, which is justified on the ground that it was a selective draft, and we know that under that law those whose services can be most useful to the country in the trenches will be sent over, and those whose services can be most useful to the country in preparing and in saving men and material will be retained in their places at home so that they may not be wasted in the trenches and elsewhere, in which others could do just as good work as they, others who could not discharge the services required of engineers or physicians.

England has, as you know, made mistakes in her great work that she has done. I do not think we have praised England enough. I do not think we realize how much she has really accomplished. But we should profit by the mistakes which England made in allowing her doctors and her medical students, her engineers and her engineer students to go into the ranks and be sacrificed. Because of this, England has reduced the supply of those indispensable persons, so that she is embarrassed, and greatly embarrassed.

Now, my friends, we ought not to make the same mistake. Congress and the Administration should see to it that the medical students and the engineer students should be reserved for the work for which they are particularly fitted; that the engineer students and the medical students should be required to go on and complete their preparation as engineers and physicians, so that they may become engineers and doctors, and then be gathered into the service of the Government in this war to help the Government in those places in which, as I say, they are indispensable. (Applause.)

Now, there has been a difficulty—there seems to have been a fear that temporary exemptions would mean favoritism, and Congress and the Administration have not been as prudent as they should have been with reference to these invaluable agencies which we should make as strong and as full as possible. Congress is now in session, and therefore Congress ought to take steps to give power, if power is lacking, to the Secretary of War, to the Secretary of the Navy, the Secretary of War particularly, to deal with embryo engineers and embryo medical students, so that we may have as many engineers and doctors as we can possibly have, because we shall need them all.

Of course, other professions are helping too, lawyers and ministers, we are likely to have enough of them (laughter)—and I do not see why exemption should be claimed for them—and being a lawyer I can say so. I do not mean to say that lawyers are not patriotic, that lawyers are not being called upon now for gratuitous services which they are rendering in connection with this draft, but I do say that as a permanent thing their services are not likely directly to promote the winning of a battle like Cambrai, whereas the engineers may help; and it thrills one's American heart to know that the members of your profession, now tonight, are engaged in exposing themselves and fighting for the great cause, in which this Republic is so much interested, and to which the greater part of the world is so devoted.

MUST TALK ABOUT THE WAR

I was not quite sure what I ought to talk about when I came here. What I have said up to this point, like the President's few remarks, has not been my speech. One cannot come before an intelligent audience like this and fail to talk about the war. I have talked about the war a good deal in various parts of the country and I have been impressed with the feeling that the war could be talked about a good deal more about the country, throughout the country, to the people of the country, with very great advantage. There are so many who are doubtful they are for the Government and they are for the war, but they are walking interrogation marks as to whether we did not make a mistake here, or did not make a mistake there, or whether we are fully and rightfully in the war, that I think an evangel ought to be preached on the subject to demonstrate that we are rightfully in the war, that we never have done anything that was not justified, and that the cause now presented to us is so righteous that if we are the people we claim to be we must win it if it costs the last man and the last dollar that we have. (Prolonged applause.)

You meet men who are now, after we have decided to go into the war, and after we are in it, who are now "judicially-minded"—that is to say, they do not say they are neutral, but they are judicially-minded. While I am in favor of being judicially-minded, I am not in favor of masquerading under a judicial mind a lack of that fine edge of loyal patriotism that we need to carry this country through the war. (Applause.) I am opposed to apathy; I am in favor of team work, and of knowing why we are in, and what we are going to do, and in favor of being determined to do it. (Applause.)

GERMANY'S BREACHES OF INTERNATIONAL LAW

You will find this judicially-minded person suggest that we were unneutral during the three years that we were not in the war, because we furnished ammunition and other supplies to the Allies. Well, we had a right to do that, under international law. Germany herself had agreed to that rule of international law with respect to the power and duties of neutrals—not that neutral governments could furnish such supplies, but that neutral governments could permit their citizens to do so, the citizens taking the risk of confiscation of those articles as contraband if found upon the high seas. And there were those who sympathized with Germany after the German commercial marine had been driven from the seas, and they said it was unneutral for us to furnish one side.

The fortune of war was not our fault. The President was right in insisting that we should stand by the rule of international law in that regard, because if by our acquiescence the rule of international law were to be changed, requiring every neutral government to suppress its citizens from carrying on such a trade, it would only make overwhelming the advantages of a military nation that devoted itself, as Germany did for fifty years, to getting ready for this war, and which has piled up the ammunition and supplies needed to carry her through years of war. We, if subjected to a war-[illegible], would never be ready. We would always be unprepared, and as a consequence, when forced into war, we would have to look about to prepare suddenly, and then find denied to us the right to get our material and supplies from the citizens of neutral nations, under the new rule suggested. Therefore, it would have been the wildest lunacy for us to consent to a change of international law in that regard, and the merits were wholly with the President in taking that position.

But, notwithstanding the fact that we pursued the path of neutrality as laid down by the law, Germany sank an English commercial liner having three thousand persons on board, and sent to their death 114 American citizens by the murderous torpedo which her submarine hurled at this vessel. Then for a year we continued a discussion, arising from Germany's unfounded claim that the vessel was armed; then she sank another vessel under similar circumstances; then we said that we would sever our relations with Germany; then she said that she would discontinue that method of warfare until further notice; then on the 31st of January last Germany notified us, as she notified the world, that she intended to resume the ruthless submarine warfare; then shortly afterwards we severed our diplomatic relations with Germany; then she sank four or five American vessels, returning to this country in ballast, and sent to their death some twenty-five or thirty American sailors; and then we declared that a state of war existed.

OUR DUTY AS A GOVERNMENT

Now, my friends, is there anything else that we could do but that? That is where your judicially-minded person would come in. The answer to my question depends, first, on the proposition of what were our rights, and what were the rights of our citizens? and secondly, what was our duty as a Government with respect to those rights? International law is indefinite in certain respects, but it is as definite as the law of promissory notes with reference to the rule of the capture of commercial vessels at sea. A belligerent may capture the commercial vessel of its enemy and sink that vessel. It may capture, under certain circumstances, a neutral vessel, violating a blockade, and possibly may sink it, but an incontestible rule for a hundred years has been that that right of capture and right of destruction is subject to one limitation, namely, that the ship's company of the captured vessel shall always be put in a place of safety before the vessel is sunk.

Admiral Semmes in the Civil War sank perhaps four hundred or five hundred vessels of the United States commercial marine, but he prided himself that in all that destruction not one single human life was lost. He was an international lawyer of repute; he was also a naval commander, and his course in that regard is the strongest evidence of what international law is on that point. Therefore, Germany violated the rights of those citizens whom she exposed to death and whom she sent to death. When a man kills another deliberately, without right, it is murder, and there is no other word nor any other term in international law that can be applied to a case where a nation kills men and women and children without right. (Applause.)

GERMANY'S WARNING OF MURDER

Ah, but it is said these people had notice. That distinguished and eminent Christian statesman, Count von Bernstorff, had whispered over the telephone and had intimated very enigmatically that any one who went aboard the Lusitania would run the risk of being torpedoed, and it is stated that those who went down in ships sunk afterward knew that Germany was on the sea with these murderous instruments. Well, that is a fine plea. Suppose a man in New York should warn a neighbor that he could not go down into the street upon which his house abutted, because if he did he would kill

him; and suppose this man who was warned was a courageous American citizen, who knew what his rights were and he went down into the street, and the threatener did kill him. Suppose that man was indicted and haled into court and called upon to plead, and he pleaded "Not guilty" on the ground that he had notified this man that if he would come down into the street he would kill him, and therefore he was not guilty because the man himself was guilty of contributory negligence in running into a bullet whose presence he ought to have anticipated on the street. (Applause.)

But Senator La Follette says—(hisses on the part of some persons in the audience), oh, don't hiss, it never helps to call names, no matter how poor an opinion you have of a man, it does not help the argument—but Senator La Follette says it is true they had the right to be where they were, but those were technical rights. It is too bad when a senator in Congress, sworn to obey the Constitution, should regard the right of those poor victims on board the Lusitania to life and the right to protection against the invasion of a murderous nation as a technical right.

What Was Our Duty?

We will now assume, therefore, that this was murder of our citizens. What was our duty? The Constitution as interpreted by the Supreme Court, indeed our general knowledge of government, would teach us that while we owe service, military and civil, to the Government, the Government owes us as a primary consideration, protection. Government is nothing but a partnership in which we are all members, and we all agree to contribute to the objects of a partnership by service; and then the partnership is to help us in enabling us to enjoy our rights. Therefore, when these citizens were actually deprived of their rights, why, it is very plain that it was the business of the Government to call for reparation in respect to those whose rights had been taken away, and security and an announcement of the policy which would prevent subsequent interference with similar rights of our citizens. Otherwise, if not, then we ought to go out of the government business, because that is the object of government.

Now, Germany announced that she not only justified what she had done, but intended to continue to murder our citizens on the high seas. Our citizens are entitled to the protection of the Government at home and on the high seas, and abroad. Abroad there is some qualification, because they voluntarily submit to another jurisdiction, but on the high seas, on an American vessel, and under an American flag, on that great road of the nations, they are just as much within the jurisdiction and within the protection of the Government at home as if they stood on the shores of New York, or Massachusetts, or New Jersey, and an invasion of their rights on the high seas by a foreign government is just as much an invasion as if Germany had landed a Uhlan regiment on our shores and shot into the homes of American citizens and killed them.

Therefore, if we were to continue business as a government, there was nothing else for us to do—Germany did not leave it open—except to measure swords with her in protection of those rights. If this act had been committed by Venezuela or Costa Rica, if either of those countries had sunk an American ship with a loss of one hundred lives, the President would have promptly sent a message demanding reparation and security against further invasion, and might have sent a warship down to convey the message, just by way of suggestion, and every man, woman and child, Senator La Follette, and every pacifist, would have said, "Well done." Well, now, what is the difference between that case and the one we are considering? There is not any in principle, but there is this real difference, that Germany is the greatest military power in the world, and Venezuela is not, and therefore we are very urgently and strongly in favor of the protection of the rights of American citizens when invaded by a foreign country, provided the country is little enough, but when it is a great power—the greatest military power—then the rights are "technical." (Applause.)

Oh, my friends, there was not anything for us to do except to declare war, and a pacifist or anyone else who says otherwise or intimates otherwise, does not understand. The President has set a precedent by calling them stupid, and, after such an authority, I am willing to say I agree.

Now that brought us into the war, but when we got into the war we found what possibly we ought to have known before—some did know—that the particular cause which brought us in was only a phase of the far greater cause which the Allies were engaged in fighting. We found ourselves in the beginning ranged with democracies against autocracies. I know that our judically-minded friend will suggest that England is a monarchy and so is Italy. Yes, that is true, but a democracy is a country in which the people rule, in which the policies of the government are determined by the popular will. The proof of the pudding is in the eating of it. Any one who knows anything about England and Italy cannot say otherwise than that the people rule in these countries, and where that is the case they are democracies. Where that is the case, the question of kings is only a question of taste. As a matter of fact, the King of Italy and the King of Great Britain have not any more to do in determining acute questions of the policies of their respective countries than an ex-President of the United States has. (Applause.)

The Meaning of Democracy

Now, the President has said that we are fighting this war to make the world safe for democracy. That is a truly exact statement. But it has been misconstrued. It does not mean that we are to force democracy on other countries, that we claim to have a patent for our form of government that we are going to drive down the throats of other people. That is not what it means. It only means that the power of a people with a military and foreign policy such as that of the Imperial German Empire, is dangerous to the continued and safe existence of smaller and less powerful countries that desire to have democracies and to work out the happiness of their people through that kind of government. That is what it means.

We Must Understand German Character

We cannot understand the issues at stake without understanding the character of the German people. We cannot understand their character without following their training in the last fifty or sixty years. We all have known Germans. We have liked them. When in Germany we have enjoyed seeing them. They are a kindly people; at least they were some years ago when I visited Germany. They are a kindly people, who love their homes, they love their families, they love music and they love poetry, of which they have some of the greatest exponents in the world. They conform to authority with a kind of pleasure. They are an intellectual people, they are an earnest people, a little lacking in a sense of humor, but a great people, people capable of great effort.

The truth is, while I have a profound admiration for the

English people and the history of England, because having been educated as a lawyer I believe she laid the foundations of true constitutional liberty, nevertheless, I am bound to say that when I went to Europe and traveled in Europe, I would a great deal rather be closed up in a railway carriage with a German than with an Englishman; because the Englishman—I mean the regular Englishman—was constantly engaged in an affirmative effort to convince me that he did not know I was in the carriage, whereas the German was always courteous and friendly and anxious to engage in conversation.

Some Glances at German History

The Germans for a long time were divided into twenty-eight different States, Austria the greatest of them, Prussia the next, and twenty-six others, and every one who longed for an improvement in the world, and an improvement among the Germans, wished for unity among them. There were liberty-loving Germans, and in '48 they rebelled against the Divine Right of Kings, and they had revolutions. They were not successful. They did get a constitutional monarchy for a little while in Prussia, and offered the crown to Frederick William, the great-uncle of the present Emperor, and he said he would not take it, because he got it from God, and did not purpose to take it back again out of the mud, showing that the Divine Right of Kings came honestly down that line to its present exponent.

A large number of these liberty-loving Germans were driven out of Germany and came to this country, and made one of the most valuable elements of our citizenship here (applause), and when the Civil War came on, loving liberty as they did and hating slavery, they went into the war, enlisted in great numbers, and on every battlefield in that war the blood of our German citizens was shed.

Their descendants and others who have come here since have continued to make a valuable part of our citizenship, and during these three years when we were neutral they have naturally, because of their pride in the success and prosperity of their brethren at home, had a sympathy with Germany and listened to the arguments in her behalf which have been put forth in this war. And now the war between America and Germany has come on, and their allegiance requires them to be loyal, and they are put in a sad position, and one in respect to which we should be considerate of them. But they are loyal, they have enlisted, they have gone into the draft, and contributed to the great patriotic funds; and while they are not vociferous—we could hardly expect them to be so—that they are going to be loyal I have not the slightest doubt (applause), and one of the things we ought to be most thankful for is that very thing. The reason why Germany treated us as she did was because she counted on dissension among our people, growing out of the disloyalty of that very element, and she has been disappointed in that regard as she has been disappointed in so many of those instances where she has attempted to read the motives of other people.

Instead of founding a constitutional monarchy, with representative institutions, and bringing about unity, as those leaders of German thought, Carl Schurz and others hoped for, there came into the history of Germany a very different individual, Prince von Bismarck, who was the Premier of Prussia in 1862. His theory was that he would conquer and unite the German nation by blood and iron, and he developed the army, always a well-controlled body in Prussia, and he made the nation into an army, and an army into the nation, and then he planned the wars upon which he founded the unity of Germany. He became involved in a quarrel with Denmark, and induced Austria to go in with him, and took away Schleswig-Holstein from Denmark; and then when he got it, he found it was so easy that he annexed it forcibly to Prussia; and when Austria asked, in a diplomatic way, just what there had been in that war for her, he said there was not anything. And then he got into war with Austria, as he had intended, and in six weeks he wiped her off the map of Germany. Then in that war he annexed forcibly Hanover and Frankfort, and made an offensive and defensive alliance with Württemberg, and Baden, and several other German countries; and then he sat down to wait until that fakir, Napoleon III, in his pirouetting, would bring about an appearance of a war of aggression against Germany, which was exactly what Bismarck was waiting for, and he only had to wait four years for that; and if you will read his memoirs you will see how he brought that about. You will be interested in reading, I am sure, that interview between himself and von Roon and von Moltke. They received a telegram from the Emperor outlining an interview between him and Beneditti, Napoleon's Ambassador, and they were thrown into gloom, because the interview was one which seemed so pacific to them that they thought its publication would prevent war; and Bismarck sat down and, without changing the body of the message, changed a few words in it and published it; and then von Moltke said—"Now we will have war." He said—"That telegram, when it came, sounded like a parley. As you have changed it, it sounds like the rattle of a drum." This was stated by Bismarck himself. So, true to his plan, Napoleon declared war, and then, in a short time, Bismarck defeated France and took Alsace-Lorraine and an indemnity of a billion dollars, which the Germans put into the army, and Bismarck crowned a Prussian King Emperor of Germany at Versailles, and he went back to Berlin and sat down as the head of the Empire to digest the pieces of territory he had bitten off in the last three wars.

Bismarck's Seeds of Kultur

He was not in favor of world dominion. He wanted to raise Germany to a great power in Europe, and he succeeded. He made fun of the ideal of world dominion, but there was held out to the German people the idea that all the rest of the world would try to get back from them this territory which had been taken, and therefore they must defend themselves, and so they went on and provided greater and greater armies.

They also adopted in their wonderful way, as you gentlemen of science know, the principles of science to the manufacture of everything, and to every field of industry and business. They introduced a system which they called Kultur, and which brought about a prosperity in competition with the world that attracted the admiration of the world. Their population increased and pressed upon their borders, and with their marvelous successes in the three wars, with their wonderful administration and the demonstration of their efficiency in their prosperity, and with their increase of population, they acquired megalomania, and they learned to think that they were supermen. They believed they had invented Kultur, and it was their duty to spread it over the world and enlarge their borders and conquer the world for the purpose of spreading that Kultur.

And they soon, by reason of their elevation as a people, associated themselves with God. They regarded themselves as the agents of God. They are a people of an inexorable logic. If they begin with a false premise, as they often do, their confidence in logic is such that they wipe out any fact

that is inconsistent with the conclusion reached by that logic. You remember the story of the old German who was in the California gold diggings and met a man out there whom he had seen only recently in New York; and anxious to find out how he had gotten there he asked: "You came the plains across?" The man replied, "No." "Then you have come the Isthmus over?" "No." "Oh, then you come the Straits of Magellan through?" "No." "Oh, I see, you were seasick coming the Horn around?" The man replied, "No," and then the German's eyes opened and he looked at the man for a minute and he said: "Well, then, you have not arrived!" (Laughter and applause.)

Having established that Kultur was necessary for the world, and that they had invented it, they believed that they were the people to spread it; and then, with that inexorable logic, all of these other conclusions followed. The State, the German State, was to spread Kultur. It was to do God's work. Therefore, every consideration must yield to the doing of that work. The State was above everything. The State, engaged in this work, could do no wrong. Therefore, these considerations of honor and decency, and the performance of obligation, could play no part. International morality was eliminated. The only sin of a State was weakness; its virtue was power. And that doctrine, or its elements, the idea that Germany was over all, was preached in the schools, in the academies, in the universities, by the great lecturers, by the military writers; and the conviction grew with the people, first, that they must protect and defend themselves and give everything to the Army necessary to accomplish that, and, secondly, that they must base their State on force and maintain that force in order that they should spread Kultur to the world by domination and conquest. They eliminated, as I say, international morality.

Now, that is the nation and that is the people that we are engaged in fighting. They are obsessed as with insanity, otherwise you cannot explain what you see and read and know. "Why is it," you ask, "we did not know this before we got into the war?" Well, we read excerpts from the lectures and military writings, but we have cranks of our own—I need not mention them—but certainly we do not want to be held responsible for their writings and their statements and their actions, and we assumed that these people, thus speaking among the Germans, belonged to that necessary and conspicuous, but we hope with us unimportant, element. But it was not so in the case of Germany, and you can read now the books that have been prepared impartially showing these sermons and lectures, and showing that these lectures spoke for all the people. Consider, for a moment, that there was a writer who in one of his writings incorporated a prayer like this:

> Oh, Thou, who presides over all, up above, high in the skies, up above the Cherubim and Seraphim—and the Zeppelins—

Now, that association, if it did not shock your feelings as irreverent, would suggest a humorous view; but to the German mind, with the idea of what the zeppelin was do to in spreading Kultur, it was the agency of God; the association between the cherubim and seraphim, which are supposed to be God's agents, with the zeppelins, was entirely proper. They preached sermons on the German God.

We Are Fighting the German People

It is the people of Germany we are fighting, with the characteristic they have of subordination to the authority of the Prussian military regime and the Kaiser, and we must not assume they are compelled against their will to do this fighting. They have made too many heroic sacrifices in loyalty to this false idea, and in loyalty to the leadership of the Kaiser, and therefore what the President says must not be misconstrued. What we are trying to do is to separate the people of Germany from the rulers of Germany, but the only way we can separate them from their rulers is by hitting them on the head with a club so that the psychology of the situation will be brought home to them. (Great and prolonged applause.)

If you look for proof of this position of Germany with reference to the abolition of international morality you can find it in their method of warfare. I do not think it necessary to go into a detail recital of the awful atrocities that have been proven before you can arrive at a general conclusion as to their violation of every rule of warfare. They bombarded unfortified towns, an act which is forbidden by international law, and the men who bombarded these unfortified towns on the east Coast of England were rewarded by being decorated with the Iron Cross.

The Hague Conference provided certain rules with respect to the carrying on of war by means of aircraft, one of which was that belligerents were not to drop explosives from aircrafts on undefended towns; and the Germans promptly sent their zeppelins, that were assembled for the purpose of carrying on war, and to which they turned for the purpose of carrying on the war, and they sent these zeppelins to England and slaughtered innocent non-combatants. Of the thousands of victims of the zeppelin raids, possibly not more than fifty soldiers and sailors were hit, and only one or two arsenals, but the great body of the victims is composed of women and children, and old men. The men who navigated the zeppelins in these air raids were also rewarded with Iron Crosses.

The Path of Kultur

When the Germans entered Belgium they violated their treaties through which they had given their plighted faith for sixty years with the other nations. You would think, when they went into Belgium, under those circumstances, they would treat the people with some consideration, even in spite of their obsession. Did they? No. What they did was to take a district in Belgium and direct their soldiers to pursue the policy of Schrecklichkeit, that is, to stand up against a wall the leading citizens and shoot them, as well as the women and children. You ask for proof? Well, read the report of Lord Bryce. He is a lawyer, an able lawyer, and an historian, and he was on the Committee with other lawyers and Judges, and they took the evidence and dissected it and analyzed it. They rejected all the evidence as to the sporadic brutalities by soldiery which you encounter in every war, and took only the evidence of cases that could not have been committed except by the order of officers, and they showed that this was part of the military policy of Germany in terrorizing the rest of the innocent Belgians by such cruel atrocities in respect to the families of this particular little district.

But the worst thing they have done has been with respect to Armenia. When England brought over the Indian troops to help that small regular army of hers, and they came and made good soldiers, showing they had been well treated, the Germans held up their hands in holy horror and said, "They are sending Mohammedans to fight Christians," all the time having that eminently Christian Monarch, the Sultan of

Turkey, in alliance with them. And after the alliance was secure, then Turkey proceeded to carry out a purpose that she had partially attempted to carry out years before in ridding herself of Armenian Christians in her Empire. She proceeded, with Germany looking on, and with officers of the German Army at hand, through her regular soldiery and her irregular soldiery, to murder eight hundred thousand Armenians because they were Christians. Now, that is an evidence of the false philosophy, the horrid philosophy, that there is no international morality, and that nothing should stand in the way of military success and the advance of the State in the spread of kultur.

That is the kind of enemy we have to fight. That is the psychological state of the German people, and the only way in which we can change it, as I say, is by defeating them. If we defeat them, then they will appreciate the falseness of a philosophy which can only be justified by victory, and then when they are defeated, as we must defeat them, then they will relegate the Kaiser—it will not need any action on our part—they will relegate the Kaiser and the Prussian military regime to the place where they ought to go. (Applause.)

It is a very satisfactory thing to see that the sin of the Germans in this regard has found them out. When the war began, good Christians hesitated about believing in a good God, when they saw that so many innocent men could be hurled into a vortex of destruction, agony, suffering and death like this. Now the thing is cleared away, and what we see is that the world has been suffering from a cancer of militarism, and Germany has been responsible for it, and she has led the world on to these great armies, and on her hands is the blood of this awful war—this war with fifteen or twenty times the number of men engaged in it, and with an equally increased amount of suffering and agony, compared with any other war—with 40,000,000 men engaged, 7,000,000 men dead, 6,000,000 men in the hospitals, and 6,000,000 men in prison camps. That is due to Germany. The causes cannot be cut out but by suffering. God works by inexorable laws, and the penalty of sin must be paid.

This is a German war of aggression as any schoolboy can now see. The White Paper did not show any communications between Germany and Austria during that anxious time, and they have never been disclosed, but we know now that Russia was not prepared, and England not any more prepared than we are today, and France was very lacking in her preparation, and yet we are to believe that these three countries conspired to attack Germany who was ready to the last cannon and the last reservist. Why, that is enough to make a horse laugh. It is true that Germany did not advise the killing of the Crown Prince and his Consort. That is not the way Germany has begun her wars. She gets ready. She plans a war. She gets ready, and then she waits for the opportunity so that it shall seem to be a war of aggression by other powers. That is true in every war she has waged since Prussia has been in power.

Germany's Woeful Blunders

So to go back to this sin of Germany finding her out. She has been perfect in military preparation; she has been perfect in military strategy, but where has she made her blunders? She has made her blunders, and her great blunders, in misreading other peoples, in her diplomacy, and she has made these blunders because she has eliminated from her own soul considerations of morality and motives of good, motives of service and allegiance and unselfishness, and therefore she has eliminated those from her judgment when she goes to judge of what other people will do. So she made a mistake about Great Britain, and her conscience in respect to Belgium. She made a mistake as to the British possessions—I mean those independent dominions—she said, "The tie which binds the dominions to the mother country is very light. There is no reason why they should go in, there is nothing in it for them," and she was indignant and exasperated when she found that her judgment in that regard was wrong. That is because she could not appreciate the filial relation between those countries and Great Britain. She could not appreciate the daughter's loyalty to her mother that had protected her. Is there anything more noble in this world war than the way in which Canada and Australia have responded to the call of the mother country? Canada has sent 420,000 men, and Australia 400,000 men, Australia having a population of five millions and Canada six or seven millions. In proportion, we would have to send an army of seven millions. And then France. Germany said France was decadent, permeated with socialism, no patriotism, and deeply affected with frivolity. France was not prepared, but she rallied her legions, and is it not inspiring to think of the fight that she made, knowing that the German military staff was attempting to crush France first, and she stood up, and with that thin line of the British regular Army, she hurled back the German hordes at the Marne and saved the world. (Great applause.)

The biggest mistake she has made has been with respect to this country. I remember some of the things the papers said—they said we were a tangoing nation. They said we were too fat to go into the trenches. They had a contempt for us because we had not prepared for war. They assumed our citizenship of German origin would prevent the war, and political considerations would divide the people in that regard. They were also obsessed with the idea that they could end the war with this murderous weapon, this weapon they could not use except by accompanying its use with the murder of neutral people. So they went in.

Now, ten, fifteen or twenty years hence, when our grandchildren go to their fathers, after having read a history of this war, they will say—"Papa, why in the name of common sense did Germany force the United States into this war?" And papa will have a hard time to tell, unless he goes into all of the circumstances and treats the subject from a psychological standpoint, because the boy will say, any child would say—"Why they had been fighting this war for three years, exhausting as no other war has been before, so that they were all not exhausted, but nearly so, and at that time they deliberately forced into the war against them that gigantic young nation that could furnish what is absolutely necessary, and what must determine victory in the war, more food, more money, more fighting men than any nation in the world."

Now, that is what they have done, and nothing can explain it except the obsession that I have referred to—their failure to see things in other people, because they have eliminated from their own consideration those moral motives. Now what are we going to do about it? I have said, potentially, we are the greatest power in the world. We are a potential military power, and we have got to make that thing which is potential actual, and that is no mean job. We have before us a war of two, three or four years. We have got to raise an army of five million or seven million, or possibly more. It is man-power that is going to win this war. Russia has become a pulpy mass, and it has got to work out its own salvation. There is one feature about that situation, and that is that the

Germans will not know any more about what is going to happen in Russia than we do, but it is going to enable the Germans to bring back, doubtless, many of her divisions to the Western front; and we must fight the war out on the Western front, and it may be that the Western front will reach from the North Sea to the Adriatic. We have got to furnish to our Allies not only food, not only money, but we have got to furnish them the man-power that will give a predominance that will win this war. We have got to wear them out, it may be by attrition, as Grant wore Lee out, but we have got to do it, because civilization depends upon it, because our own independence depends upon it. The war is not in our souls yet, not as it will be when our boys are shot down, and when we consult the casualty lists to see whether those dear to us have suffered. One of the great satisfactions is that when we are in it, when we meet disaster, as we are going to meet disaster, and we find there have been blunders, as there will be blunders—but from these blunders and from these disasters the American people are so constituted, with their inherited traits, that those disasters and blunders and defeats and humiliations will only make us stronger to carry out the struggle that is essential to liberty and Christian civilization. (Loud applause.)

KEYNOTE SESSION

An All-Day Meeting on the Service of the Engineer to the Public in Times of Crises, with a Series of Addresses on Great Engineering Problems of the War

THE topic now uppermost in the minds of everyone, and engineers in particular—the war—served as the basis for an all-day session in the Auditorium on Wednesday, December 5, which attracted large and deeply attentive audiences both in the morning and afternoon.

Promptly at the opening hour, President Hollis, after a few preliminary remarks, called Vice-President Charles H. Benjamin to the chair and then launched into his stirring opening address on Universal Public Service in Peace and War, in which he sounded the keynote of the day's discussions in his illuminating development of the thesis that training for citizenship is the safeguard of democracy, and emphasized the relations and duties of the engineer to the state in the present great emergency. Four additional addresses were delivered before the luncheon intermission, as follows:

The Engineering Societies in the National Defense, Gano Dunn.
Special Education in Time of War, Dr. Charles S. Howe.
Engineering Research, C. E. Skinner.
The Agricultural Problem, L. H. Bailey.

The afternoon session began promptly at 2 p. m., Vice-President Charles T. Plunkett officiating as chairman on the invitation of President Hollis. Five addresses were delivered at this session, namely:

The Fuel Problem, Prof. L. P. Breckenridge.
Motor Transportation, William P. Kennedy.
Army Transportation, Major L. B. Moody.
The Aircraft Problem, Prof. W. F. Durand.
The Solution of the Cantonment Construction Problem, Leonard Metcalf.

The texts of these ten addresses immediately follow.

UNIVERSAL PUBLIC SERVICE IN PEACE AND WAR

By DR. IRA N. HOLLIS, WORCESTER, MASS.

OUR profession has long been classed as one concerned only with the application of science. It covers a very wide range reaching, on the one hand, from invention and construction that affect the whole history of this race, on the other hand, to the little things that add only to convenience and comfort in our daily lives. Transportation, for instance, in opening to every nation the products of all others, and in permitting the ready ebb and flow of travel, has had a profound influence upon industry and upon the world outlook of men. Our thoughts have sprung beyond national barriers. This war is a temporary setback, but we shall come out of it stronger than ever for human brotherhood.

In the changes that are coming, the engineer can no longer dwell within his technical shell and he must prepare himself to become a citizen of the world upon whose shoulders great economic and social burdens are placed. He must study history, the science of government, and the problems of labor, that he may grow to the maximum of his possibilities. His training has fitted him for anything, providing he does not stop all the humanities after leaving college. His work will be better done for conscientious performance of civic duties and, if thereby he is drawn away from technicalities, his education will have justified itself. At this time there is nothing more important to him than a clarification of his thoughts on government and public service. He cannot afford to remain outside the life of the nation, and he must exert himself to do and to know. For that reason, it is a happy thought on the part of the Meetings Committee to set apart this day for public questions. The first thing in any discussion is a courageous look into our shortcomings as a nation. We have the faults of youth, not because our form of government is inferior, but because it is superior. We impose only as much government on the individual as is absolutely necessary to hold society together.

The great difference between the Allies and the Central Powers lies in the attitude of the individual toward the state. Two conceptions are found in modern times; one springing out of Rousseau's revolutionary doctrine that government is derived from the consent of the governed, and the other from the ancient divine right, under which the governed derive their privileges from the consent of a ruling class, or of a crowned head.

In the first case, society regulates itself and the state is wholly a possession of individual citizens. In the second case, society is regulated by those set above, and the individual belongs entirely to the state, in whose service anything may become justified. These two ideas lead to characteristic failure when carried to extremes: as, for instance, in a democracy, liberty unchecked by public opinion is likely to become license, and freedom may mean simply the power to do as the individual pleases, without reference to the common welfare; equality would be nothing but a dead level of property under this theory that would render democracy the most oppressive socialism. In an autocracy, the individual, as the

property of the state, may become a murderer, a liar, a thief, and the lowest of conspirators without loss of station, provided his deviltry is committed at the behest of the ruling power. Secret diplomacy against the well being of other states will always flourish under a military autocracy.

In the first of these cases you have the destruction of individual conscience as related to the state; in the other, the complete breakdown of national morality in relation to the world. We have these two extremes at the present time side by side in Europe: Prussia with the unbridled license of the ruling classes to do evil, that their good may spring from it, and Russia with a complete collapse of state morality in the hands of ignorant socialism.

Training for Public Office

Extremes in government are always wrong, and wise men have studied for ages how to check that tendency. It is perhaps the most important problem that we have in our own country, where every individual can express his views freely without fear of being arrested for adverse criticism against a dynasty. Every public officer is a public possession, and can be dissected without any hindrance on the part of the law. This implies for success in government a self-control that comes only with training, and the American people may well pause to think more seriously about training for public office and for citizenship in a democracy. We have had very loose views on this subject ever since the formation of the Republic. Anyone may be put into any office on the principle that American common-sense will somehow muddle through. Hence this subject is more than timely. It is the psychological moment when all people, especially the engineers, should strike a good blow toward the education of men and women for service under the state, and for that kind of self-control and sacrifice that produces efficiency in a republic.

As a matter of fact, this whole subject is of vastly greater importance at this session of The American Society of Mechanical Engineers than any technical or professional paper could possibly be. While a single invention may often change the whole course of human history, the freedom of man for his own development is so dependent upon his training, or education, that we as engineers ought now to turn our minds entirely away from technicalities of science to the fundamental rules upon which all society must be based. We are citizens first, and engineers afterwards, and while we know that the externals of civilization have only kept pace with the progress of our profession, we know also that the spiritual side of man's nature is a development of the geologic ages. Short periods of history disclose relatively little change. During nineteen hundred years of great material growth, humanity as a whole has not taken a single step toward the realization of human brotherhood, except, perhaps, in the surrender of legal ownership in slaves. The mechanic who works for us lives in a style that a monarch of the middle ages might have envied. A traveler four thousand years ago coming out from Egypt would have written a book about his adventures in crossing the little arm of the Mediterranean, called in ancient times the Syrian Sea. But we moderns have many in America who consider a journey around the world only an event worthy of an evening's conversation with a few friends. Through engineering we know the world and every corner of it, as our grandfathers could not have known it. We know how nation has come to be dependent upon nation. Yet ethically we are still as blind as the money changers who were driven from the temple by Jesus Christ, and we are fighting the most horrible war in all history.

Engineer's Task in War

Every war has its roots deep down in the history of the race, and it is often very difficult to trace the causes. In our Spanish War the immediate cause, or the immediate event, that brought about the war, was the sinking of the *Maine* in Havana Harbor under circumstances that seemed to put the responsibility on the Spaniards. The real basis of the war dated back for generations, and was only the result of many struggles against the autocratic power of a nation exploiting American colonies for its own benefit, without any reference to the good of those who were exploited. This war too is the result of great forces that seem always to have existed. It is made more horrible by the inventions that began with James Watt's improvement of the steam engine into a workable machine. While it is not caused by the work of the engineer, it is essentially an engineer's war, in the respect that it uses all of his talent toward making the war more terrible. It is the culmination of the century of invention that followed Watt, and represents a struggle between those who have deliberately conspired to make use of all human resources and invention for securing dominion over the world, and those who believe that man advances in true happiness under individual freedom far better than under the direction of autocracy.

It is our task as engineers to assist in making the world safe against the forces that we have unloosened, so that the century may not close with a total failure of the civilization of Christian races. It is we who have developed the applications of science, and it is we who are using it to destroy one another, forced into the struggle by the rulers of a nation that knows no right except might, and no mercy except that which is taught them by the sword. Our great problem will be, not how to develop further, but how to tame what we have. Unless some conscience is aroused that science is not to be used against man, but for him, then it will never be safe for this world. It will always be an explosive ready to go off and destroy. The poisoning of wells is nothing beside the reversal of preventive medicine into a destructive agency. Every practical invention can be turned into evil for destroying the white races in favor of the yellow and black men, who have no science.

Best Training is Educated Conscience

We as engineers must take our share in quickening the conscience of the American people toward the danger of unlimited, unchecked forces, and in preaching night and day the importance of an educated conscience. That is, after all, the most effective training for public service, and the best antidote against the unholy advance of scientific brutality.

It is a curious thing that James Watt should have been prevented from practising a trade that he had learned in London by the trade guilds of Glasgow. The potent influence over his life and over human history sprang out of his having been driven to take refuge in a university as mathematical instrument maker, where he was called upon to do all kinds of odd jobs in connection with a physical laboratory. By a strange irony he improved the steam engine and thereby let loose the forces of labor-saving against the trade unions, thus creating problems infinitely more difficult than anything connected with labor a century and a half ago.

In what respect is democracy to be preferred to an autocracy which safeguards the material welfare of its citizens, and provides through state regulation for their comfort? That question is an important one before the American people, and we

should study it in order to understand and buttress our own institutions. Our education has taught us that there is only one answer, and we believe that science is safe only in a democracy such as ours.

Efficiency has come to mean something new to us, and by it we can make an adequate comparison between the two forms of government, but we must take efficiency in the most comprehensive sense of the word. It is nothing to mankind if by reducing the labor required to produce the necessities of life, it simply enables a country to support a larger population. The thing worth while is righteousness and satisfaction in our lives, not a larger number of human beings on this planet. One can express but little sympathy with certain exaggerated notions about race suicide. There is no such thing. There is an ebb and flow and a divine law under which some families gradually die out and others come up to the great places of the world. Race suicide, if it existed, would be found in unsanitary conditions of life and in the recklessness by which children are often born into the world.

The best definition of efficiency, if it is to be used as a measure of civilization, has an ethical as well as a material sense. Germany has undoubtedly made an enormous advance in material wealth and in the applications of science. Her ruling classes have also provided for the welfare of the masses, perhaps better than any other nation. It is the concession that they had to make in order to keep a large population contented with their lot. That is their share in the government. But Germany is not efficient in the best sense of the word. Her scholars and her statesmen have betrayed her. One has only to read the paper signed by a number of professors to reach the conclusion that there is too much professor in Germany and too little humanity. The world has been hypnotized up to within a very recent period by Germany's own claim of preëminence and the shock of this war's disclosure is as much a sense of disappointment as it is a revulsion against the professors' claims.

Some Woeful German Weaknesses

Germany is not efficient in her relations with other nations. She is not even efficient in her spy system, for her spies are but children in the hands of Americans. Germany is not even efficient in her science and literature. She is woefully behind the English and the French, except in those applications that bring wealth and power.

In some article President Eliot has well stated what he calls "the precious lesson of the war." "Toward every kind of national efficiency, discipline is good and coöperation is good; but for the highest efficiency, both should be consented to in liberty." We are now going to prove this with the blood of our sons, and unless we succeed against Prussia our constitution will be subject to modification, and we must begin again, like Sisyphus, to roll the rock up the hill in the hope that next time it will not slip away from us to roll back.

A power of initiative in a free government and a power of initiative of its citizens is certain, in the long run, to triumph over a national organization created by a few who have carefully directed the thoughts of the masses. If we put Kaiser Wilhelm alongside of Abraham Lincoln, we see in his royal person only a belated barbarian come back out of a shuddering past to destroy all that humanity has gained in the fight against slavery. We know that the heart of man beats for the freedom of the individual, and that only the drum beats for the divine right of kings. Not one word that Lincoln has uttered is false to the doctrine of Christ. Scarcely one thing of the Kaiser's might not have been said by a heathen king. The whole Christian religion is based on the right of the individual to a life of his own, subject to a true adjustment to the Almighty's laws. Democracy is a final form of government. It may have its failures, and if it fails now it will come again and again until the whole earth is freed from the privilege by birth and the rule of a few.

What Americans Also Lack

All preparation for public service must be based upon a foundation of good citizenship in our whole country, if our officials are to serve well in this republic. A human pyramid can be formed only with strong men at the bottom, and no first-rate public service can ever be built up on a flabby, careless attitude toward civic duties. America is young yet. It is like a boy who has grown far too rapidly, loose-jointed and tall, with unlimited possibilities after his frame shall have been knit into a solid mass. One hundred and twenty-eight years is not enough to bring a nation to its majority, especially one made up of such diverse elements as ours, the dumping ground of all the world for the oppressed and the poor.

Our neighborhood and our international ideals are sound. They are found in the Bible. At the same time we lack cohesion and public conscience in relation to our own Government. Every individual must be regarded as part of the public service, and the first thing he must acquire, whether he be native born or immigrant, is public conscience. In some way the ordinary citizen too often argues that because this is a government by the people and for the people the state owes him something. In that respect, our patriotism is in part a sham, and we have plenty of evidence to prove it. A considerable fraction of the annual appropriation in Congress is the result of a trade among localities, each of which wants something out of the general treasury. The pension bills have been only too often the sop for voters, and capital and labor have already shown us more than once how little they care for the great mass of people whom they class as the public. In the lynching of criminals, and sometimes of innocent people, we find nothing but a total disregard for the good name of the state. These are our failures and we must get rid of them, in order that the beauty of democracy may not be hidden beneath its excrescences. In the matter of public conscience we need a religious revival, and the churches ought to take a share in this. It is their task, as well as ours, to lift this side of our national life.

Elements of American Citizenship

The first demand of our republic is, then, an educated public conscience. No man should expect more from his country than he is willing to give it. Those who whine about injustice in modern society are usually getting about what they deserve.

The second demand on every citizen should be a knowledge of our institutions and the method of government. It goes without saying that the English language is an absolutely essential foundation for this. Most failures in citizenship proceed from ignorance and carelessness, rather than from viciousness. The normal American is right-minded and is morally upright, but slack in his responsibilities to the public. The moonshiner in the Cumberlands makes whiskey because he neither knows his relation to the body politic, nor the evil effects of drink. His whole conception of government makes it something separate and apart from himself, an attitude of mind that, if carried to its logical conclusion, breaks down all government and ends in the ghastly travesty set up by the ignorant peasants and workingmen of Russia under the cor-

rupting influence of the German and of money. The first thing to learn is that freedom does not mean emancipation from all responsibility to others. It means the self-control that permits reasonable surrender to the needs of all men. War has given America the dim vision of a new freedom. In the fall of 1914 no one would have thought it in any way akin to our Civil War, and yet we see it now in its true perspective as the great struggle for freedom, as the struggle for the union of all nations, so that war may never come again. Yet we must have no illusions. Rousseau's doctrine, that man is born free, is false unless the word free is defined in some better sense than that in the dictionary. Men are never free. From the cradle to the grave they have to yield, and every individual lacks freedom in just the proportion in which he has to learn to live with other people. He must think of the wishes and the interests of others. When he has learned how to surrender himself and has learned obedience to the law, then he is truly free. Freedom is no more a natural inheritance than flying or riding a bicycle, but it must be learned if it is to be of any value in a republic. It demands training, hard discipline, self-sacrifice in daily life, especially on the part of those who are chosen to transact the great business of the nation and to lead in the maintenance of our democratic government.

Another much misunderstood word is equality. In its distorted sense, it has encouraged that fatal kind of socialism that would permit no individual to stand out from his fellows in mental or material possessions, and it would eventually kill any form of government; for a nation grows great only on its inequalities, if they be not the type that set up false standards and destroy the soul. The true application of the word is found in opportunity. We are equal, and we ought to be equal as to the opportunity to make ourselves mentally and morally superior. We glory in the greatness and superiority of Abraham Lincoln, and in that equality of opportunity that permitted him to go from a log cabin to the White House. Our most important lesson, then, in connection with American institutions, is the meaning of the two words "free" and "equal." Only when every man, woman and child understands them will democracy be safe.

I venture to state that only a small fraction of the people in the United States know anything about the growth of the Constitution or the reason for adopting the articles fixing a definite relation between executive, legislative, and judicial functions. The Supreme Court has been called the greatest instrument for free government in the world. Why? The most powerful element of citizenship is found in the answer to that question. It involves obedience to law, respect for judicial decisions, and the supremacy of reason over brute force. How many of our citizens grasp the significance of this in the training for public as well as private virtue? It is second only to conscience in the making of good citizens and an atmosphere in which the public can be properly served. The two, conscience and civic education, create the kind of patriotism that would lead a man to refuse a public office for which he had no training. Such a thing as a cabinet officer's resigning because he turned out to be a misfit is unheard of, either because we have not learned what a misfit is, or because our people have not been taught what to give of themselves and what to demand in Washington.

The third element of citizenship is found in true history, not that garble of victories in war, calculated to fill the breast with false pride that cannot see over an imaginary wall surrounding county, state, or nation. Germany is a victim of exaggerated ego, because her historians and writers have totally misrepresented the place of the German in modern life. God has not selected any nation for the dominion of the world. His laws undoubtedly have established ideals that dominate humanity, but never for the purpose of surrendering to some brutal ruling-class domination over men. Bad history, then, may promote bad citizenship. The history of our Revolutionary War usually emphasizes Bunker Hill and Yorktown at the expense of a proper perspective of the tremendous struggle against autocracy and the divine right of kings culminating in the French Revolution. We were fighting against George III and his Germans from 1776 to 1783, and the Declaration of Independence probably had more friends than enemies in England. The outcome of the Revolution was in the interest of democracy for the entire Anglo-Saxon race. It remains to be seen whether this war is the final blow to the old system or not. We might paraphrase Lincoln's words by saying that the world cannot longer exist half democracy and half autocracy. We must smash the autocracy in order that the world at large may recover a conscience and nations may hold a true and wholesome relation to one another. This is why history should be more carefully written and better taught in our schools.

A fourth element toward the foundation for public virtue in office is the education of foreigners in true Americanism. There are millions who must be turned into the kind of citizens found in the old colonies, the men who laid the successful and enduring foundation for free government. Could the American Constitution be written now? Have we the public men capable of striking off such a document? I believe we have, and that many of them have been created out of the children of foreigners. Through our workshops and our schools, and through associations, we should teach ideals of citizenship. This is more important than importing into the United States great examples of art in Europe. The statue of Frederick the Great, set up in front of the War College in Washington, is not a good example of citizenship. His system has ended in teaching good men that brutality is better in the will to force their *kultur* upon other men, than gentleness and love, and his work must all be undone if our conception of human freedom is to be extended over the whole earth. The perpetuation of German or other foreign societies in America is unthinkable, and we ought to break that down in one way or another. Usually the peaceful education of children in our public schools is the best method of proceeding. But we have not done enough by other methods. There should be a great organization within the United States for Americanism, and it ought to be used to counteract all other influence by public speaking and by a more effective propaganda than the Germans can ever again set up in America. This is the melting pot, and it is our duty to make sure that, when the whole mass is fused, it remains an American democracy firm in its convictions and in its demands on public service.

What is Public Service?

What is public service? Almost everything we do that brings us into contact with our fellow man is public, and we are likely to be too narrow in our definition.

Our relation to the government may roughly be divided under four heads:

1 The civil routine or conduct of business in government
2 Civil research and publicity for the benefit of citizens
3 Military training in peace
4 Military training in war.

The Civil Routine or Conduct of Business in Government

This necessarily includes everything relating to the administration, Congress and the judiciary. It is remarkable how little appreciation our people have of government business. No firm or corporation could exist under the present system in every department at Washington. In many cases the appointments, even when based on civil-service examinations, have not sufficient reference to the work to be done. In the higher offices, like the men who constitute the cabinet for the advice of the President of the United States, it is often only by chance that a man well fitted for the position is appointed. The War and Navy Departments may be included under the civilian departments so far as the secretaries and the clerks are concerned, and it is the rarest thing in the world to find, for instance, the secretary of the navy who knows anything about his business. Many million dollars and four years' incumbency are usually required to educate the man in office, and at the end of that time he goes out. Even though a few of the cabinet officers may fit into their positions, fewer still have any knowledge of government or the science of government.

When we come to the legislative branch the matter is even worse, because men are elected to represent constituencies on issues that have often no relation whatever to the transaction of the government's business. Congressmen when elected have their principal interests at home and very generally do not feel under any obligations whatever to make a study of government. Their votes are cast too often without knowing anything about the subject on which they are voting. It may be said that this is also true of legislative assemblies the world over, but it ought to be better under a democracy that throws responsibility on the individual, the responsibility for fitness and for citizenship. The lack of conscience in connection with our legislation is often disclosed in the Congressional joker. A bill that has passed the House of Representatives and the Senate may go to conference on some differences, and there have inserted by some congressman either without intelligence or without conscience certain things that were never in the original bills and never had been discussed. In our appropriation bill there is wholly a lack of system. Attention has been called to this time and time again by men who have held high office and are well acquainted with our methods. Millions of dollars are squandered because there is no budget and no plan, just as millions of lives may be lost through the failure of concerted action by the Allies in this war.

Another feature of this shows a lack of understanding on the part of our people or a lack of enterprise on the part of the engineering profession. A very large part of the business of this country relates to industries, transportation and engineering enterprises, and yet there is hardly a man in all Congress who has any grasp of the engineering matters. The curious part of all this is that our Congress does not know that it doesn't know. What would be self-evident to a scientific man must be beaten into a congressman by means of a trip-hammer, and yet our people put up with it.

We have every reason to feel confidence and pride in our judiciary, so far as the Supreme Court judges of the United States and of the states are concerned, but the courts have already been too much criticized by their own judges and lawyers to render it necessary for me to make any explanations whatever on the lack of training for doing business. Many cases have been known to hang on for years. Trials that should have been dismissed in two days have been exploited before the public for weeks. The Thaw case that was tried in New York was a disgrace to any community. The newspapers without public conscience at all published broadcast the most nauseating details calculated to satisfy only a morbid curiosity or to degrade the moral and literary taste of our youth. The difficulty with this is that the courts permit it to continue on the grounds that the newspapers publish what the public wants, the same grounds that would permit the sale of poison because the public wants poison.

Research and Publicity for the Benefit of Citizens

In our scientific departments of the government, we have in a way emancipated ourselves from the accusation of inefficiency, although much useless stuff is published. The Bureau of Standards, the Agricultural Department, the Geological Survey, the Bureau of Mines, are unquestionably helping to educate our professions, our workmen and our farmers into higher efficiency. The men appointed to office under these different departments are usually well-trained men. They can naturally be classified by some kind of civil-service examination as the men in the business departments cannot.

Every state and every community unquestionably feels the effect of what we may call publicity at this time. The food-conservation program carried out by a mining engineer is really creating a revolution because the American people have been exceedingly wasteful and they are learning now something of the moral effect of saving. Mr. Hoover is only an instance of what can be accomplished by putting a trained man at the head of a department. Mr. Scott at the head of the War Industries Board and Mr. Coffin at the head of the great industrial survey, were other examples of what our profession may contribute to the success of the government. Too often, however, the profession of engineering does not realize its usefulness. We belong to all departments, those of business as well as those of scientific research, but it is the latter that claims us and we should be ready at all times, for this our highest function in the service of the people. Few engineers confess themselves able to speak on engineering and governmental subjects. We hold a duty to this republic, and we ought to fulfill it by learning.

Military Training in Peace

One of the most astonishing phenomena in modern times is the ease with which the conscription bill passed Congress and the extreme ease by which it was enforced. Practically no objection has been raised except by a few malcontents and crazy people, and, yet, a few years ago no one was ready to listen to the words *military training*. Perhaps the speakers on the subject emphasized the words too much and gave the impression that they meant a large standing army, which we shall never want. If there is to be service in war, the whole nation, every individual, man, woman and child, must share in the sacrifice, and must be prepared. The hiring of volunteers is no longer moral. Only time will indicate how much we owe to Leonard Wood for his untiring effort to wake up the country to the importance of military preparation. The whole matter of training officers has been formed directly around his Plattsburg camp, and it is not too much to say that the training of all our men for service abroad is based on his theories. We listened too closely to the politician a few years ago and we have been fed up with three or four thoughts that would destroy the discipline and the correct reasoning of any nation if that nation believed them. The springing to arms of a million men in a single night is that peculiar kind of idiocy that is accepted in the remote agricultural regions where

ignorance of history is the dominant note. We engineers are not too proud to fight. We do not want peace without victory. We were not kept out of war and we do not want to be kept out until little Belgium has all that belongs to her again, all except the dead and the virtue that has been outraged by a brutal soldiery. I have never been a believer in the German system, because it gave too much control into the hands of a comparatively small number of officers constituting the German general staff. The idea of service beneath that system is, however, good. It makes for the education of young men and for obedience to law. Our country is not built up on the idea of obedience to individuals. It should, however, learn that liberty is based on law, and can never be anything else. It is hardly necessary at this time to dwell long on military training in time of peace. We have had our lesson and we shall probably never go back to the old system of a small standing army and a smaller militia of more or less efficiency, usually less. The conception of public service has been drilled into the people by stern necessity to maintain the liberties of the world, so that we shall probably have some kind of military training long after this war is over. Everyone has noticed what a difference the camps make in the slouchy individual who enters, to come out the trim, erect soldier.

The old pioneer days when every man was trained to use a musket have long ago passed, except in a few places not yet settled. We cannot possibly depend on the initiative of communities to teach our boys how to shoot and in fifty years from now a gun of any kind will be as little understood as the archaic engine put into operation by James Watt. Consequently, we must necessarily have some artificial methods of teaching the youths how to shoot and how to act in coöperation with other young men.

Military training is probably the best method we have of Americanizing the young men who come to us from foreign countries, and every one of them ought to be required to take his turn of service. It is not necessary that a foreign citizen making his home here, should be required to bear arms against his old country, but he should, for the sake of teaching him American ideals and American institutions, be obliged to take his place in the camps with young Americans, if he is permitted to make his living on our soil. The simplest of military training is learning how to keep step and that is a great moral influence. We need it beyond everything else in this country, where the forces are so pronouncedly centrifugal. Keep step! That does not mean that the men have to think alike. It does mean that they must act together for the good of our country, by a willing obedience to the control of men selected to manage the affairs of government. Keep step! The great leveler between the rich and the poor who must work together, whatever their homes may have been. It is the great simplifier of human relations. Keep step! The collective action that will put our public servants into a higher standard of training and education for their job. Keep step! There is nothing more inspiring, more beautiful than the march by of an American regiment. There is no goose step about it. It is the free swing of a free people that will never be trammeled by military dictation.

Military Training in War

This nation already has that definitely planned out and our conscription bill has called many thousands to the colors. The selective feature of the bill has been more or less lost sight of, and its spirit has been violated up to the present time. Selection on June 5 amounted simply to a lottery method of choosing men for the service and little attention was paid to selecting them for special positions, in such a way that an army might be formed most quickly. Our young men are graduating from the schools, colleges and technical institutions. Many of them have a training similar to that found at West Point and Annapolis, but comparatively little use has been made of this fact. There are new training schools established that will eventually turn out men for specialized service, but here are, and were, many young men all ready for special service flung into the ranks. We have had warning of this in the mistakes of England at the outset of the war, and we have done nothing about it until now. One of the very curious anomalies in connection with even temporary exemption, is found in the recognition of the special importance of dentistry and the study for the ministry, while the industries have been recognized only so far as their workmen are concerned. If the present system is maintained, our engineering colleges are going to disappear in a comparatively short time, and the government will have to set up special schools which will take years to fit men for the places that the engineering schools can fill. Training in war is very quickly seen to be the heir of mistakes in training during peace. Inasmuch as we had no training before this war came on, we are heir to nothing and all of it will have to be learned.

The most serious part of this whole business is that training in time of peace is of no use whatever unless something is done about a supply of munitions and weapons to be used in time of war. In that respect we were worse off than any of the belligerents except little Serbia or perhaps little Portugal, whose standard we just about reached at the outbreak of the war. That is what rising over night with a million men always means in the mouth of those ignorant of history, even though they be in high places.

Need Greater War Publicity

The training for the present war has a very important corollary that we seem for the time being to have lost sight of. A press bureau is established in Washington for the dissemination of information and its duties have been too narrowly defined. We need now extensive propaganda on what we are actually fighting for. The President well stated the case in his reply to the Pope's proposals for peace, but the people know only the call for troops and for money. A few pacifists and their friends, the German traitors, are concealing the great moral issue behind this business. We must have concerted and widespread publicity of a more penetrating kind. What do the Central powers stand for, the Prussians, the Germans, the Hungarians, the Bulgarians and the Turks? They are all banded together under the compulsion of the Prussians, whose ideas of war as a good thing and brutality as the justifiable method of striking terror into the rest of the world are wholly abhorrent to us. Their success means our failure and we must bring this home to every American, instead of taking things placidly while the German newspapers are fooling the public. We must, as engineers, carry back home the determination to awaken the country whether we are organized for that purpose or not. Every bit of camouflage should be torn off so that we Americans can see the vision of death beneath it. The old Persian proverb, "He that knows not and knows not that he knows not, he is a child, teach him," tells us the daily work of all our spare moments.

As part of the general publicity we must dwell on saving for the war. Economy in food, fuel and clothing is the moral duty of everyone. One of the saddest sights in an American

community is the organization of merchants to tell people to go on in their former mode of life and to buy. Carry this idea to its logical end and we shall lose the war. Prosperity has not come. All boosting of prices is blood money, and the men who are taking advantage of the country's need will be tainted all their lives. One of the most necessary distinctions in business is the priority of essential industries. All unessentials must go and all excess profits must be saved for the success of the country in war.

Engineers Must Kill Conspiracy

The twentieth century is still young, and we do not yet know what it will represent to the future historian. Will it be the debauch of science or will it mean a new birth to Christianity? It is our task to decide this. There are two tendencies; one toward greater comfort and luxury, and one towards greater service. The first can plunge us only deeper and deeper into war for the control of a commercial output. It can only bring us more firmly under a governing class derived either by birth or by commercial success. The second means the complete emancipation of the individual trained to think of service as the chief source of good government and happiness in life. The only theory that will hold men together is that of service. All others, like the control, for instance, under an overlord, are but the cracked shells of old doctrine. This war is their last stand against a modern world, and our work as engineers and citizens is to help prepare for the new day when the rule of kings shall have been swept away. Our profession has been morally responsible for America under the century of invention just passed, as it is we who have created the applications of energy and it is we who have given the wealth of the world into the possession of a few men. This war will create many millionaires. It will place vast power in the hands of the strongest and most ruthless. It will strengthen the trade unions into autocratic groups defining what each individual shall be permitted to do, and what wages each shall receive. Are we to stand by and accept this? Are we to remain forever blind to our own power? There is only one answer to that. We must, as engineers, go forward with our own countrymen to kill this conspiracy against freedom and, then, we must give our lives to fight, that science may never again be employed as a destructive agent in the hands of a few unscrupulous men.

What Can Our Society Do?

What does our Society stand for in the scheme of this world's affairs? We know that there must be more or less selfishness and there will be often a great difference in the general fundamental principle underlying organization. Coöperation may have as its motive one of two ideas; first, the desire to benefit others, and second, the desire to benefit the organization. Sometimes it is difficult to classify under either of these, as the benefit to an association is often benefit to the public, in lifting the general average. And yet when things are traced back to their origins, it is possible to place most associations in their true category. For instance, the missionary societies—and we may with equal propriety say the churches—are altruistic in their origin, and, in the main, they remain so. Charitable organizations, hospitals and colleges are unselfish, and grow out of a sincere desire to give one's self to the service of others. Our own Society belongs to that class which benefits others as it benefits itself, for it is essentially educational in its purpose. As the years have passed, we have come nearer and nearer to a true conception of what our public relations should be, and this war has brought about a sudden large vision of our duties. They are not to be found in reforms put forward by the weak, or by self-seeking manipulators of public opinion, either within or without our Society, but rather through a state of mind. We owe it to our country to think clearly and rightly, and to throw the whole weight of our Society into the scale for sound legislation, good government, and public conscience. The engineer's philosophy is shown in his actions rather than in his words, because he has never learned to explain himself. It is expressed in the desire to serve. No profession can claim a higher motive than the silent men who fill our ranks.

We believe our Constitution to be the best instrument of government ever produced, and that under it all mistakes and imperfections tend to correct themselves. Our advantage is that conspiracy can never thrive, and there can never be a policy fatal to other nations. We can discuss any question of national policy and we can always have publicity against any hurtful tendency. The newspapers have always exhibited a high degree of patriotism when the need comes for discretion, and we may depend on them in times like this to stand behind every program for the good of our country. However sensational the headlines may be, we know that behind them is always a sincere desire for the greatest good to every citizen. Whatever our faults may be, they are always in the open and, like bacilli exposed to the sunlight, they die. That is, after all, the reason why a republic or some form of democracy is always superior to an empire under a few men.

Our country is the home that we love and, as engineers, we must feel a deep responsibility for its welfare. It is given into our hands by our forefathers and we know its virtue, and, God willing, we shall strive to make it the perfect example of what life on this planet shall become when wars are past.

THE ENGINEERING SOCIETIES IN THE NATIONAL DEFENSE

By Gano Dunn, New York, N. Y.

Engineers are, indeed, coming into glory and honor—glory in the things we were reading about in yesterday's and today's papers, as to the behavior of the very men which our national engineering societies recruited in New York through the agency of the Military Engineering Committee only a few months ago, and honor in the ways that were referred to by your president in his address in which he mentioned the fact that the engineering profession and the corporate societies representing them are having an ever-growing opportunity to do their bit for the Government at this critical time. The spirit, the intelligence, the usefulness of the engineer is a matter of common comment. I have talked with several university presidents who remarked upon the high percentage of enlistments and volunteering for service, particularly of the men in the engineering schools, and Dr. Hollis has not exaggerated the part that engineers are playing, and are yet to play, in respect to the things in this great war which we have only just begun to appreciate and understand.

I should desire this morning to bring to your attention some of the things that are now being done by engineers and engineering societies. Adequately to treat of what the engineers are doing would take days, if not longer, and I can only refer to it. One has only to be in the atmosphere of Washington a short time to see that the whole Government of the United

States in respe[illegible] and [illegible]al preparation rests upon a foundation of [illegible]ness.

My task is encyclopedi[illegible], and I beg your indulgence if I but hastily skim over it. I wrote to the representatives of thirty-two different engineering bodies that are now in contact with the Government, asking them to give me authoritatively, although briefly, a résumé of what they were doing in connection with the national defense and with the war. It is beyond our time for me even to go through the replies, but I hope to put them in the record, and they are certainly a scroll of real honor to our credit.

To begin with, there is the Naval Consulting Board. The Naval Consulting Board was intended to bring formally to the service of the Government the scientific and technical ability of a group of the best advisers on engineering lines in the country, and the Government had the conception that if it asked the engineering societies to select these advisers the selection would be better made than if it itself attempted to make the selection. Consequently, two representatives from each of the different engineering bodies were nominated, and under that nomination appointed by the Secretary of the Navy, and that board has been doing able service since the time it was appointed, starting with the Committee on Industrial Preparedness, which took an inventory of all of the industrial resources of the United States. Later it proceeded to report to the Government on the needs of the experimental development of improved devices, and finally it established connections whereby its services might be made available and useful to the Army as well as to the Navy.

It now holds an honored position in Washington, where it acts as a Board on Inventions, and substantially all newly invented devices that are brought to the attention of the Council of National Defense, through various channels, are now referred to the Naval Consulting Board to be passed by, or turned down if they are not useful, or given attention if they are valuable. The Naval Consulting Board has offices at 15 Park Row, in New York City, and has a large force of clerks. The devoted services of its members are constantly given to going through thousands upon thousands of suggested devices from engineers, citizens, and others all over the country.

The Naval Consulting Board was created long before the war. The next body in order was the National Research Council. The National Research Council was started because it was seen that, just as in the Civil War, such help as was given by the National Academy of Sciences, created by President Lincoln, and is now being given by the national engineering societies, would be again needed. The Government acted, therefore, under the Charter of Congress granted in 1864 to the National Academy of Sciences, among the provisions of which were the requirements that the members of the Academy who then represented what we now represent, the engineering as well as the scientific intelligence of the country, serve the Government on request, in whatever direction called upon, without compensation. And they did an unusual amount of service at the time of the Civil War.

Between that time and now, entirely aside from their scientific functions, they have reported on about sixty different questions to the Government. It was seen that this body could be made of great use at this time.. and consequently President Wilson requested that it enlarge its scope and bring itself, as it were, down to date, and include the increasing branches of science that were not known in the old days, including engineering, and to do everything to put at the service of the Government the scientific talent of the nation.

In accordance with this request the National Academy of Sciences organized the National Research Council which may be described as being partly a federation and partly a creation, through which there comes to one single focus every important scientific agency in the United States. It reaches the universities, it reaches the industrial laboratories, it reaches the engineering societies, it reaches the isolated workers in pure science, but the keynote of the National Research Council is science rather than engineering, and engineering plays a part in it only as it deals with pure science aand applied science, in short, what we call engineering research.

When the war broke out it was only natural that the Council of National Defense should request a connection to be made between that body, which had existed for nearly a year, and itself, and since the war the National Research Council has almost dropped all other activities and directed its whole efforts to the problems in science that have been handed down to it by the Council of National Defense.

The next body in order of creation was the General Engineering Committee of the Council of National Defense. When the war broke out, our Society, in common with other engineering societies, immediately, and with a patriotic devotion, offered the services of engineers to the United States, directly to the President; and I do not think any of us realized at that time just what we were offering—quite a little confusion has arisen since as to what it was, but I do know that when we made the offer we did not intend to limit it merely to our engineering service, but we meant to go to any lengths that might be necessary.

Later on it came to be obvious that through this offer to the President we had not intended to convey the offer of our military services, and among other things we all remembered then that we were members of an even greater society than The American Society of Mechanical Engineers, we were members of the Society of American Citizenship, and that through membership in that greater society there came to us calls for military services and other things, and consequently the offer to the President of the services which we made through our Society was regarded as conveying only the offer of engineering service.

The President turned our offer over to the Council of National Defense, and from Dr. Hollis Godfrey of the Advisory Commission of the Council, an invitation was received to appoint representatives to form an Engineering Societies' Section of the Engineering Committee of the Commission. The Society acted officially upon that invitation and sent representatives to a conference in Washington, who met together with representatives from other societies.

From my point of view, this General Engineering Committee as it stands now is the official connection of our societies with the National Government; but the spirit among the engineers who want to serve the Government in more ways than this Committee renders possible, has caused the springing up on all hands of numerous other committees. I am going to read to you a list of the committees of engineering bodies which were in existence at a time, a short while ago, when outwardly and from the point of view of the Government there seemed to be so many committees that they were crowding each other, overlapping, and in their actual relations to the Government carried with them a certain degree of possible confusion, which was brought to our attention and which some of the members of our societies have been endeavoring to remedy.

These committees or engineering bodies are: Naval Consulting Board, American Engineering Standards Committee, Engineering Committee of the National Research Council, Com-

mittee on Gas and Electric Service, Emergency Construction Committee of the War Industries Board, the Intercollegiate Intelligence Bureau, the War Committee of the Technical Societies, the Engineering Council, the American Engineering Service Committee, the Aircraft Production Board, the Aircrafts Standardization Committee, the Aeronautics Committee of the National Research Council, the United Engineering Society, the Engineering Foundation, the American Society of Civil Engineers, The American Society of Mechanical Engineers, the American Institute of Mining Engineers, the American Institute of Electrical Engineers, the American Society for Testing Materials, the American Society of Automotive Engineers, the American Electrochemical Society, the Illuminating Engineering Society, the American Chemical Society, the American Gas Institute, the American Society of Refrigerating Engineers, the American Water Works Association, the National Electric Light Association, and the Association of Edison Illuminating Companies.

The mere enumeration of these engineering bodies itself is a bright light on what the engineers, as societies, have been doing for the Government. It does not begin to be a token of what engineers as individuals are doing for the Government.

As societies, however, there has been some confusion among the various societies, due to overlapping, and there has been also some lack of distinction between engineering services on the part of individuals and corporate services on the part of societies. For instance, one of the great services which no single individual could render the Government, but which a union of societies could wonderfully render the Government, is the question of engineering personnel. So great has been the demand in Washington for competent engineers for this, that and the other service that they have not known where to go to find the men. They first went to their personal friends, to the members of the engineering profession already in the departments, and to those whom they were acquainted with, but soon the supply of acquaintances of these men and the men with whom they were in contact was exhausted, and the authorities were simply at the end of their capacity.

It has been very obvious that at least one of the functions that the national engineering societies could perform was to serve as a center to which the Government could go and find an adequate roster properly classified of all of the men who could render service to the Government, so that the services of these men promptly could be called upon. Through a misconception, the responsibility for which I will not attempt to go into, the General Engineering Committee, which, as I have said, in my view is the official connection of the societies with the Government, declined to furnish the required roster of the personnel. I ought to say that it declined to do it on the recommendation of its chairman, Dr. Hollis Godfrey, who at the time was under some instruction from another branch of the Council of National Defense, which had in view the classifying of engineering service or labor generally, and consequently had in view the grouping and listing of this service in another department of the Council of National Defense, where it was hoped there would be a much broader and more general listing of labor than that which we now usually consider as labor, but be it as it was, the General Engineering Committee declined what, in my opinion, is the principal opportunity to be of service to the Government.

There then sprang up the Intercollegiate Intelligence Bureau for the purpose of making good this deficiency to a certain extent. Its origin was not in the engineering societies, but through an engineer, one of the prominent members of the American Institute of Electrical Engineers, Dr. William McClellan; he organized 170 colleges into a sort of league to supply to the Government men of technical training and engineering qualifications. He went at it through the colleges, because he is president of the Wharton School, and also because he felt that through them he could get in contact with a greater number of engineers and could accomplish better work than in the other direction.

The Engineering Council, which is a body destined to represent not only the great national engineering societies which are members of the United Engineering Society, but all of the great national engineering societies, also took up the question of personnel. It conceived its function to be a very broad one and organized in an endeavor to make certain contacts with the Government, leading up to that through the Naval Consulting Board, through the National Research Council, and through the General Engineering Committee, and there was also created under the Engineering Council the War Committee of the Technical Societies, and also a committee known as the American Engineering Service Committee; Dr. Brunton is chairman of the former and Mr. Foran is chairman of the latter.

These committees went to work vigorously, headed by Dr. Hollis in the Engineering Council, and from the beginning have seen the importance of a registry of engineers and they actually started to accomplish a registry of that kind. When representations as to what these committees had done and were doing were made to the Government, and now speaking from my own point of view, and with the hope not of producing controversy, but of allaying it, the committees were not fully aware of what had been done already by the Naval Consulting Board, by the National Research Council and by the General Engineering Committee, all of which bodies had been in efficient contact with the Government, contact through channels that had been grooved more or less bright by use, and therefore the newer committees wrote to numerous agencies of the Government and interviewed them, and from the Government point of view canvassed the Government as to what channels they should use in their relations with these various activities.

The confusion that arose, although not serious, required straightening out. For instance, the National Engineering Society, as such, had nothing to do with the appointment of the National Committee on Gas and Electric Service. They were more or less unfamiliar with that committee and its work, yet of all the committees in Washington that committee has probably done as much as, if not more than, any other committee in specific and concrete service rendered to the Government. That committee is a committee representing public utilities, or rather it represents the Council of National Defense—it is a committee of the Council of National Defense itself—but it instructs them and knows about the public utilities, and so today is charged with questions of coal supply and of power supply, questions of keeping the industries going that are engaged in munitions manufacture, questions of cantonment inspection and cantonment supplies.

The gist of the matter was that a certain member of our Society, Mr. Swasey, the Father Abraham of the Engineering profession, was down in Washington and learned of some of these things. He endeavored to bring about coöperation and understanding among the thirty-two different engineering agencies. He called a meeting of the representatives of these organizations, and they all most promptly responded and met in Washington. That meeting was an eventful one in the history of the relation of the engineering societies of the

country to the Government, for the knowledge was there brought out of the vast amount of service that was being rendered to the Government by engineers, and everyone present at that meeting was astounded at hearing how much everyone else had been doing, and the mere getting together of these committees is a thing that is going to solve the temporary and minor difficulty of a unified relation of the engineering societies to the Government.

For instance, at that conference we heard the representative of the Society of Automotive Engineers say what his committee had been doing. That Society has been intensely vigorous it has been of actual, concrete and real service to the Government in a way that cannot be known: in fact, one reason why the members of the societies have felt impatient at their Washington relations is because the work, as such, cannot be dwelt upon in detail among them. The Government requires that almost all the work of these various committees and societies be confidential and shall be kept to themselves, and that is one reason why the membership of the Societies have felt that they were not doing their bit, when in fact they were doing all that the Government so far had called upon them to do.

The status of the matter at present is that that joint meeting in Washington appointed a sub-committee to confer with the Engineering Council and with the governing bodies of the national societies, with a view of reporting back some general plan whereby the chairman of the War Board, for instance, would not be receiving four different letters from engineering bodies, each inviting him to take up problems of a certain kind through that particular committee. It is confusing to that chairman to receive such letters, and moreover it shakes his confidence in the ability of the engineers to organize their work effectively and to do the things that they most want to do.

I am afraid I have omitted ninety per cent of the things I wanted to say in regard to the activities of certain of these committees, and I perhaps ought to speak about the War Committee of the Technical Societies. That committee was intended originally to be a vehicle of information between various Governmental activities and the membership of the national societies. It was intended to be of service both ways. It was intended to satisfy this demand on the part of the membership by knowing as far as possible what was going on. It has recently established a connection with the Naval Consulting Board, and the general view of the engineers now interested in the Washington relations is that there never can be too much service in Washington, and that there is room for every committee. Colonel Carty, who presided over the conference called by Mr. Swasey, said that the whole thing is too big to be controlled by any one committee, and it is realized that the more there are of these committees that represent real service, the better it will be, and all that is needed is a little better directive force and a little more inquiry and coöperation before taking up with the Government questions that may have already been settled, in fact, by other agencies.

The situation as it stands now is one in which we may all take great pride. The General Engineering Committee of the Council of National Defense is in the awkward position of being asked by its chairman to resign. This is through, as I understand it, a fancied conclusion that service on that committee is incompatible with the ruling of the Attorney-General to the effect that men may not serve on committees of the Council of National Defense when they have other business relations with the Government. The business relations of the men in the engineering profession serving the Government are so numerous that if that principle were really carried out in fact, the Government would be deprived of the service of engineers; or, on the other hand, the industries, the engineering projects, and the very great works that are now being accomplished for the Government would be robbed of the directing heads that are producing them. Neither of these alternatives is for a moment conceivably possible.

This opinion of the Attorney-General has been interpreted by the Secretary of War to mean that no man may sit on a board in Washington when that board is engaged in deliberating upon the award of a contract to a company in which that man is interested. That is only common sense. It has gone one step further, and says that no man may sit on a board when that board is making recommendations to another board, which other board may be empowered to award contracts, except, in this case, the man is not forbidden to sit on that board, but if he sits he must file with the second board a statement of his complete relation to the contract that is under consideration, and state what other interests he may have with it.

I think one reason for the general resignations that have occurred in the Council of National Defense has gone a good deal further than this technical situation. The Committee has been overgrown, overgrowth indicating rather a lack of authority, which the springing up of so many committees always indicates. The authorities wanted to reorganize the whole matter, and certainly that reorganization is now in force, but whether it will take the form of continuing to ask for the resignations of the members of the General Engineering Committee of the Council of National Defense, or whether that committee can be regarded as an exception, because it is a non-commercial committee, and whether that committee can be permitted to retain its relation there with the Advisory Commission, or establish new relations directly with the Council of National Defense, the same relation that has been established by the National Research Council, is not yet to be known. However, whatever it is, the principal thing which is now to be settled is not the relations of the twenty-eight of the thirty-two committees, whose names I have read; their relations are very satisfactory; they are doing splendid work for the Government: they are a credit to the societies that have created them and the men who are in them. They are one of the good right arms of the authorities in Washington. Any confusion that may have existed lies in respect to the relations of the engineering societies, as such, to the Government; in other words, our own corporate relations to the Government for those things which we as societies may do, which we as engineers do not do, and under the leadership of Mr. Swasey that general question is now being happily and kindly worked out and thought out in a way which will result in the Government continuing to get not only the service it has been getting, but such increased service as the near future will lead it to demand.

We are not yet really in the war. Times are coming—they are predicting it in Washington—when the service we have so far rendered will be like but a little cloud on the horizon. Our duties will increase: our opportunities will increase. I do not think the patriotism of the engineering societies can increase. It has been at par from the beginning.

But, gentlemen, those of us who felt that because they were not yet called upon they were not going to have a place in this great war; those of us who have felt that because of some defect in the machinery at the top they were not being put in touch with the things they could do; those of us who have felt that way, I think, will soon, and very soon, have a

call for everything that they can render. In Washington, the views of the authorities are all in one accord as to the patriotism, the usefulness, the distinguished service and the ability of the engineering societies and their representatives in the national service. We have been a credit to ourselves in a big and fundamental way, even if some of our superficial relations have not been quite as orderly as we might have liked to have them. I have been told there is not yet on record a single case where the Government has actually asked an engineer to do a service for it where he has not responded, and that is a badge of honor which for our profession I hold very high.

SPECIAL EDUCATION IN TIME OF WAR

By DR. CHARLES S. HOWE,[1] CLEVELAND, OHIO

I AM asked to talk to you about some of the problems facing the engineering colleges. These problems are definitely connected with two questions, which I do not propose to discuss at any length. The first is: Does the country need engineers in time of war? And the second is: Have we enough engineers now to supply the need during the war and after the war is over?

It would be needless to mention these questions were it not for the fact that if the present methods are carried out there will be no teaching in engineering colleges after a few months have passed, and the engineering colleges are the only places where systematic education in engineering is given. Engineering instruction is carried on to some extent in some shops, and very efficiently carried on, but there is no systematic attempt made over the entire country to give engineering education in the shop. Hence the colleges of engineering are the institutions to which we must look for engineers in the future if we need them.

It is surely not necessary for me to answer the first question after you have listened to the address of President Hollis and the address of Mr. Dunn, and it will be especially unnecessary after you have listened to the other speakers of today. I shall not attempt to discuss that question.

As to the number of engineers needed, it seems to me that all of you will agree with me that we do need to continue the supply of engineers, because we shall need more while the war is going on than we have now, and we shall certainly need them after the war is over. You have found in your business the drain upon the supply of engineers now. You know in a good many cases it has been difficult to get men for engineering work in the firms with which you are connected. We in the colleges know we cannot supply any of the engineers that are demanded now and asked for every day, that it is utterly impossible to send a man to any place unless we take some one who already has some position, and that the demand now is larger than it ever has been before, and we believe it is going to continue.

Therefore, it seems necessary to train engineers for the future. But the drain upon the engineering colleges has been very great. As soon as war was declared, it seemed as if every college student—I can speak only of the engineering colleges—wished to go into the army. We had very great difficulty in keeping any of them in the colleges. While they were determined to go, the members of the faculties were trying to keep them out of the army as far as possible, because it seemed to us that these boys who were being instructed to become engineers would be of more service to the country after they had been trained as engineers than they could possibly be as privates in the army. If the situation were more critical, if the enemy were at our door and every man had to shoulder a gun, the case would be different; but as things are now, and as the supply of engineers is limited, it seemed to us that we ought to keep these fellows in the colleges until after they had been graduated. But it was impossible to do so. They enlisted in every form of service—they went into the army, the navy, the flying corps, and the ambulance corps. They are carrying ammunition in automobiles all over the battlefields of Europe, and they are in every kind of service that the army has to do. They are going now in large numbers, and most of the engineering colleges have lost anywhere from twenty to thirty per cent of their men in the last year.

These figures merely include the number who would be trained as engineers and graduated within the next few years, but now, by a ruling of the War Department, young men have the privilege of enlisting up to December 15. After that date, if they are drafted, they must go into the service for which they are drafted. The result is that there is the greatest uneasiness among all college students. They are leaving our colleges in large numbers, and unless something is done to allay this uneasiness before December 15, we shall lose a large number of men who ought to go into the army as engineers.

According to the classification that has just been given out, college students will be in Class No. 1, and that class is to be exhausted before any other class is drawn upon. Consequently the engineering students will all be taken out of our colleges in the next draft unless something is done to save them for their professions. I would not at all say that the boys object to this—these fellows are young, they are full of red blood, they are interested in their country, they are anxious to have a hand in the struggle that is going on at the present time. They want to get into the struggle, and it is with great difficulty that we keep them out of it. But we who are charged with their training are trying to look at this thing in a cold-blooded way. We say, Are these men going to be needed for a special service? If they are, they ought to bear in mind that every man should look forward to the best service that he can render, and not merely try to get into some kind of service.

Plans for Drafted Students

The colleges, recognizing the difficulty before them, have tried to interest the War Department in the question of saving some of these students, because after the second draft is made there will be only those under twenty-one years of age—and not even those, if the draft age limits are changed, as seems probable—and those physically unfit.

You are all probably aware that the medical profession took up this question last fall, and that an act was finally passed which permitted medical students to enlist in the Medical Reserve Corps, and the men who so enlisted are not liable to draft, are not liable to be sent into actual service until after they have secured their degrees, and so the Society of American Universities has requested the Government to allow engineering and other scientific students to enlist in some reserve corps until after graduation. They have asked that chemists and engineers and physicists and bacteriologists and others pursuing scientific work might be allowed to go into one or another of the numerous reserve corps where they would, of course, be subject to Government control, but would not be called upon until after graduation. The authorities at

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Washington turned down this request. A similar request made by the Association of State Colleges, has not been acted upon as yet, but probably will be turned down, because it is similar in character to the request made by the Association of American Universities.

A request has been made by a number of colleges that students who are enlisted shall be furloughed back to their institutions. That has not been acted upon. It has been suggested to the authorities, I believe by army men themselves, that a certain proportion of engineering college students be exempted from the draft until after graduation. Some of us object very much to that word "exempted." We do not want our college students exempted from service. We want them in the army, if they ought to be there, by the draft, but we would like to keep them in colleges long enough so that they may finish their training.

Another plan which has been proposed is that engineering-college students who are drafted be detailed back as drafted men to the institutions from which they came, provided that when they were drafted they were in a state of proficiency in their work in the college so that it is reasonably certain that they can be graduated with credit to themselves and the institutions with which they are connected. A part of this same plan would be to have these men wear their uniforms and have it understood by all of the students that they were soldiers in the army, and that the colleges be required to give them military drill, so that they would not be losing altogether the training which they would have had if they had continued with the active army.

Another provision is that the colleges shall report the standing of these men to the War Department at the end of each semester, and any man who is not doing efficient work shall be immediately sent to his regiment. Another provision was that after graduation these students should immediately go to their regiments as privates and work up to positions as non-commissioned officers and perhaps commissioned officers, if they were competent for that kind of service and were needed for it.

It seemed as though one or the other of these methods would permit us to keep our students in college long enough to train them for the various branches of service and that then they could be sent wherever they were needed. The Government has seemed indifferent to the necessity of maintaining the supply of trained engineers. I think that is because they have been so busy with organizing the army that they have not been able to give any time to the question of training the engineers. I was in Washington last Saturday with a committee of another society and took up this question with the War Department. It seems from what we learned there that the War Department is greatly interested in this question and is now taking steps to provide adequate training for a certain number of engineering students. The details of the plan we do not know—and cannot know until the matter has passed through the hands of the Secretary of War, but it looks now as if some method would be adopted at Washington before very long whereby engineering students may go on with their training, just as medical students are now going on with their training.

[In connection with this it might be interesting to note that the A.S.M.E., through the Engineering Council and the Society for the Promotion of Engineering Education, has passed resolutions to the Government that the preservation of a source of supply of engineers be given careful attention. These resolutions have already been acted upon and provisions for drafted engineering students made.—EDITOR.]

Special Training During War Time

Another question which has been before us is that of special training during the war. I think that all of the colleges have insisted on military drill as part of their work. Many of them have made this training compulsory, although it has been exceedingly difficult to secure army officers to take charge of that drill. Nearly all of the colleges which could not secure army officers have appropriated money from their own treasuries to pay for the services of men who have had experience as officers and who are not eligible for active service in the army at this time. Nearly all of the colleges have established some military-engineering work. For instance, they have taught the students how to build military bridges; they have taught them how to lay out intrenchments; how to make rapid plans of any region of country, how to do reconnaissance work; how to make maps which could be used by the army officers of any section of the country, and various other things connected with military engineering which are very desirable for any officer and perhaps for any soldier to know.

Work has also been given to some extent in the mechanical- and electrical-engineering departments; that is to say, men have been trained in the application of electricity as necessary in the army. Some of us have gone to the military-engineering schools, where we have been able to find out just what instruction is given the army men in signaling, for instance, and in the use of searchlights, as well as in military telephony and telegraphy, and courses of study have been introduced in many of our engineering colleges to better prepare men for that class of work. The Chief of Ordnance suggested one day in Washington that the colleges give their students in machine design in the future the designing of heavy guns and gun carriages instead of the ordinary machine design, and offered to furnish blueprints which would form the basis of some of this work.

Some of our institutions will teach their chemists a great deal about explosives, giving them not only the chemistry of explosives but the methods of manufacturing the explosives. I do not mean that they maintain explosives factories on the college grounds—that would not be allowed—but they teach them the methods of manufacture, so far as they can, without actually manufacturing the explosives, and teach them the chemistry of all of the ingredients that go into the explosives.

Quite a number of professors of chemistry have visited the explosive factories in order to find out the latest methods in use in the manufacture and handling of explosives, as well as to ascertain the different materials that enter into them. So that in all these ways the engineering colleges are trying to give their students some information which will be especially useful to them in the army if they are drafted, or if they become officers in the army.

There is still another important question before the engineering colleges: If they lose all of their men over twenty-one years of age, except the physically unfit, and have left, therefore, only the freshmen and sophomores, the greater part of whom are under twenty-one years of age, is it necessary for them to change, or is it not advisable for them to change, their courses of study in order to fit these men for the actual things they may have to do after they go into the army? It has seemed to some of us as though we ought to do this; that is to say, that if we know our courses in the engineering colleges are to be limited to two years, that we ought to materially change our courses of study during those two years in order to fit the men for some of the engineering work which it would be possible for them to do.

In conclusion, I would say that the engineering colleges have tried to look at this matter in an entirely unselfish way. They are not thinking of the number of students they will have, or of any income which will come from these students, but only of the question of the most efficient way in which they can train these young fellows for service, and they are ready to do anything which the Government wishes them to do in order to carry out this plan.

THE OPPORTUNITY FOR INDUSTRIAL RESEARCH

By C. E. Skinner,[1] Pittsburgh, Pa.

THE successes of the past and the host of problems awaiting future solution should be ample proof that industrial research has before it a field of unlimited opportunity. There are many phases of the subject which might be discussed to advantage at this time, such as the extent to which industry should carry on pure scientific research, the extent to which different industries could pool their research interests, methods of attacking research problems, the education of research workers, the coördination of industrial, governmental and university research, and others. This paper will, however, be confined mainly to an attempt to show by illustration some of the opportunities which exist. Possibly no better example could be chosen than that of the study of alloys, and this should appeal to the mechanical engineer as no other single development has perhaps contributed so much to his progress in the last two decades. Machine tools have been revolutionized. There are few important machines today which do not depend on alloys for some of their vital parts. The automobile, the airplane, the modern locomotive, dynamo-electric machinery, and many others, would require changes much to their detriment if modern alloys were not available.

And yet, in spite of the work already done on alloys, we have explored but a fraction of the really useful fields. Few, if any, general surveys have been made of the possibilities of binary and ternary combinations, and such studies should yield results of great value. The subject might be attacked in either of two ways: first, by endeavoring to get at the fundamental laws governing the alloying of metals so that the results of making any particular combination could be predicted; or, second, by experimental methods actually making and testing a sufficient number of the alloys under consideration to give the data essential. The purpose of such a study may be to produce an alloy with certain desired characteristics for a specific purpose or it may be to determine the useful alloys possible from the combination of any two or more metals. The former may be relatively easy or very difficult, depending upon the requirements. The latter cannot fail to be anything but difficult and long-drawn-out, no matter what the method of attack. Let us consider briefly what such a survey means. It would be desirable to start with chemically pure metals, but metals chemically pure are practically unknown and often metals of a purity not at present commercially obtainable show characteristics very different from those commercially obtainable. For example, magnesium as ordinarily obtained is quite brittle, while the metal approaching chemical purity is very ductile. Tin of high grade combined with lead gives us a solder with well-known characteristics, while certain commercial tins now on the market carrying small percentages of bismuth impart to solder characteristics markedly different from the purer tin. Consequently natural impurities must be studied both as to their influence and as to their elimination. Methods for the preparation of the constituent metals with unusual purity must be developed. The differences between the effect of natural impurities and added impurities must also be examined, as these differences are sometimes very marked; as in the well-known effect of added sulphur as compared to natural sulphur in steel for certain purposes.

Keeping in mind the necessity for pure materials and the influence of impurities and alloying methods, we may assume that a series of alloys of any two metals is to be made varying in their proportions by 1 per cent. This would give us ninety-nine different alloys for each grade of each of these two metals. Each of these will require a large number of tests and repetitions to determine the various influences which may change their important characteristics, and each sample will require a large number of determinations to arrive at its chemical, physical, electrical, magnetic, thermoelectric and other characteristics. It may be necessary to study the effect of each natural impurity on each alloy of the series, which will multiply the tests manyfold. Those which promise to be commercial will require many further tests to determine their working qualities and adaptability to commercial uses. In addition to the above, it is well known that certain alloys have very sharp and very marked inflections in certain of their characteristic curves, sometimes within a range of less than 1 per cent variation in their composition, as, for example, the variation in the thermoelectric value of certain nickel-iron alloys which occurs at approximately 27 per cent nickel.

Such a study even of a single series of binary alloys would involve tens of thousands of determinations and much time and expense. If we add a third and a fourth alloying metal, it will readily be seen that a lifetime would be entirely too short to compass a full exploration of such a series. In fact, it is doubtful whether a relatively complete study of the possibilities of a single binary combination could be accomplished by any one in an ordinary lifetime. A very elaborate study of the single alloy, 88 per cent copper, 10 per cent tin and 2 per cent zinc, has been under way for two or three years, the leader in this work being the Bureau of Standards, assisted by a number of producers and users of this material. The Bureau has outlined over a score of characteristics to be determined and the work is as yet far from complete.

It may be argued that such an elaborate study would not be warranted even to give complete data, as many zones could be passed by as not promising or a few experiments at most prove that the combinations in certain zones were of little or no commercial value, but we are learning that where ordinary methods with metals of commercial purity fail to give useful results, other methods or purer materials may give results of great value. Unfortunately, we do not know the theory of alloying well enough to predict results with any certainty. We know of no theory to account for the fact that an alloy of 3¼ per cent nickel with iron has low permeability at low inductions and high permeability at high inductions, while an alloy of 33 per cent nickel with iron has high permeability at low inductions and low permeability at high inductions, and an alloy of 27 per cent nickel with iron is totally non-magnetic, except at very low temperatures. Or again, how shall we account for the fact that certain alloys of copper, aluminum and manganese, where all the constituents are non-magnetic, produce an alloy which is strongly magnetic, while an alloy of 12 per cent manganese with iron—the latter being our most strongly magnetic material—gives an alloy which is non-magnetic. Again, alloys of aluminum and tin, with or without

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other alloying metals, may make alloys with fine characteristics when first smelted, only to disintegrate to powder later. No satisfactory explanation for this action is now available. These phenomena are just as difficult to explain as the fact that two gases, hydrogen and oxygen, combined in a certain proportion give a liquid (water), while three materials, carbon, hydrogen and oxygen—the one a solid, the others gases—when combined in certain proportions give a resulting gas, in other proportions a liquid, and in still others a solid. The idiosyncrasies of certain alloys cited above show the futility of attempting to predict results with our present theoretical knowledge of the subject. It is probable that the necessary theory for a full understanding of the subject may come only from a study of the atom—its structure, its combination into molecules and the ultimate forms and characteristics which the constituent elements may take. A general solution will hardly be possible from a study of the chemistry or the metallurgy of the subject, but by a coördination of the chemistry, the metallurgy, the physics and the magnetics through the work of the molecular physicist. Thus the ultimate solution of a very practical industrial problem can hardly be expected, except through the work of the pure scientist. True, the patient experimenter trying to explore the whole field may furnish the facts to prove the theory conceived by some brilliant mind, which will make further drudgery in this line largely unnecessary.

The above example has been dwelt upon at some length to show the possibilities of unlimited research in what might seem from a superficial examination to be a highly restricted field. This is equally true in numbers of other fields. We know very little of the laws governing insulation and the theory of conduction in dielectrics. It is possible that the fundamental laws governing the characteristics of alloys may also explain some of the mysteries of dielectrics.

The examples cited illustrate another phase of the subject that may be emphasized to advantage, and that is the ever-widening field of any research, no matter how restricted in scope its object may be. The study of a single series of binary alloys may necessitate studies in the source and preparation of the raw materials, methods of smelting and alloying, a study of containers and molds for the molten metal, types of furnaces, temperature measuring devices, smelting and pouring temperatures, rates of cooling, effect of quenching, methods of forging, rolling and drawing, development of new test methods to determine new characteristics and many other phases of the subject. Totally new characteristics may be found by using hitherto untried methods; for example, alloying under extreme pressure or temperature, or both. If the worker is to understand fundamental laws governing the work which he is undertaking he must have a thorough knowledge of the chemistry, physics, mechanics and magnetics or he must have co-workers available who can look after such phases of the subject together with the necessary equipment for carrying on the necessary tests.

Compares Nation to Alloy

If this country is the melting pot, then this nation is an alloy, an alloy infinitely more complicated than any I have described. What are the influences for good? what are the poisons? what evil influences can be fluxed off in the smelting? what will remain to vitiate the resultant alloy? what will be the result of the heat treatment of war? will it respond to the new treatment necessary after the war? What a research we have before us as engineers and citizens!

No paper on research today is quite complete without some reference to the war. Prior to the war some one decried research and scientific development generally, because of the possibility of their making war more horrible when war should come, and many felt that war would become so horrible as to be impossible. We must admit that much of the horror of the present world war which particularly appeals to our imagination has been made possible through our latter-day research and scientific development. We have but to refer to the submarine, the airship, noxious gases and high explosives to illustrate the point. It is doubtful, however, if any right-minded man would wish that all development through research should have been halted at any previous specified time, in order that the use of such things should be impossible. We would not give up our advances in chemistry in order that high explosives and noxious gases could not be used. We would not discard the telephone in order that the submarine could not be provided with listening ears. We would not discard our advantages in aeronautics in order to prevent the dropping of bombs on defenseless women and children. Each element of frightfulness based on scientific research can and must be met and conquered by scientific research. The agents of frightfulness and the means of overcoming them will become the means of restoration and reconstruction after the war. The "die is cast" and we must go forward with our research as never before, both to win the war and to provide for the readjustment necessary after the war. We are spending our natural resources at an appalling rate, but we must use the last pound of coal and the last drop of gasoline, if necessary, to win the war. If this be necessary, we must find other substitutes through research. The development and use of the internal-combustion engine has reached a stage which makes it impossible to think of the world after the war without internal-combustion engines, even though our present fuel for them be exhausted. Furthermore, the restrictions imposed by the war have taught us that many substitutes are possible where such substitutes would have been considered impossible or at least very undesirable before the war. Tin-base bearing metals were considered absolutely necessary for some services until the scarcity of tin made it necessary to use a substitute containing little or no tin, and this has been perfected until it meets every service equally as well as the genuine babbitt.

Research Necessary to Win War

We cannot emphasize too strongly the two main points brought forward in this paper: first, the unlimited field open to research in every conceivable line of endeavor, and, second, the necessity of taking advantage of these fields both to win the war and to provide for the reconstruction and readjustment that must follow. Research can and must do its bit now. Research can and must be an important factor later. To meet these requirements we need workers trained in the fundamentals of all branches of science who can bring to their work the devotion, the enthusiasm, the optimism and the imagination so essential to success in any work and doubly so in research. We need the aid of all who can help in the training of research men. We especially need the aid of men with imagination who are in a position to furnish the funds, the equipment and the organization to provide that pure science and applied science shall advance in every possible way. It is not hard to show that industrial research through applied science pays. It should not be difficult to show that this depends on pure science and, therefore, that pure science should pay in every sense of the word.

THE AGRICULTURAL PROBLEM

By LIBERTY H. BAILEY,[1] ITHACA, N. Y.

(Abstract)

I AM here by telegraphic order, standing in another man's shoes to discuss his subject, yet without having his paper. All I can hope to do is to establish a point of view. If I were to make any statements on the place and office of engineers in the body politic, I should want first to attend their meetings for some time and also to associate with them in their professional capacity in order that I might see something of their problems in their public relations and also understand their own measurement of themselves. You deal with mechanical or physical forces. It is your business to handle these forces and to make them serve you in a large way. It is one of your problems to eliminate time and space as they apply to the ordinary man. You are dealing with large affairs, with persons in the mass, and with work that has distinct public relations.

There are those, however, who deal primarily with biological forces. The forms of life are adapted to the conditions in which they are placed. It is not necessary to inquire here what has been the process of this adaptation, but all biologists recognize as a starting point of their discussions that the animals and plants are adjusted to the conditions in which they live. Today I invite your attention to this situation, asking you for the moment to forget as far as possible the physical and mechanical relations in which you customarily deal.

Farmer's Attitude in War

Just now we hear much about the farmer's attitude toward the great affairs confronting us. There is considerable criticism. All the criticisms I have heard are projected from the point of view either of class organization or industrial organization. Those who would defend the farmer speak of his psychology and the necessity that the rest of us understand it. The result is that much of the treatment of the farmer is cajolery. The situation lies far deeper than psychology. Let me give you a formula:

"The farmer is part of his environment, matching himself into his background, perhaps unconsciously, much as a bird is matched, or a tree, or a quadruped. His plan of operation, his farm management, is an expression of his situation in nature: he has worked it out because it fits. He cannot shift it radically to meet the advice of any other person. As he himself develops in ability he will modify his plan of operation so far as he can, but the plan must always fit his place in the environment; no great change is possible unless his natural conditions change: he does not make his conditions. The farmer exemplifies, in the human range, what the naturalist knows as "adaptation." His situation does not admit of compromises, perhaps not even of adjustment, and therefore it may not be understood by teachers, publicists, officials."

Farmer Cannot be Pressed

The consequences of this formula, if it is true, are tremendous. All the advice given the farmer that does not recognize his necessary adaptation to his environment is useless; and useless advice is harmful. It is of no advantage to rail against the farmer any more than against the wind or the rain. It is idle to try to apply to him the pressures that are exerted on corporate business. It is of small consequence either to praise him or to condemn, to take sides for him or against him, except insofar as it may affect his spirit as a man. When, under pressure of great crises, we radically change the conditions under which the farmer works, we must allow him time to readjust himself: he must take account of the latitude that he may reasonably expect in weather and soil and human forces. He needs not favors, but conditions that will allow him to operate. The natural conditions within which he works cannot be changed, but they can be modified in some ways, and he can make new adjustments within certain limits; these possibilities he begins to understand, and they are parts of his problem as a farmer; when the economic or outside conditions are changed, the modifications must be such as will match the natural limitations, if he is expected to adopt them. In the present crisis our public agencies must understand and recognize what can reasonably be required of the farmer.

It is an old adage that appearances are deceitful. I wish to add that they may be misleading. Persons managing corporate, industrial, labor and professional affairs have a certain air and habit of presentation. The farmer operating his farm may not have this air. He has nothing to present. He may be following a plow in the back lot, unshaven, trousers in his boots, working until the work is done, even though the clock points to five. Perhaps he would not discuss politics or civics or religion, at least not till he knew you; but, good or bad, he has worked out the management of his farm, and he thinks he knows why. He will listen to your advice; then he will go on with his plowing. He is hard against facts—real facts, not paper facts; he accepts them and acts accordingly. You may not like him, but he himself is a fact.

Attitudes Toward Farmer Ridiculous

Bearing in mind these fundamental considerations, established in the nature of things, some of the popular attitudes toward the farmer become ridiculous. I was out of the country when war was proclaimed, but I understand that everybody who had a public voice fell to advising the farmer. This is futile, since the farmer is the one part in the population to whom advice of this nature is of no value, and for the reason that it cannot be applied. I am sure that much of this advice made no account of situations that neither the farmer nor any one else can change. Such advice is not only vain, but it works mischief. The farmer fails to accept the advice not because he is unwilling, but because he cannot. It is suggestive that every person thinks he can advise the farmer in his occupation; it is significant that the farmer does not undertake to advise other occupations and professions.

It is simple enough to change an outside or commercial condition in relation to the farming occupation; it is quite another matter to expect the farmer to accept it unless other essential conditions are changed to meet it. Fixing the price of any product, while it may be necessary in times of crises, does not add fertility to the land, or modify the weather, or affect the habits of a sheep or a horse or the requirements of a herd of swine. To say that a billion dollars is to be added to the income of farmers by war prices means nothing, unless we have at the same time a statement of outgo. To say that the increased gross value of farm products of 1917 over 1914 represents war profits is to state only one factor in a transaction, and to state it loosely. To advise the use of less milk in order to save it does not take the cow into consideration; the cow is not a machine that can be stopped by turning off the steam and discharging the operator.

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To establish any regulation touching production on a basis of compromise or agreement between contending parties does not take into consideration the fundamental problems on which the regulation must rest for its operation. This is well expressed in Warren's recent statement following a long hearing on the cost of milk, that there is no known way of making a cow produce milk by argument.

The political method, which is the method of compromise or expediency, cannot change a single fundamental fact in agriculture.

Is the Farmer Profiteering?

You understand that I am not defending the farmer—his acts are as much open to review as those of any other citizen—I am merely stating his natural situation. As illustration, let me refer to the recent charge that he is profiteering. The farmer does not make profit in the commercial sense, but only a labor income. Now and then a farmer may buy and sell without producing, or even speculate, but this is not farming. The producing farmer does not become "rich" in the commercial sense. His occupation yields only the returns from his work. His overplus is likely to go back into the land, and the next generation has the benefit.

One of the most amusing statements I have heard is that reported of an influential financier to the effect that we must now take the farmer in hand and control him. The idea is that the farmer is becoming too powerful and makes too many demands. Now, for the past ten years or more public men have been advising the farmers to organize for protection, and the farming people have been shown the results that have been won by organized labor and industry; yet as soon as the farmer begins to use this dangerous weapon, a shout of alarm goes up from those who have advised it. If the farmer anywhere uses the weapon of organization, he only follows the precedent of industry and commerce. This is to say that the weapons of industry and commerce are then turned against themselves. The present mood to discipline the farmer is but another expression of the old disposition—so old as to be automatic—that the farmer must be kept where he belongs.

Agriculture Very Little Organized

In fact, however, agriculture is yet very little organized commercially or politically. Former attempts have failed. We are watching the two movements now before us with new interest; it is yet too early to measure their accomplishments. It is now charged that farmers are withholding the sowing of wheat in order to hold up the prices. In the first place, there is no organization of farmers that can control the wheat situation; and if any number of individuals reduced their own production they would be playing into the hands of the heavier producers or of handlers. It is impossible for farmers to control their production as manufacturers control their output. Whether a man sows more or fewer acres of wheat, he does not know what his crop will be: the unpredictable conditions that make the wheat crop are too many.

Organization for commercial offense, or even for defense, is indeed a dangerous weapon. It is dangerous in itself; it is dangerous because it forces government into compromises, and also because it relieves government of its plain obligations; it is dangerous because it sets one part of society against another. In agriculture it is specially dangerous: it has here all the danger that it has in any other realm, and, besides, it cannot change a single natural condition.

[Having laid down these general statements, the speaker illustrated by calling attention to advice that is likely to be given the farmer and which cannot be applied because it does not fit. He spoke about plans for doubling the produce of the poultry yards and other stock, bringing out the fact that this requires more feed, and that this feed cannot be fed to livestock and to humans and certain parts of it sent to the Allies at the same time. To talk about doubling the output easily in poultry or some other special line under the limitation and conditions that are now apparent may be little more than nonsense. He also spoke of the fallacy of trying to secure more beef by allowing the veals to grow up. Veal is practically a product of the dairy regions, and the only reason for desiring calves is that the cows may freshen. If these calves are all kept for beef, then they will compete with the cows for feed and labor and the dairy business will greatly suffer. Recent studies have shown that possibly one way to increase the supply of meat is to kill the veals earlier rather than later, so far as it can be done within the law.—Editor.]

Food and the Labor Problem

The food problem is now on us with staggering force. Fighting men, munitions and similar supplies, and food, are the fundamental or essential materials in the prosecution of the war. We now face the problem of supporting vast armies in a foreign land, making good the losses by land and by sea, and supplying the needs of millions of allied and neutral peoples. We are to expect that the problem will increase in magnitude. Never has a people been presented with a food problem of such stupendous proportions.

At the outset we are to face the contingency of the probability of a lessened yield. In the three war years the yields of the staple grains have been heavy. Only five times previously in the last twenty years have they been as great. This fluctuation is due, to a great extent, to unpredictable conditions of weather and climate. In two of the years the yields have been very low, and if very untoward conditions should arise next year, it is well within the range of possibilities that disastrously low yields might result, although they are not expected. We must take every precaution, therefore, to reduce all the elements of chance that are reducible in order to safeguard the situation and to secure a food supply as nearly adequate to the situation as possible. We are already applying these cautions effectively.

The labor condition may prove to be the key to the problem. Farm laborers and farm operators both are involved. They have volunteered; they have been drawn off by the great industrial demands, receiving wages that food production cannot pay; they have been drafted. The situation is not to be met by argument or by any array of tabulated figures. The actual experience of the farming people the country over must be accepted as true. The farmers also must coöperate to the full.

Farmers should not be exempted as farmers, for exemption is not a class interest. Yet we must save the energies of the people for the production of food as well as for other war purposes. Some of the harvest of food may be accomplished by volunteers, young and old, sent to the rural districts when emergencies arise; this, however, affords no solution of the regular and steady application that is needed on the land, a need that is now greatly increased. The producing of food, as the producing of anything else, needs dependable and experienced labor; food production needs farm labor rather than city labor.

Four Requisite Food Regulations

The food production is not to be maintained by the ordinary processes of economic regulation, particularly when the law of supply and demand is so much interfered with or even abrogated. Many movements and activities will influence the production, but four are of paramount importance.

1 We must save the food. This saving is not only economizing in the use of it, whereby we reduce the waste, but quite as much in the redirection of the diet and the reconsideration of the family activities. Fundamental changes are to take place herein if the war continues any length of time. To every person in the land, to every family, to every hotel and club, to every social organization, the call must come to consider whether the present eating habits are either sound in themselves or patriotic. Not only does the question of wheatless and beefless days seem to be involved, but that of better dietetics as well.

2 We must save labor. Extensive activities employing labor; perhaps whole industries must be stayed; perhaps some of them should never be revived. If we eliminate the useless and also the unessential, we shall be able to release much labor. The simplifying of the household scheme will also liberate woman labor for industries and farms; we shall need it all. If the war long continues women must take the places of men in countless industries where heretofore only men have been employed.

3 We must grow more food on the small home properties in city and town and suburb. This is not farming, for the householder does not maintain himself and family by the raising of supplies. This activity is justifiable only so far as the operator does not demand labor that can be used elsewhere. Himself and members of his family and household establishment should do the work. There may be many failures and disappointments; but there is no charge for labor. What energy one puts into the raising of food is likely to be deflected from less patriotic uses. Much foolishness is displayed in some of these home food gardens and in some of the semi-public enterprises of this kind. I hope that something has been learned this year. We may expect better results next year, even if the gardens should be fewer. We shall learn to grow the dependable things, few in number, and those that can be utilized to best advantage in the family. Great secondary and civic gains will result from this tilling of the land by the sweat of the face. Yet, with all that can be accomplished in the making of home gardens, we shall not affect the production of the great staples, as the breadstuffs and the red meats; but we may relieve ourselves of the necessity of using so heavily of these staples, thereby saving them for export.

4 We must directly increase production on farms. To this end we must establish food production on a wartime basis, giving it the best economic protection and the directest aids. Here lies the great remedy. The major strategy of the nation having been determined, we must then apportion and distribute the activities of the people toward the accomplishment of the one result. No industries or activities should be allowed to proceed at the expense of munition making and food production, or with the distribution of them, or any part to work to the disadvantage of another part: all the parts make the whole. The entire people now makes war. The war is one problem. If by stimulation, oversight and regulation the food situation cannot be met, then men must be assigned to farms as definitely as they are assigned to armies.

North America is the last defense in the food support of the war.

THE FUEL PROBLEM

By Prof. L. P. Breckenridge, New Haven, Conn.

Precisely stated, the fuel problem is that the coal bin of the United States is not full. How much do we need to fill it? One hundred million tons. Can we get it? We will try to produce more coal. We may produce fifty million more than we have ever produced, but we shall have to save another fifty million.

If you will build a coal bin 1000 feet on each side, that coal bin will have to be 4½ miles high to hold the coal which must be mined this year in the United States. That is a good-sized coal bin, higher than any mountain in the United States, and it takes a good deal to fill it, but if everybody saves a little coal we will save fifty million tons.

The question of the fuel problem is divided into three parts: the production of coal, the distribution of coal, and the use of coal.

In connection with the subject of production, Dr. Noyes, of the Fuel Administration Department, says that there is no use of producing coal—taking it out of the mines and piling it around the mouth of the mine. It is better to go down into the mine and get it with the machinery available than to raise it when there are no cars to put it in. If that is so, and it seems entirely probable, the coal in the mine is ready to be taken out and is being taken out as fast as cars are put there to receive it.

The railroads of this country distribute a large proportion of our coal, about 85 per cent, and nearly 35 per cent of the entire freight they haul is coal. No wonder we would like to fill the coal bin just to have the coal, but we would like also to get rid of the job of hauling it. We need the railroads for other things, not only for hauling food, but for materials which go into munitions. The problem of distribution is after all one of the most serious problems in connection with the fuel problem at this moment.

The problem of the use of coal divides itself very naturally into two parts: First, if we are to use coal we should use it with economy; second, will the time come when it will be necessary to limit the supply of coal to certain industries? If we are careful of the coal we possess that will not be necessary; but if we are not, there will have to be some priority of use of coal.

It is preëminently the function of the engineer to use coal with economy. During the entire period of this Society's existence, 38 years, I doubt if there has been a meeting when papers were not presented which referred to the economical burning of coal, or the economical use of steam, or the economical use of electricity. They are one and the same thing, as we burn coal to make steam, to make power, or, as a secondary product, the electrical energy which is to be distributed for power and lighting uses.

Sixty-seven per cent of all the coal produced is used to make steam. The steam is not all for power purposes, however, part of it going for heating. But this use of 67 per cent of the coal production shows the desirableness of using economy, and saving a lot of this coal by saving steam, and by saving the power we make from steam.

The United States, Great Britain and Germany produce the coal of the world, the world's production now reaching about 1,600,000,000 tons.

In the United States we mine, speaking broadly, two kinds of coal, anthracite and bituminous. All of our anthracite coal comes from Pennsylvania, from Scranton, Wilkes-Barre and vicinity, and we have never yet produced 100,000,000 tons a

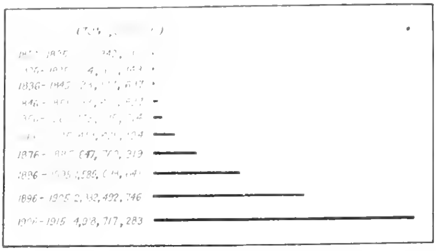


FIG. 1 TOTAL ANTHRACITE AND BITUMINOUS COAL PRODUCTION IN THE U. S.

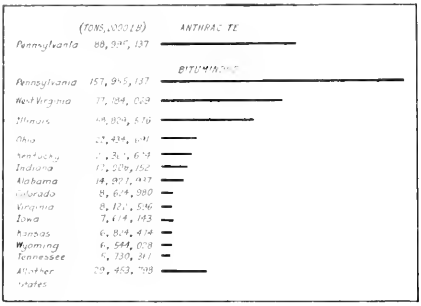


FIG. 2 COAL-PRODUCING STATES, 1915

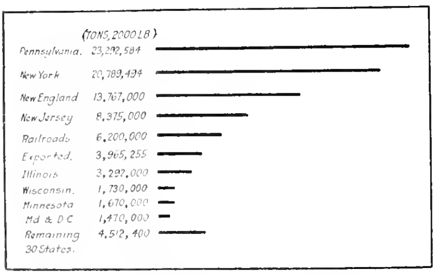


FIG. 3 STATES USING ANTHRACITE COAL, 1915

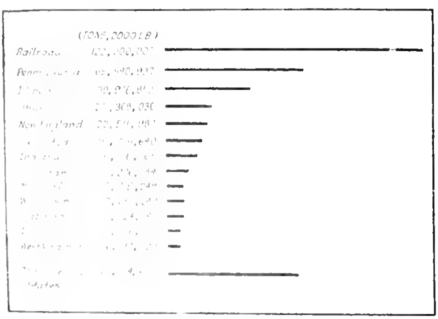


FIG. 4 STATES USING BITUMINOUS COAL, 1915

year. In the rest of the country we get bituminous coal, which varies much in its composition. We get most of it from Pennsylvania and West Virginia, a lot from Illinois, and a little from the lignite fields west of the Mississippi. We are producing bituminous coal in increasing amounts, and will mine close to 600,000,000 tons this year.

Anthracite coal becomes more valuable in the ground next year, and we have only enough to last perhaps one hundred

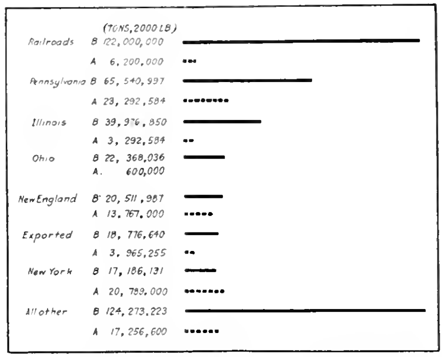


FIG. 5 BITUMINOUS AND ANTHRACITE CONSUMPTION, 1915

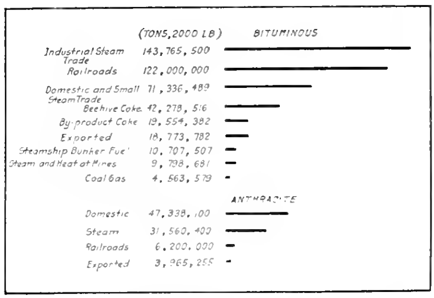


FIG. 6 COAL CONSUMPTION IN U. S. BY INDUSTRIES, 1915

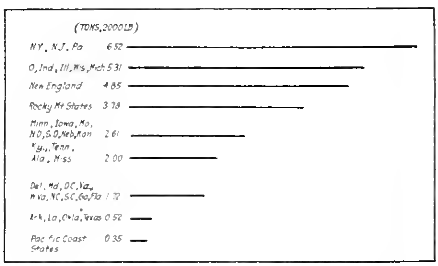


FIG. 7 PER CAPITA COAL CONSUMPTION IN U. S., 1915

years. Our bituminous coal will last us 1500 years, according to Geological Survey estimates. A few slides are now in order.

Fig. 1 shows the coal production at each ten-year interval in the United States, beginning in 1800. Up to 1885, about the time this Society was formed, we had not mined in this country as much as was our increased production in the last ten years.

Fig. 2 shows the states which produce coal, Fig. 3 those which use anthracite, and Fig. 4 those using bituminous. This year I think the railroads alone are using 145,000,000 tons, and will need, and must have, perhaps, more.

Fig. 5 shows the proportion of bituminous and anthracite coal used by the various states. The railroads only use a very little anthracite compared with bituminous. Illinois uses only a small amount of anthracite. Ohio uses a very small amount of anthracite, less than the city of New Haven. New England uses more bituminous than anthracite.

Fig. 6 shows the coal consumption by industries. Fig. 7 shows the per capita consumption in various sections of the country. In the Pacific Coast states the consumption is only about one-third of a ton per capita—they use hydroelectric power and burn oil in their steam power plants, and as the winters are mild they do not use much for the purpose of keeping warm.

The fuel administration has a coal-conservation department, in charge of Dr. Noyes, and his activities reach to every state where there is a fuel administrator. The Bureau of Mines, augmented by a committee appointed by the four national engineering societies, is acting as technical adviser to this conservation department. The various engineering societies can give much help to this question of conservation in their own localities, and it would seem they should coöperate with the fuel administrator in their particular locality.

The United States Chamber of Commerce, having connections with 950 cities in America, is issuing from time to time valuable information bearing on this subject, and its committee on coal conservation has invited Dr. Hollis to appoint a number of engineers to sit with them; and so they are helping in that way. In many of the state fuel administration offices we have engineers working with them to help save coal.

MOTOR-TRUCK TRANSPORTATION

By William P. Kennedy,[1] New York, N. Y.

Motor-truck transportation has now become firmly established in military and commercial service, and the purpose of this paper is to point out the developments to be expected from our immediate necessities created by the existing condition of war.

There are three stages to the introduction and development of most of our industrial utilities; first, the pioneer stage in which the designer and producer bring the apparatus in question to a condition where it can be practically employed as an economic device; in this stage there is a period during which considerable missionary work must be done to induce the prospective user to recognize its economic advantages. The next or second stage is that in which the apparatus is used in a preliminary way, during which period the user becomes gradually familiar with the possible accomplishments of the device and begins to have confidence in its commercial value, by being able to satisfy himself definitely of the reduced expense or increased performance which he is actually gaining by its employment. The third and last stage is that in which the device becomes a competitive necessity in the hands of the user, due to its general employment in commercial service. In rare instances the coming of this stage may be hastened by some extraordinary situation in which the failure of existing means for performing equivalent service forces the employment of the new device as a necessary substitute.

In the development of the use of motor-truck transportation we have now reached the beginning of the third stage, just described, and are confronted with a situation where the older means of transportation is so overcrowded and congested as to demand the immediate and general use of the motor truck as an urgent expedient for relief. Our general situation therefore at the present time of congested rail and water transportation may be the greatest possible boom that could exist for a very extensive development of highway transportation, by means of the motor truck. This development during the next year or two will probably be the equivalent of that which would gradually take place over a period of twenty-five years under normal circumstances.

As indicated above, the reliability and economic value of the motor truck is already established. The employment of these machines to the number of 300,000 throughout the country in commercial service is sufficient proof of this. In its application to military requirements there has been a more rapid and conspicuously successful development, as is evident by their numbers and the character of their service in the various zones of military activity in Europe, as well as the great quantity employed for military requirements at the home base of each of the belligerent nations.

While the motor truck cannot be regarded as having created any revolutionary change in methods of warfare, the effective character of its service, wherever time has been an important element, has had a marked influence in speeding up military operations. It has consequently found its place as an indispensable adjunct in military equipment, from which it can never be displaced and in which its usefulness will continue to extend. The motor truck has provided the army with other utilities beyond road transportation of munitions and supplies, in furnishing the speedy ambulance, the scouting armored car, the mobile gun, the powerful caterpillar tractor, and finally the tank as a formidable fighting machine.

There may be lines of demarcation as to the limitations of the motor truck in military field service between the railroad in the rear and the army mule at the front, but its permanency and usefulness in between these limits is unquestioned. The extension of its application in overlapping the service of the railroad and superceding the army mule has been demonstrated in many occasions of emergency, and it is therefore likely to continue forcing its value in both directions as its superiority becomes more frequently demonstrated in cases of actual necessity.

The motor truck is already so well entrenched in military service that our Government has been abundantly supplying itself with many thousands of these machines. It has been able to take advantage of the experience of other nations engaged for a longer period in the conflict to furnish itself with the most suitable equipment which the industry could provide as its regular commercial products. It has gone a step further in securing through the collective coöperation of the engineering ability of the industry several special types of motor trucks, the design of which is based upon the accumulated experience of three years of vigorous warfare; while the industry in the few years of its rapid growth has become so substantial that the emergency requirements of 30,000 to 50,000 motor trucks can be furnished almost as a matter of course, and without any serious impediment of the routine conduct of its business.

Our immediate interest is now concentrated not upon these past accomplishments, but in a determination of what are to be the demands of the near future in furnishing domestic highway transportation to aid in conveying, from our scattered centers of production to our seaport terminals, the vast quantities of supplies and munitions required to maintain from

[1] Consulting Engineer.

one million to five million men in the field in a foreign country.

We have already in evidence the limitations of our old-line means of rail and water transportation, and although vigorous steps are being taken to find satisfactory remedies for their congested condition, the problem of making these already overworked facilities conform to our increasing necessities is an extremely difficult and complicated one. The situation calls for extraordinary activity and extraordinary methods in finding its solution, and one of the principal factors which will develop as an element in the solution of this great problem will be the employment of motor-truck trains in scheduled operation over our principal highways.

The producer, merchant and consumer of materials requiring transportation from one place to another throughout the country have become so habitually shackled to the limitations of our railway and waterway transportation facilities that it is extremely difficult for the prosaic commercial mind to release itself from its accustomed methods and to rise up and find a new and efficient means of relief. It will probably require the superior genius of the military mind in its capacity for meeting emergencies, coupled with the resources which military organization provides, to take preliminary and effective steps toward making use of the motor truck and the highway to offset the limitations imposed by our older transportation systems.

Fortunately, the situation has all the elements which can possibly contribute to success practically lying at hand waiting to be utilized; and the only thing remaining to accomplish the purpose required is the necessary authority with a competent executive or administrative organization to put into actual operation road motor trains adjacent to all the centers where freight congestion now exists.

The ability of the motor truck as an individual operating unit or as a tractor coupled to trailer equipment has been well demonstrated under a great variety of operating difficulties throughout the country. All the highways in the country may not be fit for transportation of this kind, but over the comparatively limited number of routes where the operation of such motor trains would be required the conditioning of highways is either an accomplished fact at present or could be made so with little difficulty or loss of time, by making use of the facilities which most of the state highway organizations have at their command and are ready to supply for such emergency requirements almost immediately upon notice to do so.

In the present-day motor truck, backed by the brains and facilities of one of the greatest industries ever developed, we have the means for providing transportation equipment with which we can accomplish extraordinary service. For several years past the manufacturers of motor trucks, under the stress of keen business competition among themselves, have developed the machines produced to a point where they are capable of performing almost any task allotted to them. Aside from their normal functions of transporting freight, they are in many instances called upon to perform a great variety of military service incidental to transportation. In some cases their equipments constitute portable power plants for performing service of some distinct character, such as that required in lodging and mining camps. They occasionally furnish lighting. Frequently they perform loading and unloading operations, such as the hoisting and dumping of coal bodies, or the removal and replacement of separate bodies which have been loaded while the truck itself has been absent on its delivery route. In fire-fighting service they are practically replacing the old line of equipment, and a special type of motor truck has been developed which is now regularly known as a road builder, hundreds of which are doing marvelous work in the rapid development of our highways.

It will therefore be seen that under the intensive development of competitive motor-truck equipment the manufacturers have been prepared for just such emergency requirements as they are now likely to be called upon to meet, and therefore any organization which may be developed, either by the Government or by commercial institutions, to solve this problem of highway transportation will find the truck manufacturers perfectly competent to furnish quickly suitable machines in any capacity or number that may be required.

With this assurance as to an adequate supply of rolling stock, the next step in the project will be to put a few selected stretches of highway into serviceable condition and to keep them so.

Whenever the question of highway transportation has been considered in the past, the good-roads topic has always been introduced and discussed in terms which embrace the entire road system of the country and the magnitude of the task of putting this complete system into first-class shape is usually dwelt upon as an almost insuperable accomplishment. It requires, however, no very great analysis to bring out the fact that only a very small fraction of one per cent of the highways of the country would be required for the contemplated service of relieving our present congestion or expediting the movement of freight between the principal centers of production and our seaports. This being so, the facilities now available in each state for the construction and maintenance of its roadways, if concentrated intensively upon the few routes likely to be required for this character of service, could put them in excellent condition and keep them so with comparatively little effort and expense. Consequently, this project of bringing into existence organized highway transportation has none of the cumbersome impediments usually attendant upon railroad extension.

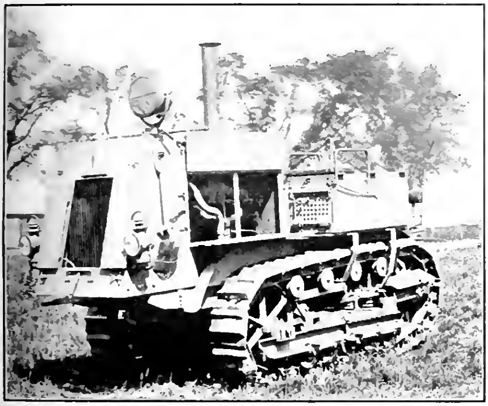
Many cases already exist where limited highway transportation is operated on schedule over definite routes. Many more systems would come into existence rapidly by virtue of their commercial value were it not for the fact that it is difficult to procure capital in large quantity for this kind of investment. One of the alleged reasons for this difficulty is the fact that the power of railroads has in the past been used to obstruct parallel competition of any kind, and this promotes the belief that if road-transportation operations were organized on a large scale the same influence would be felt in interfering with their development and prosperity. If this is really the case, then it will require initial steps on the part of the Government in such an emergency as the present one to put into extensive operation road-motor-transport service, and incidently prove its practicability and establish the permanency of such methods. Action of this kind should be advocated and strongly urged for the many advantages which would result from the spread of the use of this highway motor transportation. Its competitive influence would be a very valuable one to the public, as placing in the hands of producers and merchants their own independent facilities for limited freight movement would bring about marked economic changes in which all would be likely to benefit.

We should not be slow to take advantage of the lessons which have been taught us in this direction by France, England and Italy, in carrying into effect, almost immediately upon the opening of hostilities, road motor transportation upon an extended scale. Some cities and many of the small towns in these countries are almost entirely dependent upon

the motor truck as a means of conveyance, and the well-defined organization which has been brought into existence to maintain the equipments employed and to keep in condition the road surface required, are examples that should exercise a stimulating influence upon us to make advanced preparation towards meeting the more serious conditions which the increasing demand for transportation is likely to force upon us.

Discussion

George P. Hempstreet, in discussing Mr. Kennedy's paper, said that he wished to call attention for a moment to a peculiar state of affairs. We had one branch of the Government anxious to promote motor transportation, and had been assured that there was an ample supply of rolling stock available. In order to use that rolling stock it was necessary to have a highway to run it upon, the first requisite of which



45-hp. Holt Artillery Tractor with Armor Doors Open

was a sufficient foundation, generally of crushed stone or gravel.

Another department of the Government had issued Priority Order No. 2, which prohibited the shipment of gravel or crushed stone or anything to be used for road construction in open-top cars. Most of the quarries from which crushed stone was taken could only put their materials into open-top cars, as it was very difficult and expensive to use any other type of car, and very difficult to unload it.

The question might be asked, Why not use motor trucks? A motor truck could be used to haul a load of five tons, and if the load was worth $1,000 the $25 charge for hauling would not be very excessive. But if the load was only worth $2.50, a freight bill of $25 would be excessive and prohibitive.

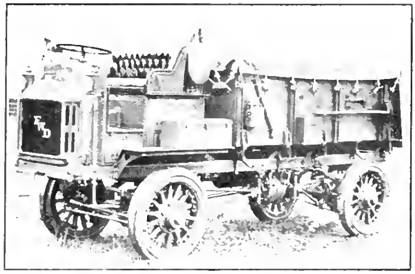
So we had one department of the Government which wished to have motor transportation and to use good roads, and another which was preventing their construction.

There had been every effort made to relieve freight congestion in the East by the use of motors to haul high-grade goods rather than use freight cars, but a branch of the Government was practically prohibiting the building of roads on which such motor trucks could be used.

ARMY TRANSPORTATION

By Major L. B. Moody,[1] Washington, D. C.

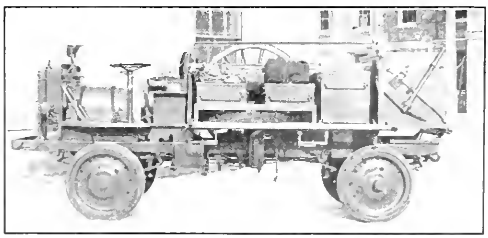
This question of army transportation is a pretty broad one, and in general it comprises very broad and distinct classes of service, all back of the fighting lines. When you go into the zone where troops are operating the first assumption is that there is no road, and also that transportation



All-Steel Ammunition Motor Truck Driving on All Four Wheels

becomes specialized, that is, the Medical Corps do not want their patients handled on the cubic-foot or pound-per-mile basis. Likewise, the engineers have special apparatus, such as portable searchlights and demolition equipment. The Signal Corps has its wireless outfit and equipment for their aeroplane service, etc. The Ordnance Department depends on the motor transportation, as it furnishes all the field guns and the materials known as munitions.

When the question of replacing the horse in this special service came up, it was referred to the Ordnance Department. There is no serious difficulty in replacing a horse where you have a road; but where you have no road and where you have got to be 100 per cent certain that you will arrive at your destination, that is where the difficulty of replacing the horse with the fighting troops has come in. That is, if the general supply trains fail on the main roads, it is possible that the men might go hungry for a day. But, if on the other hand



Jeffery Supply Truck for 4.7-in. Gun Battery

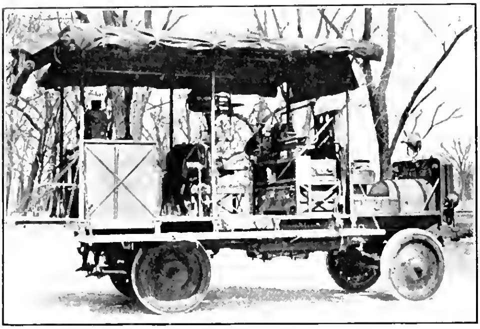
you wish to use a gun for a certain purpose, it is of no use to have it arrive a day late—it must be there on time. That has led to special forms of transportation.

As to the volume and the organization, it can be said that practically every gun handled by the United States Army will

[1] Carriage Division, Ordnance Department, U. S. A.

be handled by motor equipment, and if we get an army approximating in size those on the other side you will obtain some idea from the number of guns engaged of the magnitude to which this important matter of transportation has now grown.

I do not want to say our problems are solved, as they are not, but from operating the experimental equipment we had at the middle of April last, we have progressed from one officer in charge, a couple of officers, and a couple of draftsmen and five desks, to the point where we have schools turning out men to repair these trucks at the rate of 30 to 50 trained officers and several hundred trained men every month. We have estimated the number of men actually building these trucks (not counting those in related industries) and they number about 50,000. The number of officers actually on duty is from 300 to 400, the number of enlisted men runs into the thousands, all for repairs only.



Jeffery Repair Truck for 4.7-in. Gun. Drop Sides in Working Condition

The cost of this will exceed that of the Panama Canal, and the Ordnance Department has expanded something like forty times, by actual count, in the last eight months of its history.

We are endeavoring in the department to handle this problem ourselves, but we would have made but little progress but for the assistance received, particularly in my section of the Ordnance Department, primarily from the Society of Automobile Engineers, and from those among our officers who belong to The American Society of Mechanical Engineers or who would be eligible for membership. Without the assistance of these trained men it is safe to say that we would be nowhere.

[Major Moody then briefly described a number of views which he had projected on the screen, these views showing various forms of specialized motor transport, including ammunition trucks, a repair truck equipped with machine tools, an armored car, a tank, late forms of standard tractors used for hauling guns, a few of which are herewith reproduced. Four of the views were of unusually bad road conditions that could be successfully met by tractors, but in no case by horses. The facts that horses can be reached with poison gas and cannot be camouflaged as can the tractor, along with particulars regarding difficulties in ocean transportation, were given by the speaker as some of the reasons for the adoption of tractors.]

THE AIRCRAFT PROBLEM

By Dr. W. F. Durand, Washington, D. C.

It is perhaps fair to say that when hostilities were declared last April, no one at that time in connection with the Government had any vision of the part which the Air Service was destined to play in the plans which were soon to be developed. It is perhaps further fair to say that it was not until the visits to this country of the Balfour and Viviani-Joffre missions that these ideas began to crystallize into definite form. Very promptly, however, they did commence to so crystallize, and we began to get some vision of what the air service might possibly mean. Immediately there arose a series of the most important problems which have ever been presented to the United States and to her engineers in an engineering and industrial way.

I have jotted down a few of these problems, as follows:

1 Of the various types of machines, fighting, reconnaissance, bombing and training, what number shall be set as a goal for active service at one time?

2 What wastage in such machines is to be anticipated?

3 In consequence, what numbers in each type must we be prepared to build within a twelvemonth or any other specified time?

4 How many trained aviators will be required to maintain the desired number of machines in active service?

5 How many men must be put through preliminary training in order to secure the needful number of active aviators with the necessary reserves? Or, in other words, how much raw material must be handled in order to secure the necessary amount of finished product?

6 How many mechanics and repairmen will be needed to keep this fleet of airplanes in all classes up to "concert pitch," and ready for instant service at any time and at all times?

7 Where and how are we to undertake to build the number of airplanes indicated as necessary as the gross output, say for a year, in order to maintain the fleet continuously at proper strength? Or, put otherwise, we may perhaps well ask what is the maximum number of airplanes which can be built in those various classes in the United States, or by the United States, without undue disarrangement of either needful war industries and of the irreducible minimum of peace industries?

8 To what extent will further demands be placed on air productive capacity by demands of our allies in Europe for airplanes or engines in types which we may hope to produce with high economic efficiency? and to what extent may we expect to draw upon them for certain types—as, for example, the fighting scout—thus relieving the United States to some degree of attempting, at least at the start, to produce this final word in the evolution of fighting aircraft, as developed on the battlefields of Europe?

9 To what extent will the demands of our allies call for raw material, such in particular as airplane timber? Will the total demand exceed the presumable supply, and if so, to what substitutes may we turn?

In considering this question, certain conditions are obvious. There is no use of talking about an air service if the number is to be limited to hundreds. If we have any vision of the activity and efficiency of air service as now conceived, it must mean the production and operation of airplanes in large numbers, measured in units of thousands and not hundreds. We must therefore fix as a number, in order that it may have any significance in the problem, a number measured in thousands. If

we can say five thousand, it is well. If we can say more, it is better. There is no definite answer to this question; but we are committed to maintain airplanes, once we are under way, in many, many thousands.

Again, what wastage in such machines is to be expected? That is a matter of statistics, and the data for the accurate determination of the answer to this question are not available. The data are contradictory. We lack definite information as to the average life of machines. Under certain conditions one may continue in active service a month, a week, or perhaps a day. But machines do not fly every day; conditions of weather intervene, and of the 365 days of the year only a fraction of them will be available for the fighting machines on the front. So, taking the average, we get to the approximation that the effective life of the machine will be several weeks, possibly two or three or four months.

In consequence, what numbers in each type must we be prepared to build within a twelvemonth or any other specified time? This is tied up with the question, how many can we build? And the answer is the same. We must be prepared to build airplanes in thousands. We must be prepared to build a multiple of the number in active service at any one time. If we are to maintain 5000 airplanes in active service at one time we must be prepared to supply during the twelve months a multiple of three, or four, or five or six times that number.

How Many Aviators and Mechanics Do We Need?

Again, how many trained aviators will be required to maintain the desired number of machines in active service? Obviously, there must be one for each machine in service. With modern machines, carrying more than one man, we must maintain in active service more than one man in each machine. There has been a tendency not always to insist upon the capacity to handle the machine on the part of every man who goes up. A man may be a good observer without being a good pilot. But this is not a good ideal. We believe that no man should go up in a machine for any purpose whatever without his being able to pilot the machine; to manage the machine in case the regular pilot is injured or killed, and to bring the machine back within our own lines. That means there must be a number of men trained for auxiliary service, but with a given minimum of skill. It is obvious the number of men we must be able to turn out in the course of a twelvemonth must be measured in units of several thousands. Five thousand would be minimum, and we must look toward some multiple of such number.

With regard to the actual provision for meeting this requirement, it is perhaps proper to give some idea of the capacity of the schools now occupied in this particular work.

The first step in training an aviator is to give a brief course of eight weeks in the so-called ground school. This is a school intended for preliminary instruction, not including work in the air. It includes elementary instruction in the principles of flight; in the principles and operation of internal-combustion engines, meteorology, photography, scouting, machine-gun work, reconnaissance work, and comprises lectures, class work and laboratory exercises in these subjects. This course runs for eight weeks.

The course contemplates the feeding in at these institutions of twenty-five candidates per week, and the feeding through and graduation each week of whatever is left of the twenty-five, taking into account the wastage. Without wastage it would mean twenty-five per week for each school to go to the flying schools; and with eight schools there would be about two hundred cadets a week, or something of the order of ten thousand per year.

There would be, necessarily, a considerable wastage and perhaps not more than one-half of that number can be expected to realize an efficiency which will make them significant units in the program as time goes on.

The capacity of these schools could be multiplied, and such multiplication is now in process of development. There need be no ground of apprehension about training these men, assuming that we can obtain properly qualified young men, with the necessary personal, physical and mental characteristics such as are needful to enter into the composition of the bird man.

It is true that of men qualified for the last and highest degree, men whose nerves and muscular reactions are such as to make them react instinctively—as bird men—the number is small. But, on the other hand, every well-built, normally developed and endowed young man is able to develop a degree of skill adequate to render him an effective unit in one place or another in the air service, even if only a few reach the supreme excellence which we see in some of the specially trained airplane fighters.

The number of these engineering, technical and scientific schools can furthermore be multiplied two, three or four times, and the capacity of each can be multiplied perhaps by two, on the average, and we thus have abundant possibilities for the development of a very large amount of material for ultimate service in connection with the plans now in formation.

The number of mechanics and repairmen is again a matter of experience, and it is found that for every airplane there must be one specially skilled mechanician who will give his entire time to the maintenance of that particular machine; and for each group of twelve, twenty-four or thirty-six, there must be an additional number, and in the base supply depots and other points back of the line there must be others.

If we go back to the supply of gasoline and lubricating oil, and to the supply of elements of that character, we may greatly multiply the number of men necessary to maintain in a state of efficiency any one airplane. But stopping short with the number of men concerned with the machine itself, we must multiply the number of aircraft by three, four or five.

If we take into account the number of fliers contemplated and the number of mechanics and repairmen behind the line in one capacity or another, it results that the contemplated officers and personnel of the Signal Corps will exceed the entire standing army at the outbreak of the war.

How Will We Maintain Our Air Fleet?

The next question: Where and how are we to undertake to build the number of airplanes indicated as necessary as the gross output, say for a year, in order to maintain the fleet continuously at proper strength? Or, put otherwise, we may perhaps well ask what is the maximum number of airplanes which can be built in those various classes in the United States, or by the United States, without undue disarrangement of other needful war industries and of the irreducible minimum of peace industries?

Now this question No. 7 comes closest to us as engineers and men concerned with the industrial affairs of our country: Where and how are we to undertake to build the number of airplanes indicated as necessary as our gross output? Where

to find and now to develop the tremendous extension in the industry necessary to provide this enormous number of airplanes for immediate production? It means the development of an industry, highly trained and highly specialized—not, indeed, out of nothing, but out of very small beginnings. Perhaps I should say that it meant the crystallization of the elements of such an industry. And it was splendid that there were found shops, and trained personnel and equipment and organization for the production of airplanes, right in the automobile industry. It meant, nevertheless, an enormous extension in productive capacity beyond any vision which the wildest flight of imagination could have contemplated a few months ago.

Only a few weeks ago I was able to visit, by way of inspection, three of the principal centers of airplane production at the present time Dayton, Ohio; Detroit, Michigan, and Buffalo, New York. There we saw new factories which were either completed and occupied or on the point of occupancy, aggregating something like thirty-five to forty acres of ground area, to say nothing of the gallery space.

Furthermore, there was ready for immediate expansion perhaps twenty-five to forty per cent in addition. It is fair to say that early in the next year there will be occupied actively in the production of airplanes something like fifty acres of ground area, with their gallery space, which did not exist eight months ago. And this is without taking into consideration the automobile factories. Acres upon acres of area in existing automobile factories are running solely on airplanes and airplane parts; and we are just on the edge of a period of very large production.

The period which has elapsed since last June or July, when the present program began to crystallize into reasonably approximate and definite form, has been necessarily spent in measures of preparation for this tremendous program of expansion and industrial development. And we may certainly anticipate within a few months, say two or three at the latest, that this factory capacity will be actively occupied in turning out airplanes at the rate of at least several thousand per month. The precise number I hesitate to define more closely at this time.

What Further Demands Will Arise?

The remaining questions I will touch on more briefly. They are: To what extent will further demands be placed on air productive capacity by demands of our allies in Europe for airplanes or engines in types which we may hope to produce with high economic efficiency? and to what extent may we expect to draw upon them for certain types—as, for example, the fighting scout—thus relieving the United States, to some degree of attempting, at least at the start, to produce this final word in the evolution of fighting aircraft as developed on the battlefields of Europe?

The other one, the ninth, is: To what extent will the demands of our allies call for raw material, such, in particular, as airplane timber? Will the total demand exceed the presumable supply? and, if so, to what substitutes may we turn?

It is sure that the demands of the Allies will put to the test every bit of our productive capacity for airplane material. We are now making for them flying boats in large numbers, and they are looking more and more to us for the production of airplanes for the training of aviators. In fact, the nearest approach to the standardization of a definite type is the American type, for at least the American, Canadian and British services. And they are coming to look to us for other types as well, and for the production of airplane engines.

The demands for supplies are also at the limit of our productive capacity. The demand has been incessant for timber—spruce, spruce, and again spruce! Serious difficulties have been met with on the Pacific Coast in the way of supply, but on the whole the prospect seems to be improving.

Substitution of other woods has also been introduced in some measure, which, while they have different characteristics from spruce, yet give effective service. And then there are suggestions in the way of metal substitutes which seem to hold hopeful and interesting possibilities.

The Problems of Standardization

One of the questions which presented itself again and again, and aside from the questions of policy or program, a question which is vital to the engineer, is that of standardization—standardization of elements and standardization of types. I need not take your time with a statement of the advantages of standardization of parts used in large numbers.

The standardization of elements, such as screw threads and fastenings, has progressed very satisfactorily; and for general airplane parts much excellent work has been accomplished through the efforts made by the Society of Automotive Engineers. And there is to be held soon in London an International Standardization Congress to which this Society has been asked to send a representative, and I understand that this Society will have one of its eminent past-officers at this conference as its representative and at which we may anticipate a still further approach toward standardization by way of elements and parts.

The other problem relates to the standardization of types, but here is danger. It is necessary to standardize; but it is fatal to attempt to standardize a type too rigidly, because if we know anything at all from experience on the western front it is that a type has no longer begun to prove a measurable degree of success than it is put out of date by the appearance of some new and improved type; and so as the weeks go by one type comes along after another.

The entire program must be based on the expectation of displacing from time to time types which for production purposes may be standardized for the time being, but which cannot be kept in production too long after the development of more efficient types.

I have tried to visualize this as a tremendous stream of production. Parallel with this stream of production we must have likewise a stream of development, research, investigation and a program which is seeking to contact with the unknown and the new; developing, judging, testing and determining their technical characteristics and their adaptation to the conditions of active service. And so fast as new types and forms are developed and proven superior, just so fast must they be fed into the stream of production, taking the place of out-of-date forms. Only in this way can we maintain the types and forms in use at the front responsive to the advance in the science and art of airplane production, and responsive to the conditions at the front and which must determine the characteristics of the material to be supplied at the fighting front.

The So-Called Liberty Motor

I should not close my remarks without saying a word regarding the attempts to standardize the airplane motor. You are all familiar with the story of the design and development

of the so-called Liberty motor. I will not go into that at all. But you can appreciate the fact that of the various problems requiring standardization, that of the motor was one of the most important. The question was: Shall we copy outright a European motor? Shall we copy outright the best American motor? Shall we combine the best in American motors and make a new motor? or shall we combine the best in European motors? or shall we combine the best in European and American practice and call that the standard motor?

In effect, the latter was the program undertaken. Drawings of European airplane engines and to some extent actual engines were available in May and June when the characteristics of the Liberty motor were determined upon. The characteristics of the best in American practice were naturally present in the minds of the designers, and on the basis of this and the best information from Europe and this country, the determination of the characteristics of the Liberty engine was developed.

The first engines, as you will remember, were built in an astonishingly short period of time, a matter of twenty-eight days from the time two men sat down in a room at the Hotel Willard until a motor was set up, and two days later was ready for test at Washington.

Then there was the question of the anticipated "teething troubles." The motor has been taken to Pike's Peak and sent up the grade and tested at various altitudes; and while there have been varying reports in the public press in regard to this motor, I wish to say that the reports in some degree unfavorable which have emanated from certain sources have not been well founded. The motor has met and is meeting the full expectation of its designers. It has had, as every design is expected to have, minor difficulties and troubles, but not one of them has been fundamental to the motor itself, and they all readily admit of correction and removal; and means have been found for the improvement and correction of such troubles and the motor is now in course of active production and on a large scale.

A few days ago we saw in Detroit in one of the factories there the process of manufacturing the forgings of the Liberty motor cylinders. All of the forgings are being made in one plant, and that plant is to supply the trade with Liberty motor cylinders. The forgings are made by a hot-forging process from seamless tubing, and they were being put through at the rate of 1200 cylinders per day. The factory was planning to double that capacity and they are ready to go still further and increase capacity as the needs require.

Perhaps in conclusion I should mention two or three problems not solved yet and which are of special importance, and which I shall take the liberty of calling to your attention and recommending to your special thought and study.

One is the supercharging airplane engine: the engine which shall be supplied with means to secure the maintenance of the power at high altitudes, and not suffer the loss normally attendant upon working in a rarified atmosphere. If we have the same engine working at sea level and then soaring upward, it is found that the power diminishes with the density of the high-altitude atmosphere. Many devices have been suggested, but the problem is to realize the end in the most effective way and with the least cost in excess weight and added complexity. If we can solve this problem we can assure our supremacy in high-altitude service.

Another development is that of modifying at will or automatically the pitch of the airplane propeller. It is of small use to maintain power if the propeller is to maintain its same pitch in an atmosphere of reduced density. The engine will speed beyond the limit or the rotation speed of the engine will impose a limit upon the power which could be developed.

Some way or means is required, therefore, for properly modifying the pitch of the propeller in order that we may without undue sacrifice of efficiency cause the rotative resistance of the propeller in a rarified atmosphere to correspond in some degree to the continuing torque of the engine.

Another problem is that of the spark plug. The modern spark plug has been a development in response to automobile conditions, in response to the compression pressures which prevail in automobile practice. It is found that under the higher pressures in aeronautic service the spark plug, based on the automobile program, rapidly breaks down. The insulating characteristics are lost in one hour or two hours or ten hours, and there is a bewildering uncertainty as to the life of the spark plug under present conditions. This is one of the outstanding problems, particularly with reference to the increasing demands of modern airplane service.

One final thought is this: Throughout this trip of inspection we were very strongly impressed with the serious purposes with which the captains of industry in this field of production are approaching this problem. They realize its magnitude and its importance, and they are approaching it with high purpose and patriotism; and with the presence of such a pervading spirit in the industries of this country we are going to make good with regard to our program of airplane production. Not quite what was hoped, perhaps, in the first flush of anticipation, but we are going to make good, and the production in airplane manufacture will not he our least contribution toward settling this world war, and toward settling it in the way we all hope it will be settled.

THE SOLUTION OF THE CANTONMENT CONSTRUCTION PROBLEM

By LEONARD METCALF,[1] BOSTON, MASS.

I HAVE been asked to tell you the story of the work of the Cantonment Construction Division, an organization which did not exist six months ago, which has built in this incredibly short period of time sixteen National Army Cantonments, with 26,500 buildings to house and care for 675,000 men; two embarkation camps for 43,000 men; one quartermasters' training camp for 18,000; additions to the regular army barracks, for 100,000; repair shop units; and the semi-permanent structures at sixteen National Guard camps, to care for 462,000 men; and which has designed and purchased equipment for certain large plants for our army in France, a tremendous task involving 200,000 men, and an estimated cost of approximately $187,000,000, over three-fourths of which has already been spent. It is a wonderful story, not of planning and preparation, but of doing seemingly insuperable tasks daily, an inspiring story of loyal and effective coöperation between army officials and civilians, the one with army traditions and experience, the other with their widely different professional and commercial training.

The cantonment work is done, a splendid achievement, creditable alike to the Government, to this bureau of the army, to the construction quartermasters at the camps, to the supervising engineers and contractors, to the railroads and supply men and to all concerned.

Not a sandpapered or polished job, but rough-hewn, strong and calculated to serve. Wasteful in certain details, no

[1] Consulting Engineer.

doubt, but economical in the best sense, for the saving in time here has saved life and treasure on the long firing line across the water.

Where can you duplicate the experience, involving as it does an expediture of $150,000,000, in six months' time, three times the maximum rate of expenditure in twelve months on the Panama Canal, and which increased tenfold the normal building activities of the country, without substantial increase in the cost of materials, from beginning to end of the task, due largely to the work of the War Munitions Board of the Council of National Defense and its committees; involving meager compensation to the administrators, designers and supervisors and voluntary service on the part of many skilled advisers, who dropped important personal obligations to go to Washington for days, weeks or months in response to telegrams asking for help; voluntary coöperation and work by the railroads, telephone, electric and other utilities, and substantial expenditure without guaranty of return; contractors taking contracts to build structures estimated to cost from $3,000,000 to $4,000,000 and actually building these and many additional structures so that the final contract sums ranged from $8,000,000 to $10,000,000 per cantonment, nearly doubling the necessary construction period, but without increase in compensation, and this when the compensation upon the building of the National Army cantonments was limited, *not* to a *profit of 10 per cent*, as has so often been stated, but to a gross return of *$250,000*, averaging for the sixteen cantonments less than 3 per cent. out of which sum had to come an overhead expense of probably $100,000 and interest charges upon $600,000 to $1,000,000 of working capital amounting to perhaps $25,000 to $40,000 more, leaving a *net profit to the Contractor of substantially less than 2 per cent?*

Broadly speaking, labor costs alone have risen, following closely the local cost of union labor for an eight-hour day, with time and a half or, in some cases, double time for overtime, according to the prevailing local conditions: and even as to these, there are the extenuating circumstances of increased cost of living, the fact that the settlement of the labor rate disputes was not always left to this Board for solution, and, most serious of all, the failure of the Government to adequately control priority of its construction, which would have prevented the bidding up of the local labor markets by its own agents in different departments having contiguous construction underway.

I speak advisedly, not loosely, for the conditions of the work may not equitably be overlooked. They are vital. The work had to be done, *was* done, without delay, and no plea or excuse of inability to get labor, throughout the work, at rates prevailing at its inception, would have excused postponement of completion or have brought back life or treasure spent at the front during such delay.

Call Comes for Organization

On May 17, 1917, Brigadier-General I. W. Littell, then Colonel of the U. S. Quartermaster Corps, was detailed by the Secretary of War to assemble and direct an organization to be known as the Cantonment Division of the Quartermaster Corps, to provide facilities for training and housing the new National Army and the National Guard. He called to his aid Major, then Captain, W. H. Oury, Major then Captain, R. C. Marshall – both of the Regular Army, and Major Dempsey of the Officers Reserve Corps, the former of whom had been supervising the enlargement of some of the army barracks, the second of whom was soon engrossed in the new cantonment construction, and the last of whom took up the question of auditing construction expenditures.

Neither funds nor quarters nor personnel were available for the designated service, for the appropriation bill which carried $77,000,000 for the inception of this work was still in debate in Congress.

This was the opportunity of the Committee on Emergency Construction of Buildings and Engineering Structures of the War Munitions Board of the Council of National Defense. Of the latter Board Frank M. Scott, of Cleveland, was the able chairman.

This committee was made up of five experienced builders: William A. Starrett of New York City, architect and formerly of the building firm of Thompson-Starrett Company, Chairman; C. W. Lundoff, of Cleveland, Ohio, President of the Crowell, Lundoff, Little Company, building contractors; M. C. Tuttle, of Boston, General Manager of the Aberthaw Construction Company; Capt. Wm. Kelly of the U. S. Engineer Corps, who, however, was unable to give much time to the work of the Committee, owing to other army obligations; and Frederick Law Olmsted, of Boston, engineer and landscape architect. To their assistance they called many engineers, city planners, architects and specialists of different kinds, to act on sub-committees or to give desired advice on special subjects.

Circumstances thus made it possible for the Committee to render General Littell service in an advisory capacity on the formation and civilian personnel of his organization, on the form of contract under which the work should be built, on engineers, city planners and contractors of responsibility to design and build the cantonments, and at the moment to make the most of the time which might elapse before the appropriation bill should be passed by Congress, by preparing typical plans or layouts for the buildings and other structures involved, making topographic plans of the sites, studying the water supply, sewerage and other public-service facilities, the best arrangement or grouping of structures, adapting the typical plans to the local topography—all through the voluntary service of achitects, engineers and city planners.

Organization Adopted by General Littell

The organization proposed by the Committee and adopted by General Littell comprised four different groups, reporting to his staff officers:

- Major Frank M. Gunby, member of this Society and formerly associated with Mr. Charles T. Main of Boston, in *Charge of Design;* assisted by Major F. B. Wheaton, Captain Doten, Dabney H. Maury, Clarence Goldsmith and W. M. Johnson of the National Board of Fire Underwriters, and George Gibbs, Jr., of Boston.
- Major Robert E. Hamilton, formerly Purchasing Agent of Stone & Webster, in *Charge of Materials and Transportation.*
- Major M. J. Whitson of Seattle, formerly partner of Grant, Smith & Company, in *Charge of Construction;* assisted by a staff of division engineers, Peter Junkersfeld, Charles L. Parmlee, Ezra B. Whitman and others.
- Major Dempsey in *Charge of Accounting.*

Since that time, benefiting by the earlier experience and with a view to handling the additional work of building ports of embarkation, ordnance depots, coast-artillery posts, medical department construction, mobile ordnance school barracks, quartermasters' warehouses and miscellaneous plants, the or-

ganization has been enlarged, modified and strengthened, Major Marshall remaining in command under General Littell, assisted by Captains Thompson and Maupin; the engineering branch being still in charge of Major Gunby; the construction of Majors Whitson and Junkersfeld; the materials of Major Willcutt; finance and accounting of Major Dempsey; construction and repair of Major Zollars; the law, Major Shelby; information, Captain Erck; transportation requisitions, Captain Ritche and Chief Clerk Moreland; and several other engineers of large reputation and breadth of experience, such as Lincoln Bush, Major Betts, Warren R. Roberts, and others, have been drawn into the service, fine examples of personal sacrifice.

The Committee on Emergency Construction of Buildings and Engineering Structures first undertook to get local investigations under way and the preparation of typical building plans. As soon as cantonment or camp sites were designated by the department commanders, approved by the army staff and reported to General Littell, city planners and consulting engineers were asked to go to them, voluntarily and at their own expense, to make topographic maps, study the water-supply and sewage-disposal problems, the location of railroads, roads and other utilities, and to report to Washington with all despatch. Within a week's time, in a number of cases, topographic maps were prepared of areas of from 1000 to 2000 acres, and essential information was obtained upon the points desired. Meanwhile, leading architects and engineers of this section of the country had been summoned to Washington to assist in the revision of the plans for the barracks, the preparation of typical plans, which were afterwards adapted to the local topography, on the ground, by the staffs sent to the individual camps.

Form of Contract Prepared

Contractors, too, were assembling in Washington to see if they could be of service and the Committee directed its efforts to the preparation of a form of contract under which a work, of the magnitude then contemplated and since largely increased, could be built with reasonable certainty within a time limit of ninety days, in the face of congested transportation conditions, soaring materials and labor shortage.

A form of contract inducing speed was essential. This compelled the elimination of the financial hazard to the contractor, and for the protection of the Government the selection of contractors solely on the basis of experience, merit and integrity. It was at once apparent that the competitive form of contract dictated by past Government precedent was out of the question with the time limit available and the conditions to be faced.

Lump-sum-profit basis form of contract was weighed and rejected as likely to emphasize the idea of barter and trade rather than of fitness and competency, and to embarrass the Government in awarding contracts to more experienced contractors if lower profit basis were offered to the Government by less experienced or less desirable men.

The cost-plus-percentage basis, however, appeared to meet the fundamental requisites and the addition of a limiting lump-sum profit made the Government safe in its operation in the event of substantial increase in the amount of work done under it. The combined efforts of many able men—lawyers, engineers and contractors, as well as of various engineering organizations, produced the "Emergency Construction Contract"—a radical departure from Government precedent—which provided essentially for the construction of the work on the basis of cost plus profit, the latter varying from 10 to 6 per cent with the magnitude of the work, with the important limitation of an upset profit of $250,000, from which sum, however, the contractor had to meet his own office overhead and interest costs. It is interesting and but fair, in the face of some of the unfounded public criticism which has been heard, to note the effect of this upset limit of profit. On the construction of the sixteen army cantonments, involving a total cost of approximately $134,000,000, or upward of $8,000,000 per cantonment, the nominal profit to the contractors will be less than 3 per cent, and after deducting the probable contractor's overhead and interest costs, the *actual profit* substantially less than 2 per cent—in some cases perhaps less than 1½ per cent. Upon the construction of the National Guard camps, involving a total cost of $36,000,000, or about $2,250,000 per cantonment, the contractor's fee is higher, approximately 7 per cent, but as the overhead cost is also proportionately much higher the total return in cash for the six months' period of work is substantially less than in the cantonment construction.

Inasmuch as nearly all of the war construction work now being executed by the Government is being done on an emergency basis, where speed and not cost must control, thinking men will be careful not to criticize carelessly and will weigh fairly the influence of the time element. In the execution of work on such a tremendous scale, under prevailing labor and material cost conditions, it is inevitable that money will be wasted and mistakes made, but the work must be done—expeditiously done—that the saving may be one of lives and days, not dollars.

While the preliminary investigations were under way, the Committee sent out questionnaires concerning contracting firms in this country, seeking references, a statement of the magnitude and kind of work executed during the past two years, the number of men handled and fed at one time, and the financial resources of the concern; obtained the rating of the contractors by important financial-credit concerns, and called to its assistance John H. McGibbons, formerly of the U. S. Fidelity & Guaranty Company of Chicago, to aid it with his broad knowledge of the standing and financial credit of contractors.

Committee Selects Contractors

Armed with this information a sub-committee of five men, with Mr. Starrett as chairman, selected the contractors deemed best qualified at the moment to undertake the work and who had demonstrated in their past experience their ability to handle work of such a character and upon such a scale; and reported its findings to Mr. Scott's committee of the War Munitions Board. From the latter committee, recommendation passed to General Littell, and after submission of the evidence and recommendations to the Secretary of War, appointment was finally made by General Littell. The subseqent experience in the building of the camps seems clearly to have justified the course of procedure, and it is greatly to the credit of the Government that it can be said, unequivocally and with absolute candor, that these appointments were made on the merits of the case, as they were understood, without political pressure or "influence." It is further greatly to the credit of the leading firms of contractors that as a rule their representatives left Washington before they knew whether they were to be recommended for specific work and before appointments were made, though personal disinterestedness and unwilling-

ness to use political influence cannot be claimed for many others who sought contracts.

The Committee then turned its attention to the preparation of forms of contract for the employment during construction of the engineers and other experts necessary at the camp sites, being greatly assisted in its work by different members of the national engineering societies, who voluntarily came to Washington in response to telegraphic request, to assist the Committee.

Engineers believed to be most competent and at the moment available for service at the various cantonments were also designated, appointments in all cases being made, of course, by General Littell and his staff.

In this way the Government had the voluntary service of many men skilled in the particular field involved—in building up an effective organization and personnel for the work in hand; men who coöperated in a thoroughly disinterested way with the administrative army board in responsible control. The results attained here seem to indicate the advantage of such a purely advisory board, the recommendations of which could be followed, modified or rejected with cause by the duly constituted executive authorities.

Details of Camp Construction

Time forbids the attempt to chronicle the details of camp construction executed under the direction of General Littell and his staff. The sixteen National Army cantonment sites were approved at various dates ranging from May 31 to June 27, 1917, contracts for their construction were executed between June 15 and June 23, and work was begun between June 13 and July 6. On September 4, or in less than three months' time, about 450,000 men could have been taken care of at the cantonments, on the first-adopted basis of 200 men to the barrack, later reduced to 150 men; and today, December 5, 1917, the camps are substantially all completed, despite the great increase in construction involved by the prescribed increase in cubical air space per man in the barracks (from 365 to 500 cu. ft.), the addition of remount stations, to care for 10,000 horses at each of the camps having them, hospitals and other changes, which have nearly doubled the work originally contemplated.

The story of the construction of the National Guard camp equipment is similar, except that the work involved is only about one-fourth of that involved in the construction of the cantonments.

A few figures in regard to the magnitude of the work, involved in building the sixteen National Army cantonments, may be suggestive. There were required upwards of 800 million feet, or 37,000 cars, of lumber, and 40,000 cars of other material, a total of 77,000 cars upon the cantonment construction, without allowance for the materials ordered locally and not from Washington—the total involved in the cantonment, camp, and embarkation-station construction to October 31 being approximately 112,000 cars—756,000 squares of sheathing paper, 800,000 of roofing paper, 172,000 doors, 34 million square feet of wall board, 106,000 kegs of nails, 314,000 barrels of cement, 282 miles of wood and cast-iron pipe, 3550 hydrants, 75 miles of fire hose. The total area of land rented or controlled at the cantonments is 261 square miles.

As the construction of the cantonments was drawing to an end the work of this bureau was extended to cover the construction activities of the army, except in a few special cases, such as in the aviation corps, where it was thought wiser by the Secretary of War to leave the construction in the hands of the departments for the use of which the structures were to be built. This new work is well under way, constantly growing and broadening.

Whole Work Monument of Loyalty and Ability

As one reviews the work accomplished by this cantonment division, he cannot but be thrilled by this fresh evidence of the resources of these United States and the loyalty and ability of its people, remembering how recently and in what manner this bureau was organized; that cantonment construction involved but one branch of governmental activity and one comparatively small group of men; and that similarly inspiring evidences of effective service are to be found in all of its other branches.

If constructive criticism is warranted at such a time, it may be said that one of the greatest needs today, as it was recognized to be six months and more ago, is better coördination of the governmental construction program, ways, means and priority. The subject has been studied in its various phases by many men, but no sufficient authority has yet been delegated to accomplish substantial progress. Effective organizations of thousands of men have been built up with large expenditure of time and money, only to be disbanded on the accomplishment of their specific tasks, when these organizations might have been transferred directly to new tasks, with telling effect, had there but been the necessary government authority to plan well-coördinated effort in its construction field.

In an emergency of the magnitude created by this war, and in the face of the Government's failure to prepare for it, the question immediately arose as to the basic principle which should govern the selection of the agencies to accomplish the enormous task before the Government. Should the governing bodies be creative or essentially administrative? For instance, should the necessary design of warehouses, hospitals, power plants, terminals, nitrogen- and gas-producing works, engine and aeroplane construction, and other work, be executed by old governmental bureaus with greatly enlarged personnel, by new governmental bureaus to be created solely for this purpose, or should it be entrusted, under proper governmental supervision, direction or control, to well-established, adequate and efficient engineering organizations, skilled along these lines and competent to handle the work, of which organizations there were many in the country? Similarly, should the different army corps, with totally inadequate personnel, act as purchasing agencies, or should this highly specialized work be delegated, under governmental supervision, to existing firms of high capacity and reputation?

Mr. Balfour, in his visit to this country, had wisely cautioned against the mistake made and the loss of time incurred by England in building up new bureaus to do the work before the Government, instead of utilizing well-established and live organizations enlarged and controlled by the Government, if necessary, to the end not only of saving time and expense, but also that when the war was over the gigantic work of reconstruction and readjustment might be facilitated by the enlargement and strengthening of these existing private or corporate agencies, instead of being retarded and hampered by their disruption.

The Committee on Emergency Construction had this thought clearly in mind and predicated its efforts on the three hypotheses:

1 The work must at all times be under the superior control of the United States Government, through its duly accredited representatives

2 Services must be equitably compensated
3 Government methods of contracting for and compensating construction work and services should be such as to utilize and strengthen and not to impair or destroy existing organizations.

Unfortunately, the Government has not carried this principle as far as it might advantageously have done, but has in a number of cases built up in Washington and elsewhere new agencies for executing work instead of employing existing ones competent to render effectively the service desired, thus failing to benefit by the mistakes of England and France and the helpful advice of Mr. Balfour. But, on the whole, and in spite of the waste thus involved, surprisingly rapid and very commendable progress has been made.

BUSINESS MEETING

Address by President Hollis on Society's Activities—Presentation to Society of Bust of Rear Admiral B. F. Isherwood—Award of Prizes for Papers—Appeal for Mechanics for Ordnance Department

The annual business meeting of The American Society of Mechanical Engineers convened in the Auditorium of the Engineering Societies Building on the morning of Thursday, December 6, at 10 a.m. The meeting was called to order by President Ira N. Hollis, who delivered a forceful address upon the activities of the Society for the year 1917. In this address the President laid before his hearers a clear conception of the internal and public activities of the Society. He presented a detailed statement of the work of its Council, committees, sections and branches for the year. He described the nature and magnitude of the Society's service to the public in the war, and defined the extent to which he thought the Society could continue to render such service. The text of the President's address is appended to this account.

The Secretary said he was sure that every member would be glad to express his appreciation of the tremendous devotion of the President to the work of the Society in the past year and of the energy which he had displayed in discharging the many functions and duties of his office. He then presented formally the reports of the Standing Committees for the year, which were published in the December issue of The Journal, discussing each one in turn in detail. He pointed out that the income of the Society had risen in the last few years from $50,000 to $230,000 a year, during all of which time the activities had been continuously extended. The Society was in a unique financial condition—it had not a single dollar of indebtedness of any kind outstanding, and moreover had $50,000 invested in bonds, $21,000 in banks and $10,000 of the First Liberty Loan and $10,000 of the Second Liberty Loan—all put away against emergency. These splendid results were due to the consistent, business-like attention to our activities on the part of Mr. R. M. Dixon, Chairman of the Finance Committee, and Mr. I. E. Moultrop, Chairman of the Increase of Membership Committee. The Meetings Committee, under the chairmanship of Prof. R. H. Fernald, had devoted itself assiduously to its work, as attested by its wonderful progrom for the Annual Meeting. The Publication Committee was striving to make the publications inclusive of all engineering and the most pertinent to mechanical engineering.

Five amendments to the Constitution were next presented by Prof. F. R. Hutton, Chairman of the Committee on Constitution and By-Laws. These amendments were first presented at the Spring Meeting in Cincinnati in May 1917, and were published in the October issue of The Journal. Each amendment was, by vote of the meeting, ordered put to letter ballot.

The first amendment was to bring the Constitution into accord with the New York State Law and to make the quorum in the Council a majority. The second amendment was to provide that administrative committees be officially represented in the Council, the Standing Committees on Administration to be Finance, Meetings, Publications, Membership, Local Sections, Constitution and By-Laws. The third amendment provided for the appointment of such annual committees as might be required from time to time. The fourth amendment was for the purpose of enabling the Society to meet its greater responsibilities in public matters, while still excluding discussions of partisan politics. The fifth amendment was to remove the present bar to the approval or adoption by the Society of any standards presented through its committees or otherwise; heretofore standards have always been received, but not approved or adopted.

The next business was the award of the Student Prize for 1917 to H. R. Hammond and C. W. Holmberg for their paper on A Study of Surface Resistance with Glass as the Transmission Medium. A report of the committee on this award was made by Professor Hutton, who also presented the prize. Professor Hutton said that there was a pathetic note to be added to the report—the Society had just received information of the death of Mr. Hammond. Mr. Holmberg was present and received his prize in person.

At 11.00 a.m., while Professor Hutton had the floor and was presenting the amendments to the Constitution, the President interrupted the proceedings to introduce Lieut. B. C. Detchon, who made an eloquent appeal on behalf of the Military Engineering Committee of New York for help for the Ordnance Department—the mechanical-engineering department of the Army—which he said was in urgent need of mechanics for repair work in France. He suggested that each member present deprive himself of some of his men for the time being to supply this immediate need.

Lieutenant Detchon also appealed for aid, personal and financial, for the Military Engineering Committee, whose activities in connection with the war were manifold.

Prof. A. L. Williston called attention to the number of trained men who will be needed in this crisis, and pointed out the opportunity which colleges and technical schools have of serving their country through putting at the disposal of the Government not only their technical equipment, which is immensely valuable in this emergency, but their teaching experience, which is indispensable.

He made a motion that the Council immediately appoint a committee to investigate whether coöperation between the War Department and the technical schools cannot be started immediately to put into effect training schemes for technical men for the War and Navy Departments, which was carried. The

motion [illegible] by [illegible] E. [illegible], Prof. L. P. Breckenridge, the President and the Secretary.

Following Lieutenant [illegible]'s appeal, an impressive ceremony was held of the presentation to the Society of a bust of the late Rear Admiral Benjamin F. Isherwood, Honorary Member. The presentation was made by Mr. William M. McFarland, Past Vice-President, and the bust was unveiled by Benjamin F. Isherwood, grandson and namesake of the Admiral. President Hollis accepted the bust on behalf of the Society, taking the opportunity of paying his own personal tribute to the genius of this great engineer. Mr. McFarland's and President Hollis's remarks will be found on a following page.

The business meeting was followed by a Local Sections Session, an account of which is given in the Society Affairs section of this issue of THE JOURNAL.

ACTIVITIES OF THE SOCIETY FOR 1917

BY IRA N. HOLLIS, PRESIDENT

THE past year has been of such vital influence on the future of our profession, as well as of our country, that I desire to lay before the members a brief report of our activities and our possibilities for the future. This is not intended to replace the annual report of the Council, which is a detailed statement of all business during the entire year. The only regret I have is that the completed Council report has been delayed to permit me to make such extracts as seemed necessary toward a consistent comment upon it. The reports of Committees are, of course, in print for this session. It seems wise, on the whole, to bring the Society up to date in a general way.

The American Society of Mechanical Engineers was organized in 1880 for the purpose of promoting engineering science in every way. At that time mechanical engineering was hardly recognized as a profession. It was never distinctly a part of civil engineering, but grew out of the modern demand for men to take their places in industries and manufacturing. The few who practised mechanical engineering in the early days were essentially designers of machinery or investigators, like Leavitt and Thurston. Consequently, for many years the papers of the Society were confined to technical and educational subjects for the benefit of its members, and through them for the benefit of the public. Our Society is fundamentally educational, and that must always be its chief function if it is to continue as a society for the advancement of applied science. Through the influence of the engineering colleges and the rapid advance in manufacturing, the profession has changed, and the mechanical engineer is no longer tied exclusively to technical questions. The old guard has given place to consulting engineers who deal with industrial and power questions on a large scale, and with the management of great industries, leaving the details of design and construction to thousands of young engineers who have been absorbed by manufacturing and operating companies. We must recognize also that mechanical engineers have by training and experience become leaders in business, especially in business connected with manufacturing.

SOCIETY HAS RESPONDED TO CHANGES IN CONDITIONS

To this rapid change during the past generation, the Society, while holding to its original purpose of advancing engineering through the discussion of scientific papers, has responded in proportion to the demands of the members, to the vision of its officers, and to the needs of the country, exactly as the constitution of the United States and the governments of our commonwealths have been made to fit a growing population and a larger understanding of coöperation. While there have been differences of opinion on all kinds of subjects (and no society is in a healthy state unless there are differences of opinion), and while we may have missed some opportunities for usefulness, on the whole our Society has not failed of its duty to the country. We have never been leaders of propaganda on political and social reforms, and we cannot be without running the risk of losing our character as a scientific organization or splitting up into cliques that would destroy one another. On the other hand, our annual meetings have provided a forum for discussing and assisting great advances in industrial organization and in the art of manufacturing. It is here, for instance, that papers have been presented on a wide range of subjects, extending from test codes for power and the boiler code for the construction of safe boilers, to standardization, testing of materials and scientific management.

The attitude of the Society, as a whole, is well indicated by the character of the men who have been elected to the governing boards. They have invariably been friendly to the coöperation of the engineers with the public in the proper development of our material resources, and have been both sympathetic and responsive to the desires of the members. In going about the country during the past year, which I have done systematically as part of my duty while president of this Society, I have never heard a word of complaint against the Council or their methods, excepting in a very few cases, unhappily, open to suspicion of an unbalanced judgment. Our Society does not stand for that.

We must remember that in a national society covering the vast range of territory we have in America, there are many scattered groups that seldom come in touch with one another. The general headquarters must necessarily be in some one locality, and New York was long ago chosen as perhaps nearer the center of the enterprise of the world than any other city. The Atlantic Ocean is nothing now, and New York places us in almost the center of gravity of manufacture. Nevertheless, a group of our engineers in San Francisco, for instance, is far removed, and they seem sometimes as if they were not genuinely a part of the national society; but it is a mistake to feel any isolation. Every member of our Society ought to know that he is very likely to get out of the Society what he puts into it, and any effort toward inproving the Society or toward educating its members through scientific papers or by contribution on broad, general questions is quickly recognized.

During recent years the Sections of the Society have been regularly organized, and the Sections Committee has been established to encourage activities within every Section. There is a session at this annual meeting that will bring their representatives together for a concerted study of how to make the Society reach out even more effectively to every one of its members.

DEMOCRACY OF THE SOCIETY

The democracy of the Society cannot successfully be assailed. It has been suggested that the president has it within his power to continue his own influence by appointing his own kind of a nominating committee for the officers to succeed him. To use the language of the street, this is absolute

rot. It has not been the custom for the president or the officers to influence the choice of the new Council members, and almost invariably the whole Society has been solicited for suggestions. The consistent tendency is toward a greater participation of the members, and therefore toward greater democracy as we learn how to be wisely democratic. This Society is not an assemblage of the "bandar log," ready to chatter over the latest fad, but a union of men sincerely interested in benefiting their country through science. That we must always remember in scanning proposed reforms.

Furthermore, the Society is in the hands of its members and not in the hands of a few corporations. We must not permit ourselves to go to an extreme because corporations have sinned in the past, and because they are going to sin in the future. The directors of all corporations are human as our directors are human, and they will make mistakes over and over again, and we will help to correct them over and over again, but our Society is not a creature of any public-service corporation, and it never has been. It stands for truth in science, and it ought to help the truth in the social life of the country. Its purpose, however, is the truth in science and not a partisan conception of the truth.

One has only to take a list of the officers who have served our Society to find that all aspects of modern industrial life have been wisely represented. There is no earthly reason why our Council should be organized as the enemy of the men who conduct our great affairs, nor should it be organized as their special advocate. It is organized for the truth and nothing but the truth. Consequently, we should not as a Society permit ourselves to be led away by catchwords, nor should we permit ourselves to be fooled by a list of our mistakes. We know that no human institution ever can be freed from imperfection and mistakes will always be made. and in our country, thank God, will always be corrected.

The Society's Public Relations

It is sometimes difficult to determine how far the Society ought to go in its public relations. At this time, while we are at war, there is no limit to the sacrifice that ought to be made to the common good, and to the work that ought to be done by the members individually and the Society as a whole toward the success of our country in war. There is a difference, however, between individual activity and collective activity. This is the time when the individual can offer himself, and when the Society can best serve as simply the intermediary for assisting the individual to serve well. That we have systematically tried to do. At the present date, fully ten per cent of our membership is in service. In ordinary times of peace it is sometimes a question how far we ought to depart from the orderly discussion of technical and scientific papers. We have the right by our charter at any time to enter into legislative questions or into any of the great economic questions before the country. We have no right to take part in partisan politics, either from the point of view of the legality of our charter or from the point of view of policy with regard to the future development of our Society.

We have taken part in many things of public interest and in many things involving the public. For instance, in our Boiler Code we have affected legislation in many of the states and municipalities. In our Committee on Standardization we have done a great deal of good work, culminating finally in a general Standardization Committee to represent many societies so that we may work together. In our Test Code for Power we have had a very wide influence throughout this country on the development and design of power stations. It is not necessary here to go into the details of our activity, but I think it is easy to make evident the fact that our Society has always been one of public relations.

In connection with public relations there are sometimes great differences of view on the part of engineers generally. I have been disposed to ask the question, "Is it right that any one society of engineers should take a stand on any public question that affects all engineers without a full discussion of the subject with other engineering societies?" The engineers have only slowly come to a proper representation of themselves before the public. If we are to have our legitimate influence over public affairs we all must act together. It is only common sense then at least to thrash out subjects before a senate of the engineering societies, or what we have called an Engineering Council. To that end the American Society of Civil Engineers, the American Institute of Mining Engineers, The American Society of Mechanical Engineers and the American Institute of Electrical Engineers have joined together to form the Council for considering all matters referred to them by a single society or by our Government. It is the only method of taking up public affairs. Consequently, we may well ask ourselves the question at the present time, "How far ought any single society to act alone?"

Our Activities for the Year

I am glad to call attention to some of the details of our activities during the year. The election of Major-General George W. Goethals as an honorary member adds one more to the long list of distinguished men who have had membership in our Society. This kind of membership has never been refused, and it is rightly regarded by us as the highest acknowledgment we can make to great service in engineering. The regular membership of the Society has been steadily increasing, mainly due to the efforts of the Increase of Membership Committee and to the good standing of the Society as a useful aid to engineers who are going into mechanical engineering.

The Local Sections all over the country form a very important adjunct in this regard, and the administration has been wise in permitting them to invite non-members of the Society to all meetings. The coöperation of these Local Sections is encouraged in every way, in order that they may have touch with the sections and branches of other societies. Every engineer in the United States ought to have membership in a national society, and also some relation to the local sections or local societies. It is the only method by which we can be drawn together as engineers.

Attention is called in the Council report to the number of Local Sections in the country. There are twenty-two, one of which is a state Section, with five branches. This is a very interesting departure from former practice, and promises rich developments in the future. Every state could have its organization of engineers, with branches in the principal cities. Our Society would accomplish much good by fostering that idea.

It is not necessary for me to refer here to the Cincinnati meeting beyond the remark that it will go down in the history of our Society as one of the great meetings where Cincinnati outdid herself in the entertainment of her visitors. We met with the Machine Tool Builders' Association, and the meetings are rightly emphasized in the report submitted by the Council.

The Student Branches hold out possibilities for excellent coöperation between the colleges and our Society. This has not been developed as fully as possible, and we should, by

visits to the colleges, by cooperation with the Society for the Promotion of Engineering Education, and by a better acquaintance with the faculties, lend all possible aid toward the better education of men who are going to come into the profession of engineering. We ought to have some systematic part in education.

Our Big Work of Classifying Engineers

There has never been a more important year to our Society than the past, during which war has been declared against a strong combination of nations and the country has been called upon to form and equip a large army. We have all been eager to serve in some way. At the same time, the place for service has not always been self-evident. In the inevitable confusion, no system was adopted by the War Department or by the Navy Department in the organization of men for commissions in either service. Orders were issued and recalled for a great variety of things, so that even at this time an engineer is puzzled where to apply. Our Society has done something to help in this situation, but not all that might have been accomplished under more favorable conditions. We have joined with other societies in the Engineering Council to form a committee for tabulating the members of our Society as to their attainments, their previous experience and their willingness to serve. This committee, with George J. Foran as chairman, has done yeoman work in devising an admirable system for obtaining the information required. Inasmuch as the tabulation is a long-time piece of business, they have quickly listed several thousand names from the various societies as specialists along various lines. The names have been submitted to the departments of the Government and to the industries generally as they have been requested.

It has been very puzzling to know just how far the Society could go, as the responsibility for the selection of men and for the suggestion of the needs of the service must rest with the commissioned officers of the army and navy, under orders of the President. Wherever the Society has been requested to lend its aid in the procurement of men for commissions for special service in civilian lines, or for the formation of regiments, it has gladly responded, always supplying more names than were needed in order to be absolutely fair with all members. The members of the office force, from the secretary down, have had a full realizing sense of the obligations on the part of all of us to serve in every way and to help in the formation of an army so that our country might be most speedily prepared.

The tabulation of engineers, if carried through all the societies, national and local, will be a directory of American engineers. It should be catalogued and cross-catalogued for names and branches of the profession. There should be at least two copies, one filed in New York and one filed with the local society in which a member is resident. Such a directory can be made useful in the readjustments of our industries in peace after this war is over and in the better organization for the conduct of business. The United States never has been able to coöperate well in industries. In fact, such coöperation has been discouraged under the idea that it might in some way defeat competition, which is said to be the life of trade. Nevertheless, coöperation ultimately means exchange of information, and a resulting reduction in the cost of everything that we make.

There is another aspect of this, so far as the individual societies are concerned. Every society, and ultimately the Engineering Council, ought to provide some method to assist the younger members. An employment office is a perfectly legitimate part of our activity, and, as a matter of fact, it has been carried on by The American Society of Mechanical Engineers for many years, to the great satisfaction of many men who have found positions through the office here in New York.

The Society and Standardization

Reference is often made to standardization, in which our Society has taken a very active part for years past. The committee appointed to act with other committees will assist in placing the development of commercial standards among the men best able to pass upon them. The example of the Society of Automotive Engineers should stand as an inspiration to us toward the establishment of all kinds of commercial standards to facilitate manufacture; although it was much easier for that society to promote standardization in the automotive manufacture, because it was one of the methods by which they could get their orders filled. Where the steel industries were called upon to provide hundreds of different kinds of steel, many of them for the same purpose, and hundreds of different dimensions, where comparatively few would have sufficed, it was imperative that the manufacturers should get together, and they have done this effectively. Our Society stands at a disadvantage with respect to standards, as it has nothing of the commercial about it, and no method of forcing upon any manufacturer its findings with regard to standards. We depend, then, upon the slow process of persuasion.

One of the aspects of standardization appears in the controversy over the metric system. There is much difference of opinion about the wisdom of replacing the English units with the French units. Many sincere men believe that we ought not to make any change. Others believe as strongly that we ought. It would be wiser, on the whole, for the Society to maintain this place as a forum and to keep out of this controversy as a society until the way seems more clear. That will not prevent any member of the Society or any group of members writing on the subject, under the encouragement and for the benefit of our membership and for the benefit of the country.

One of the industries that has grown with remarkable rapidity in the past few years is that pertaining to gages of all kinds for the manufacturing of munitions and other supplies. Gages are as necessary in time of peace as they are in time of war, but not in such great quantities. The mistake made by the Government has been the neglect to accumulate a large stock of gages. Last spring in Cincinnati very strong representations were made to the departments in favor of a central locality for the comparison of gages and for certifications as to their correctness. Congress appropriated a large sum and authorized the Bureau of Standards to take on, as part of its function, the comparison and certification of commercial gages of all kinds. This is a radical departure, and it should lead to a great improvement of manufacture in many respects. Our Society has appointed a committee to serve as consulting engineers for the Bureau of Standards in connection with this new departure. We as a society are prepared to assist the Bureau, which is doing such fine work for the country.

Another question which has come up during the year grows out of a request on the part of the Bureau of Mines and the fuel administration to assist in fuel conservation. The whole subject was referred to the Engineering Council, and through the Council consulting engineers have been appointed for the Bureau of Mines to advise in regard to the technical matters connected with fuel conservation and with the use of fuel. A

committee was also appointed at the invitation of the United States Chamber of Commerce to serve with a general committee on the whole general question of fuel. During the year, committees of our Society were also appointed to assist the Bureau of Mines in various ways, but inasmuch as the war has seriously interrupted the development of the new laboratory in Pittsburgh, these committees have been inactive. Their time will come, however, and they will be able to do for our Government the work that this Society is glad to give.

Our Varied but Vital Activities

It is not necessary to refer at any length to the service of the members of our Society in the army and navy. At this time, John H. Barr, W. B. Gregory and Max Toltz of the Council hold commissions as majors in the army, and are serving in important positions. The Society itself has sent so many to the colors that we would find it difficult to tabulate them here. In fact, it is doubtful if we shall have a complete list until after this war is over. Those serving for the Naval Consulting Board and in other capacities are helping splendidly, even though they are occupying positions less spectacular than those on the lines.

The year has seen an innovation in connection with the meetings of the Council. We held in November a meeting in Chicago, in order to test the value of meetings outside of New York. It seems only right that the larger Local Sections at least should have an opportunity to meet all the members of our Council; not only for their own satisfaction, but also to inform them about the needs of the localities. It is hoped that this plan of meeting in the different large cities from time to time may be carried out in the future. The meeting in Chicago was a great success, as it brought together a very large number of the mechanical engineers. The visiting of the various Local Sections by the Committee on Sections is also an important move in making our members better acquainted with one another and it is quite certain that the journey made by the Committee this fall was useful.

One of the valuable elements of the work in the Engineering Building relates to the Library, in which all the societies share. There is no respect in which we can make our distant members feel more interested and benefited than in giving them access to the library by correspondence. Any member ought to feel free to write for a synopsis of any article or for a search, at a minimum cost, and the library should have duplicates, in order that books might be loaned. They could be sent by express to different parts of the country for use, to be returned within a specified time. This is the practice in many other libraries and it could be made very useful here.

The Power Test Committee, under Mr. Barrus, has long been giving its attention to the details of all kinds of power tests. The usefulness of their work in the past has been amply proven, and every effort should be made to assist them in perfecting the code. A hearing and a discussion in our building has been encouraged. Its results should be bountifully fruitful. It must be remembered, however, that no one group of men will know all power tests. Consequently, it seems advisable to invite sub-committees to work out the different kinds of tests. This has been planned and it is hoped that by advisory boards and sub-committees we may improve our test code.

This Society and the whole engineering world owes a debt of gratitude to the members of the Boiler Code Committee, whose patient work has benefited us so much. The Code is operative in many cities and eventually it will probably apply throughout the whole of the United States, thus promoting the safety and welfare of many men.

I call attention to the printed report of the Council, which will be issued later, for a fuller statement in tabulated form of all that we have done. The development of The Journal as a means of placing important papers most quickly into the hands of readers is extremely gratifying, and under the direction of the Publication Committee and Mr. French's excellent management it has disclosed many unexpected possibilities. The question may well be asked why we continue to publish the Transactions as a separate octavo volume when the whole of our activities may be printed in The Journal. No foreign society ever publishes duplicate transactions. If some way could be found of making The Journal a mouthpiece for all of the societies, the bulky volume issued annually for each society would have a natural place; otherwise, the extra twenty thousand dollars spent by our Society might be saved to make The Journal better.

I cannot close this brief report without a cordial acknowledgment of the politeness and consideration that I have received from Sections and members of the Society. It has been a pleasure instead of a task to serve them as president. The patience and kindness of the office force could not have been surpassed and the untiring zeal of our Secretary, Mr. Rice, for the good of the Society and of our country deserves the warmest acknowledgment from members and their officers.

Presentation of Bust of Admiral Isherwood

Address by W. M. McFarland

The honor and pleasure of making the address in presenting the bust of Admiral Benjamin Franklin Isherwood to the Society was assigned to his old friend and assistant, Commodore George W. Magee, U. S. Navy. Unfortunately, the Commodore has fallen ill, so that this honor has been delegated to me. I am sure that you will all regret as sincerely as I do that we are not to have the pleasure of hearing from his own lips the tribute of this venerable man to his former chief, whom he loved and esteemed so highly.

Fortunately, we have a copy of Commodore Magee's proposed address, which I shall read you in a few minutes; but as the opportunity is afforded me, I wish to pay my own small tribute to the great man whose memory we are honoring today.

It will always be a source of satisfaction to me that I met him a number of times, and once had the pleasure, while I was a youngster in the Navy, of doing a little work for him. My admiration for his genius and ability came from acquaintance with the work he had done, as shown in the published records; but more particularly from an intimate acquaintance obtained from older officers who knew him and all his deeds well.

Supplementing Commodore Magee's address, and remembering that our esteemed President, Doctor Hollis, was also a naval officer, and an admirer of Isherwood, I would emphasize the importance of his scientific work as a pioneer.

In these days of technical societies, great technical journals and splendid textbooks, when the general principles of the science of engineering are so thoroughly established, it is difficult for us to remember that there was a time when many of these principles were either unknown or were considered to be debatable. It is the special glory of Isherwood that he helped to establish a number of the most important of these basic principles.

As showing the state of the art in his early days as an engineer, it may surprise you to learn that a rather careful search through engineering literature showed that the first reproduction of actual indicator cards from a marine engine published in any book was given in Isherwood's work, entitled Engineering Precedents, published about 1856.

Just another word about the enduring value of his work. His reports of experiments are models of what such reports should be. They include a complete description of the apparatus; and the log of the experiment, in each case, gives all the data which could be observed, whether they were immediately applicable to the purpose of the experiment or not. The result of this is that these reports constitute a mine of valuable information; and other engineers, many years after, seeking information on an entirely different line from that for which the experiment was conducted, find in the complete and careful record just the information they want, and which often can be found nowhere else.

Isherwood's wonderful work and personality had so impressed itself upon the older men of the Engineer Corps who knew him well, that to all of us younger men he became one of the heroes of engineering. We worshiped him at a distance. Our dear old friend, Commodore Magee, was his intimate personal friend for more than half a century; and I now have the pleasure of reading his tribute, which I so greatly regret that he could not make in person.

Tribute by Commander Magee

THE pleasant duty has been confided to me of saying a few words in the presentation to the Society of a portrait bust of Admiral Benjamin Franklin Isherwood, U. S. Navy, who was for many years, until his death, one of your honorary members.

This duty is all the more pleasant from the fact that during my active service in the Navy I was associated with Admiral Isherwood during several tours of duty, and especially during that trying time of the Civil War, when he was Engineer-in-Chief of the Navy. I was a young man then, as indeed was Isherwood himself, and I worked for him with all the enthusiasm which a young man feels when he is in constant touch with a great genius and administrator. He honored me with his friendship, which lasted unbroken until his death.

The work by which Isherwood is best known among engineers throughout the world is his splendid series of experimental investigations. The most famous of these perhaps were the ones on the *U. S. S. Michigan* in 1859, to investigate the expansive working of steam. His screw-propeller experiments at Mare Island, in 1868, have, however, been praised just as highly by those who found them a perfect mine of valuable data.

He availed himself of the great shipbuilding program during the Civil War to make further experiments on expansion, on the use of superheated steam, and on the use of forced draft, to mention only a few of the many. The great value of this experimental information was so thoroughly appreciated by the profession that the results were published in book form by subscription.

Isherwood was a wonderful engineer. Loving him as I did, I may be pardoned for saying that I think he is the greatest marine engineer who has thus far appeared in our country. I fear that it is not appreciated as it should be, however, that he rose fully to all the responsibilities of his great office and was not only a great engineer, but a great administrator and executive.

When the Civil War was over he was criticized by good men who were engineers, but not administrators, on the ground that the machinery of our naval vessels during the Civil War was unduly heavy. They forgot, what Isherwood remembered, that his duty was not to provide the lightest machinery—with possibilities of breaking down in the hands of inexperienced men—but to provide machinery which would not break down and which would enable our vessels to be always ready to answer every call upon them. Many of the brave men who volunteered for service as engineers during the Civil War had little or no experience with marine machinery, and to have designed the engines which were to be entrusted to their care according to ordinary methods would have been almost certain to invite disaster. As a matter of fact, the machinery did not break down, was highly satisfactory, and carried our flag to victory. To my mind, this is one of the greatest glories of his career.

If time permitted I would love to go into detail about this remarkable man, telling of his broad general culture, his interest in art and music, and his remarkable felicity in the preparation of engineering papers. The older engineers in my audience know these things, and the younger ones can learn by reading what he wrote.

He retained his mental faculties in their full vigor to the very last, when he was more than 90 years of age. On one occasion, only a few years before his death, I was with a party of younger engineers who had called to pay their respects. We were all amazed at the wonderful range and accuracy of his memory, and even more at his intimate knowledge of the engineering questions of the day. His remarkable gift of fluent and lucid speech was strikingly evident, and we felt that we had enjoyed one of those rare treats where the wisdom of the sage is clothed in the elegant diction of the accomplished scholar.

A number of his friends and admirers, with the hearty approval of his family, believing that there could not be a more fitting place than the rooms of this Society for its permanent location, have commissioned me to present to the Society this portrait bust of the great engineer. Here, it is in fitting association with other busts, paintings and photographs of the leaders of the profession, many of whom were his contemporaries and by all of whom he was held in the highest esteem. And here, while engineers of the future gaze upon the features of this famous master in their calling, they may reflect upon his achievements which have added luster to the profession, especially as a great engineering executive whose genius contributed so essentially to the carrying of our flag to victory.

Dr. Hollis's Acceptance of the Gift

LADIES and Gentlemen, my old friend who sits on the stage, I accept this bust on behalf of our Society, to be placed in our little hall of fame that we may carry memories on to those who are going to follow us in this Society. It is with a certain amount of emotion that I personally stand here to accept this bust, because I knew Mr. Isherwood when I was in the Naval Academy, and I served him in a similar way, after graduation, as Mr. McFarland served him—the proudest service, perhaps, of my life, and one of my great memories is to have seen him and known him and known that charm to which Mr. McFarland has referred. I think of him as perhaps the father of our great research laboratories in engineering, as his investigations in connection with steam engines and with boilers preceded all of our schools of mechanical engineering.

I think of him also as the father of high speed on the sea.

Few people realize that it was Benjamin F. Isherwood who during the Civil War planned and carried to its completion the first ocean greyhound, a ship which went outside along the Jersey Coast and made four hundred miles in one day with ease, something that was not equalled again for twenty years. With a certain characteristic slowness in carrying things to completion, his ship, built to run down the *Alabama*, was not completed until the *Alabama* had been run down by another ship.

I think the rooms of this Society constitute a fitting place to put this bust as the example of a great man who can stand to us as a double father, the father in research engineering and the father of ocean navigation. I thank, on behalf of the Society, the family which has contributed this bust, Mr. McFarland who has made the presentation, and the small boy who has unveiled the bust, for giving us this treasure to be carried upstairs and placed in our rooms.

MANAGEMENT SESSION

Important Papers and Discussion on Some of the Modern Problems of Management, Including the Woman Worker in the Skilled Industries and the Re-education of the Crippled Soldier

THE American Society of Mechanical Engineers helped to contribute to the solution of war problems of the day by holding on Friday, December 7, an all-day session on the subject of Managament. The morning was devoted to the vital question of the Employment of Women in the Skilled Industries. A paper was presented by John W. Upp, of the General Electric Company, on the Woman Worker, and an address was given by C. B. Lord, of the Wagner Electric Manufacturing Company, on the Psychology of Environment. Invitations had been extended to manufacturing companies throughout the country to send representatives to the session or to outline their practical experience in the employment of women on the questionnaire prepared by the Society. Representatives from many manufacturing plants were present, who added to the discussion by relating the very interesting and enlightening experiences encountered by their respective companies.

The paper by Mr. Upp is here given in full, and is followed by the remarks by Mr. Lord and an abstract of the discussion at the session.

THE WOMAN WORKER

By JOHN W. UPP, SCHENECTADY, N. Y.

EARLY in 1917 it was necessary to materially increase our manufacturing facilities in one line in which the writer is particularly interested. It was evident that we could not obtain enough men employees to operate the equipment which was purchased for these increased facilities; we could see that this lack of sufficient men employees would continue and increase rather than decrease our difficulties; and we knew we could obtain men for our facilities only if we withdrew them from other manufacturing departments or companies which were occupied on actual or related Government work. After thoughtful consideration we decided to make a definite attempt to use women operatives instead of men on all classes of machine work. Our plans were made accordingly, and the accompanying photographs will give you at least a little conception of the work that these women are doing for us.

In our minds, and in yours no doubt, there has been a feeling that women are not suited to operate complicated machine tools or to do the work that is required in a modern and high-grade machine shop.

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Thus the solution of the first problem, What can a woman do? would determine the measure of her value to us. The answer is extremely interesting and satisfactory, for we have found women under proper conditions and with proper training almost, if not quite, the equal of men on the work to which the women have been assigned.

We have been much surprised at woman's strength and endurance and are now willing and ready to assign her to duties which were until recently assumed to be entirely beyond the scope of her ability. She is remarkably quick to learn. With only a short intensive instruction many women are working at duties which we would only give to apprentices of two or three years' training.

We have found, however, that it is necessary to recognize some fundamental difficulties if women are employed in these unusual occupations. In considering her ability to successfully withstand work in the factory, it should be remembered that she is not so strongly built as a man, that she is not so tall, that her reach is not so great, that she cannot stand so long, that she is unsuitable for the lifting and carrying of heavy weights, and that she must have a great many conveniences that men do not require. Thus it has been necessary in all our machine operations to greatly change our methods of handling the work. This is so arranged and the carrying trays so constructed that it is impossible for a woman to obtain a load that is greater than 50 pounds, except where the size of an individual piece makes such a limit impossible. Stools or chairs are provided where possible and short rest periods have been found to be advantageous in many cases.

All the states have quite stringent regulations in reference to rest rooms and hours of employment for women. We have always felt that it was desirable not only to live up to the letter of such laws but to provide facilities beyond those which were required, because most encouraging responses have been made when we provided additional facilities and conveniences.

We do not feel that any employer should encourage women to work in his shops unless the conditions are suitable for such employment, and that a very serious error will be made if employers put women to work in the machine shops under conditions which men are willing to endure.

In hiring women, especially for tasks which are new to them, several points should reeeive their proper share of consideration so that both the company and the employee may benefit by the partnership.

Careful attention must be given to the character of the

women employed and more thorough investigation must be made of their references than in the case of men, for the employment of one undesirable woman will frequently destroy the usefulness of a large department. All the women working in any section must be acceptable to the other women or resignations with or without explanation will be apt to take place rapidly.

We also found early in our experience that women between the ages of 18 and 31 are more adaptable and learn more quickly than those who are younger or older—those who were younger than 18 not having reached a period of physical development which warranted their undertaking strenuous factory work, and those who were older than 31 being so fixed in their habits that they do not learn quickly enough to suit our purpose. In this experience, however, the employment of women has not differed materially from what it would be if we were employing men under the same conditions, for it is probable that if we completely changed the environment of men they would not be easy to instruct unless they were within the age limits specified.

WOMEN OPERATING SCREW MACHINES

We have not made any attempt to discriminate between unmarried and married women, except that we have investigated every acceptable applicant with minor children to assure ourselves that she had means of having her family taken care of while at work in the factory.

We begin to train a woman for her duties immediately after she goes to work. We never add many women to a department at one time, as we have found it impossible for an instructor to give to each of many new employees sufficient attention to obtain satisfactory results. If we take on too many women at once it is necessary for them to wait some time for instruction. In this interval they become discouraged, impressed with the thought that they will never learn, and usually nearly all those who have not been given the undivided attention of the instructor during the early days of their employment, resign, apparently having reached the decision that the work was going to be so difficult that they could never learn how to perform it. But when the new employee can be given the undivided attention of the instructor and can have the operations explained until understood, there has been laid the foundation for a probable permanent employee, and one whose work will in almost every case be satisfactory. We attempt to instruct two women at one time on each machine tool, giving them alternate opportunities to operate the machine tool themselves, but under the immediate and direct supervision of the instructor who is assigned to that particular job.

We found early in our experience that we had a smaller percentage of failures when our women employees came from the industrial walks of life, that is, from families in which the husband, brother or father was a mechanic. The women then understood many of the machine operations, particularly if they had a sewing machine at home or were familiar with modern household apparatus. If we drew our prospective employees from those walks in life where the men of the families were engaged as bookkeepers, clerks, or on similar work, the women had to receive much more instruction and they were more easily discouraged.

We find it difficult to teach women to operate screw machines, but when they learn, their work is as satisfactory as that of men; and on the lighter screw-machine work we are having the remarkable experience of finding their work more productive than that of men. We do find it difficult to teach women how to operate milling machines and we have had many failures, yet we have women operatives on milling machines doing high-grade work as efficiently as it can be done by men. We have found it difficult to teach women to operate lathes, but now have good women lathe operators in our employ. It has never been difficult to teach women to operate light punch presses, and although we have always considered heavy-punch-press work a man's job, we now have women operating heavy punch presses in an entirely satisfactory manner. We have always considered the assembly work on some of our more important operations as being essentially the work of the man who had been trained as a mechanic; but we now find that when properly instructed, women can do this work in a way that is entirely satisfactory to us.

TYPE OF CLOTHING WORN BY WOMEN ENGAGED IN SHOPWORK

It has been necessary to more closely supervise and inspect the work turned out by the women than by our regular run of men employees, for few women have any conception of the importance of dimensions, or any judgment as to mechanical strength or requirements. Therefore, they work by instruction rather than from any inherent mechanical knowledge. But you can be sure that once a woman employee is taught how to use a gage or learns what constitutes satisfactory work, the good work produced in the afternoon will be ex-

actly the same as that produced in the morning. The judgment which is frequently so disastrous on the part of our men employees will not enter into the work of the woman operative. She will follow instructions absolutely. Therefore, it is extremely important for the instructor to go into the minutest detail when he is outlining the character of the work.

We have found it very difficult to teach women the difference between a dull and a sharp cutting tool. But all the difficulties mentioned, as well as others, are within the possibilities of correction; and there is no inherent reason why the women of this country should not do most of the work in our machine shops, although regulations governing such work must be more carefully stated and followed than when men alone are employed.

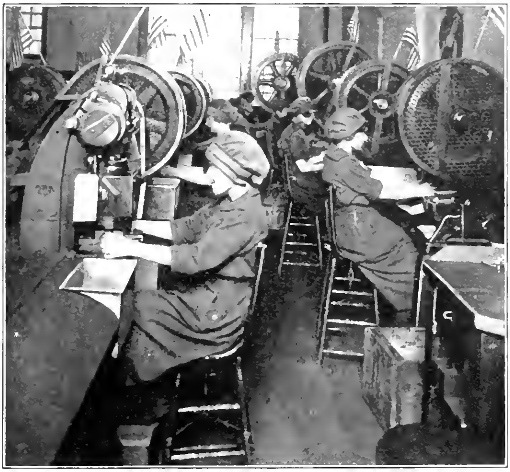
As a rule, the best results are obtained when the supervision of work is under the direction of men, although as immediate superiors of the women other women can be used to advantage.

When a woman begins to work in the factory it is of the utmost importance to impress on her the need of great care in the handling of machinery and also to explain that we are going to coöperate with her in keeping her free from accident hazards.

Difficulty with the clothing of women engaged in shopwork has been one of the most important problems we have had to solve, since loose sleeves, thin waists, skirts and unprotected hair are not safe in a machine shop, and to meet this problem we have encouraged the use of clothing more in keeping with factory conditions.

Women Operating Light Multi-Spindle Drills

When we originally adopted our plans there was some uncertainty as to whether we should ask our employees to wear the type of clothing shown in the accompanying photographs; and in order to settle the question once for all, the matter was submitted to the workers in a certain department for their own decision. We had had a few minor accidents due to loose sleeves, uncovered hair and loose skirts, and it was evident that in order to protect our workers it would be necessary to adopt some type of clothing which would remove that industrial risk. We arranged for a conference with our employees in the department mentioned and left to them the selection of the clothes which they should wear. We explained to them the reason we were increasing the number of women, that it was necessary to have these women to take the places of men, that we intended to employ more and more women in the future, but that we could not forgive ourselves if we permitted their employment to result in



Women Operating Light Punch Presses. The Wire Guards Have a Smaller Mesh than When Men Operate the Machines

accidents which might ruin their usefulness in future years. The conference was a most interesting one and the results were surprising; for of those who attended, 98 per cent voted, after a half-hour's consideration, to adopt the clothes which are illustrated in the cuts that accompany this paper. Of course, we do not ask or want our factory office employees to wear clothes of this type; they are only recommended and used in the factory proper.

Machines must be somewhat more carefully safeguarded if women are to operate them than if men were doing the work. In general, safety for women who wear proper shop clothes is provided by the same safeguards as for men, except that with wire guards it is necessary to make the mesh smaller so that the hair cannot get through and to place the guards farther from the moving parts.

The segregation of operatives has been given a great deal of attention. Until the present emergency we have made an attempt to separate our women employees from our men. We do now arrange to have our women employees quit their work a few moments earlier than the men so that the women can leave the factory without confusion, but we are making no attempt to separate them from the men in the manufacturing departments. They of necessity work on adjacent machines, for when the man who operates one of a line of machines is called to military duty we cannot move that one machine from its desirable location, but we can train a woman to operate it. Where the number of women in a department is relatively small, the desirability of segregation is most evident, and if it were possible we would segregate operations; but it has not been difficult to entirely control the situation by proper supervision, and now that our men are

becoming used to women workers, the interruptions and confusion have practically disappeared.

We have found in all classes of factory operations that women are more attentive to their work than men. They are more prompt, observe factory regulations in a better manner and, in general, are neater about their work, but we have not been able to impress them with the importance of being on hand every day. Many seem to feel that it will be perfectly satisfactory to be absent occasionally, particularly if they have any household duties to finish, and for this reason we have been careful to select those women who can be entirely relieved of such responsibilities if they enter our employ. Our record of absences of women is as a rule about 20 per cent greater than it is in the case of our male employees.

I have mentioned changing occupations in the manufacturing departments. We have also carried on a most successful experiment in the employment of women in one of the estimating departments. We have always employed many women secretaries, stenographers and clerks, but until recently have not found it advisable to employ women who were graduates of women's colleges in our commercial estimating departments, there having been a sufficient number of men trained in technical colleges to fill our requirements.

The withdrawals for military service, however, have practically exhausted our supply of technical graduates, these young men being the first to take part in military activities. We found ourselves, therefore, without a sufficient force to carry on our work, and, recognizing the situation, employed a group of college women, who are taking up the work heretofore carried on by the younger technical graduates. These young women had no technical training. They are, however, well educated and we selected those who had specialized in physics, chemistry, or other work of this character when we made our appointments. Then we immediately started an elementary course of instruction. The activity and interest of this group of young women is all that could be desired. They are more anxious to learn than the young men. The majority of them are not only anxious to earn their own living, but are most anxious to do some definite work which will release additional men for military duties. It is as yet too early to make definite statements in regard to what has been accomplished, but the situation is most promising and there is no reason to believe that our experiment will be anything but successful. This change cannot be brought about in a moment, however—there must be painstaking education and at the same time patience with inexperience.

As to the future, who can predict? Will the women we train on the work of men desire to retain their positions? It would be a wise prophet who could give a true answer at this time. But it would appear from our experience with thousands of women who have worked on the lighter machine-shop and assembly operations, that these women are always looking forward to the time when they can leave their industrial occupations and take care of a home of their own, and I do not believe that there will be any different condition after the war is over. The women who are entering our employ are prompted to do so because they are trying to do their part and because they desire to assist or supplement the family income. And it is probable that the larger number will desire to drop their factory work on the day that their husbands, brothers, or fathers return and are able to do the work for them

PSYCHOLOGY OF ENVIRONMENT

BY C. B. LORD, ST. LOUIS, MO.

PSYCHOLOGY, either accidental or predetermined, is the basis of successful management. Walter Dill Scott says, "The time has come when a man's knowledge of his business, if the larger success is to be won, must embrace a knowledge of the laws that govern the thinking and acting of those who make and sell his products as well as those who buy and consume them."

A knowledge of these laws enables us, when making rules, not to forecast with certainty, of course, but to make an inspired guess as to the effect of any cause in advance of its execution, and thus to lessen harmful experiments.

The part of this discussion assigned to me mentions environment only, but we must not forget that in this case environment has a direct bearing upon heredity, and that most of our troubles are psychological. When the wise man said that the training of a child began thirty years before its birth, he had in mind the physical wellbeing of its mother and the moral training of its father, for both of which, as employers, we are largely responsible.

As I see my duty, it is to secure maximum efficiency. This includes maximum average output, continuity of attendance and employment, a minimum of mistakes, and the anticipating of future requirements. If this entails analysis of mechanical requirements, a clean factory, and surroundings tending to cheerfulness and begetting modesty, than I am going to do all these things. If securing the desired results necessitated doing the opposite, that would I do. Therefore I want to disclaim any benevolent interest and put the matter on a practical dollars-and-cents basis. I can more readily do this, as it has been my experience that maximum of efficiency is secured by attention to the details just enumerated.

We find that contentment in woman is not induced by allowing her too great liberty of action, but rather in laying down strict rules for her guidance. When she becomes habituated to these rules, she accepts them as logical limitations and is content, provided always that they are just, equitable, and for her ultimate good.

Dissatisfaction with surroundings is a prolific cause of discontent. The same building, the same old stairs, the same rough bench and the same work contribute to this—unless the worker be sister to the ox—in mental fatigue. And as these influences are cumulative, a crisis is possible at any time, affecting maybe the individual only, perhaps the group or mass—trifles, perhaps, and yet such slight irritation has caused more murders and started more revolutions than has oppression. And so cheerfulness is an important factor.

The temperament of woman makes her acutely sensitive to color. She is influenced longer by the mourning she wears than by the loss of the departed. She also has an intuitive desire to decorate herself, and to be opposed to surroundings that satisfy the average man. This desire, carried too far, is destructive of efficiency, as is also an entire lack of it, but we can at least cater to her innate delicacy to the extent of having neatness and cleanliness. And so in harmony with this idea all machines that are operated by girls are painted with a white, oil-proof enamel, not as a fad, but to promote cheerfulness. Our floors are scrubbed, not impulsively, but regularly. Our toilets are clean, not disinfectantly, but soap-and-water clean. It would seem beneath the dignity of an executive to be responsible for clean toilets, yet it is indicative of his management.

Personally, I am tending more and more to the conclusion that the efficiency of men and women lies as much in their mental attitude as in their manual skill. I do not mean by this that contentment makes them skillful. It does not, but if they possess a certain skill, contentment enhances their productive output and lessens their liability to mistake, hence increases their efficiency.

Woman is more self-conscious, probably I should say sex conscious, than man. This is indicated by her inherent fear of men in general, and her equally inherent desire to attract man in particular. In this latter the decorative instinct comes into play and begets clothes consciousness. While it is common to both sexes, it is intensified in woman.

During investigations which I made as to the influence of wages on morality, I came to the conclusion that while there was no general connection between the two, where immorality did exist it was due to a desire, not for better education, or food, or surroundings, but for better clothes either to arouse the envy of her fellow-workers by outdressing them, or to mingle in society beyond one's means.

The point of all this is that no woman who is clothes conscious is efficient, and any woman who is either not as well dressed, or is better dressed than her neighbor, is clothes conscious. The obvious answer is uniformity of apparel, but with sufficient latitude to permit the exercise of individual taste. We have found the remedy by furnishing at cost an unfadable blue chambray. I want to emphasize the unfadable, for it is this that makes it successful, and as the waist is the most in evidence, and most abbreviated, we require a uniform waist and apron.

The success of the uniform depends upon an absolute enforcement of the rule. It is one of the peculiarities of feminine psychology that women will obey almost any rule, however disagreeable, if it is enforced impartially; but if favoritism is shown trouble immediately results. Having in mind the pleasure women take in showing their clothes, and also that they may want to go shopping on Saturday afternoon, we make it optional with our women employees whether they wear uniform waists or not on Saturday.

I mentioned as one of the features of my duties the ensuring of a future supply. Marriages in our plants average nearly two per month where both contracting parties are employees. These marriages are invariably successful because they are the result of observation, one of the other, under the most commonplace conditions, and not the result of proximity of one to the other, each in his best clothes and on his good behavior. The uniform waist is a big factor in this; it gives girls a clean-cut, neat appearance, with only the advantages nature gave them.

In some factories girls are wearing overalls, but I think it will be found that they, or the ones responsible for the decision, were rather masculine. In my estimation, this masculine tendency accounts for much of the feminist agitation of the present day; it also accounts for the increased efficiency of women, as the reasoning and point of view are more masculine. This type also lacks acute sex consciousness and looks a man straight in the eye, but unfortunately it also has the masculine moral aggressiveness, or I might say a lack of feminine retirement, and constitutes a dangerous element in the shop.

In an article which I recently wrote for *Industrial Management,* I described our method of combating this condition, and do not wish to reiterate, but I am reminded of Katherine Blackford's remark to me in this connection, that a man's passion is the dynamo that determines his ability; but of course, she did not mean that he has to violate the social code just to prove it.

According to Blackford, man may be classified by eight cardinal attributes, but for practical purposes woman may be classified as masculine, feminine, short- or long-fingered, phlegmatic or nervous, usually interchangeable terms, and sometimes blonde or brunette, for there is considerable wisdom in the maxim, "Send a blonde salesman to secure customers, a brunette to keep them."

In considering comfort and contentment we must bear in mind that fatigue may be caused by position, by improper form or height of seat, improper foot rests, or lack of them, awkward fixtures, left-handed girls on right-handed machines and other minor causes. These are all remediable troubles, but unless adjusted they cause girls to quit, and foremen to discharge them. It should not be forgotten that as the poor workman quarrels with his tools, so does the poor executive complain of the labor material at hand, and tells what he might do were it better.

I do not know whether or not the question of pay comes under the head of environment, but as much of it goes for clothes, perhaps it may be classed as such. It is a perplexing problem and one which must be settled locally, depending, as in other things, upon supply and demand. A woman is not as strong as a man, but is more dextrous; she has not the reasoning power of a man, but has a quicker mind. Where either of these attributes add to her ability, she should reap the advantage. Where piece rates are set, they should apply equally to both sexes, but when I am asked should she receive equal hourly compensation with a man, I must answer no, but she should receive as much as, or more, than a good-sized boy.

I will conclude as I began, by quoting Scott, who says, "Psychology is, in respect to certain data, merely common sense—the wisdom of experience, analyzed, codified and formulated."

DISCUSSION

J. N. Bethel, of the Taft-Pierce Manufacturing Company, said that his company most successfully employed in their surface-grinding department, 32 women surface grinders, who at one time were making for the Lanston Monotype Machine Company the molds for casting type, which called for a high grade of workmanship. Four of the machines were operated for several months on work that called for absolute figures with an allowable error of less than 1/10,000 in.

About twelve girls work on milling machines. They are not mechanically qualified to set up their machines, but when given good rigging hands and set-up men to set up their work, plus close supervision and careful instruction, they do very well, indeed.

Thus far girls have not been employed on the screw machines, but an alternative department is being installed to teach girls how to operate screw machines, also lathes and milling machines and cylindrical grinders.

Mr. Bethel was certain that female labor would be used to a much greater extent in his plant that ever before, and he believed that with the aid of the alternative department, girls would help solve the labor difficulties.

John W. Higgins, of the Worcester Pressed Steel Company reported that his company had been exceedingly successful and pleased with their experiment in using girls on press work in the manufacture of munitions, that is, on large cartridge

cases, helmets, etc., both on screw-machine work and press work, and especially in inspecting and gaging. They are deft, and uniformly more successful than men in these operations. Classes are being planned in the boys' trade school and girls' trade school for preliminary instruction for girls who have not worked in mills, in operations of inspection, gaging and assembling, and also to familiarize them with machine-shop methods and practice, especially with a view to their protecting themselves against accidents by teaching them the dangerous points of a machine, and also how they may conserve their strength.

Frank E. Blake, of the Remington Arms-Union Metallic Cartridge Company, stated that his plant had employed women for about forty years. In their new rifle plant, which was organized and equipped for men exclusively, and where up to a year and a half ago none but men were employed, 1300 girls and women are now very successfully employed, and very largely through the efforts of the 1300 women their output has jumped from 300 a day to 5000 a day. The women are employed in milling, drilling, polishing, filing, inspecting, and all of the operations in the shop which do not require man's strength.

A uniform has been adopted consisting of an apron and a net cap, which provides the ventilation that a closer woven cap would not give, and an apron of an approved design.

The speaker felt that the girls in the shops would stay there whether the war stayed or not. They have a place there, they are doing good work, and work that is satisfactory to the management. In one shop upward of 5000, and in the other about 1300, are employed.

L. W. Wallace, of the Diamond Chain Company, pointed out that the employment of women in the Diamond Chain Manufacturing Company was no experiment, as it had been done for 25 or 30 years. At the present time 30 per cent, or 300, of the factory force is composed of women. They are used successfully on punch presses, light and heavy assembling machines, automatic machinery of all sorts, drill presses, where they operate a gang of eight drills, and countersinkers, and on assorting, gage-inspection and assembly work. Women in the engineering office are doing drafting work. Two university graduates are in charge of the bonus department and cost department.

There is a woman called "Director of Mutual Service" who looks after the welfare of the women, their wage increases, their discipline, their discharges, their disputes. Through her the whole plane of the factory has been raised. Men and women work together, they check out on the same clock, get their pay from the same window, wash up in the same place. Profanity and obscene stories are absolutely barred, and because of that college graduates and high-school graduates are coming in and the general plane of the factory is being very much raised, and thus there is no trouble in attracting to the factory a high type of young womanhood.

Mrs. Harry E. Henstis, superintendent of women in the Ross Rifle Works, Canada, explained how the women of Canada volunteered as did the English women, and as the American women are doing, as munition workers, supplementing men for war service. They went in as machine operators, on drills and on all the other machines. There are three women experts in rifling. They set their own machines, grind their own cutters, and give an output in quality and quantity as high as any expert man rifler.

Miss Kate Gleason, Mem.Am.Soc.M.E., emphasized the fact that now the best class of women are attracted to the work in the skilled industries. In years past they were used on automatic machinery, which deadened their minds. Miss Gleason cited the case of a woman in Berlin, employed at the Deutschen Waffen Fabrik, who had been one of the many ordinary women employed there, but when the man at the head of her department had to go to war, she was given his place, and now is full of the pride and power of a real job.

Another woman in Rochester, forelady of a shoe factory, invented team work in shoe manufacturing. Through it her employer made a great fortune and it cut the price of shoes in two.

Major Frank B. Gilbreth brought up the question of the elimination of unnecessary fatigue.

This question of unnecessary fatigue in the industry is not to be confused with necessary fatigue. We expect workers to go home fatigued when night comes, we will insist on their having enough work to be fatigued when night comes. The proposition to be discussed is unnecessary fatigue. A fatigue survey should be made in each plant. A fatigue survey will bring out the fact, for example, that women use the wrong kind of chairs. Nearly all women insist on trying on their shoes before they wear them, but many in this country, certainly not one per cent, have had chairs assigned to them, with their names or numbers on them, and yet the necessity for that is perfectly obvious. The idea of assorting people by the top of the head from the floor, when it is the elbow that determines their length from a sitting or standing position, is ridiculous.

Major Gilbreth agreed with Professor Kimball, who, in speaking at the luncheon on Thursday, stated that mechanical engineering consists of almost everything in the world. He further continued, "I also agree with him on the psychology of management, and yet how little we act, from a psychological standpoint, having the employees and employers get in the habit of meeting on some subject, coming together during the period of lockouts and strikes, and if they would take this subject of the elimination of unnecessary fatigue as one typical case that they have no scrap about, and get in the habit of agreeing, it would be of great benefit."

A. W. Marshall related an experience with two damage cases against employers on behalf of girls who had had their scalps torn off on account of working near moving machinery. Such accidents can be very serious, and in both these cases the girls had their entire scalps cut off, and they were mutilated for life. Therefore it is of extreme importance that the women's hair be protected, either by caps, or by having the machinery amply protected. Both of these injuries were due to the fact that the shafts on which the hair was caught were charged with frictional electricity, which attracted the hair to them.

E. J. Poole took up several questions concerning the employment of women in the steel industry. First, in the matter of lifting, it was found that up to a certain point women were just as efficient as men. He told of an amusing incident of a man who was an employee in a wire mill who was continually complaining about having to lift the heavy coils of wire. One night his wife brought his supper to the mill and said to him, "Where are those heavy coils you have been complaining that you have to lift?" He pointed to them. They weighed probably from 10 to 70 pounds. She was rather husky and with

one hand picked up a coil and threw it on the reel. Immediately everybody began to chaff him and we have never heard any complaint from him or from any other man doing that same class of work.

As to the question of mixing nationalities, this should be done in order to avoid trouble.

On the question of wages, the system that has been very successful in England has been followed, namely, two-thirds of the wages of the men who are on that particular job. When the women become proficient they get the full wages of the men. If it is piece work they get the same piece-work rate that a man gets.

On the question of close work, in grinding for example, women do a great deal better work than men formerly employed.

Professor G. F. Blessing spoke of the research work done in Swarthmore College. Swarthmore College is a coeducational college, and it seems that the ideal we are striving for is to fit men and women for the same industry.

Professor Blessing described how fatigue-elimination day was observed at Swarthmore.

"We had our juniors in drawing and kinematics design fatigue-eliminating devices that might apply to their own work. For example, they would design a student lap board—that placed everything in a convenient and unique position. Another designed what he called a desk combination or help, on which he arranged all the things that he used in his ordinary studies in the most convenient place possible, and from that we worked along. In the shop we built a couple of Mr. Gilbreth's chairs, and we wrote to a number of the business and manufacturing men in Philadelphia to send us out such devices as calculating machines to be exhibited, and so we kept open house in the engineering laboratory during that day, and had all the students go through. In my class I had them write a report on conditions that they found wrong in the college."

Prof. F. R. Hutton, the chairman of the meeting, recalled the visit of the society to the Cash Register Company of Dayton, Ohio. The very best quality of women workers were secured by the simple means of allowing the women to leave the plant at five minutes of five so that they might have the advantage of going back in a trolley car from the cash register works into town a little ahead of the rush.

The following companies outlined their practical experience in the employment of women in the skilled industries on the questionnaires sent them: E. W. Bliss Company, Mergenthaler Linotype Company, Worcester Pressed Steel Company, American Locomotive Works, Brown & Sharpe Manufacturing Company, Hamilton Gear and Machine Company, Canada, P. W. Ellis Company, Limited, Canada, Canadian Fairbanks-Morse Company, Limited.

The Engineer, the Cripple and the New Education, by Major Frank B. and Lillian M. Gilbreth, was the next feature of the session. The paper is given here practically in full.

THE ENGINEER, THE CRIPPLE AND THE NEW EDUCATION

By FRANK B. GILBRETH and L. M. GILBRETH, PROVIDENCE, R. I.

THE purpose of this paper is to report progress in the solution of the problem of training the crippled soldier. At the present stage of the work we are able to formulate certain conclusions that have a bearing upon the activities of this Society and upon the part that the Engineer should take in the Crippled Soldier work.

These conclusions are as follows:

a The Crippled Soldier problem is practically identical to the problem of the cripple in general

b Its solution lies in a new type of education

c This education is destined to be the education of the future

d It is based on

(1) Finding the *one best way to do work*

(2) Adequate assignment to work, i.e., intensive vocational guidance

e The engineer is best fitted to determine the one best way to formulate it into methods, and to supply necessary devices and mechanical appliances.

All cripples, no matter what the cause of the crippling, require a training that will be mentally satisfying and physically beneficial. This training must be such as will enable them to become productive members of the community, and to remain on the world's payroll. This implies either competing with non-crippled workers in occupations open to all, or setting aside certain work for crippled workers exclusively, or both. It implies discovering and making available such opportunities for crippled workers, discovering which cripple is best fitted to utilize the opportunity, and training him to make the best possible use of it. It also implies not only opportunities for individual development, but such social opportunities as will enable the cripple to fit back into the ordinary social life with the greatest ease and the largest amount of durable satisfaction.

Those crippled in war furnish a small percentage of the total crippled as compared with those crippled from other causes, such as disease and accidents, especially in the industries. This is true even in Canada, which has furnished such a remarkable quota of fighting men in comparison with the total number of her population.

The solution of the crippled-soldier problem as outlined above consists of a type of education that is *new* in that it eliminates the greatest amount of waste possible in the educational process. It teaches *the one best way* at the outset, instead of following the old practice of "learn every way," with the vague hope of arriving at efficiency as an outcome. It enables the learner to arrive at a desired outcome with the greatest amount of speed and the least amount of effort, and with the largest return in efficiency and the resulting satisfaction.

This new method of education, discovered as a result of synthesizing measurements of champion workers in our *quest of the one best way to do work*, is spreading through the general interest in re-educating military cripples to the re-education of all cripples into the manual-training schools, corporation schools and the general educational fields.

Two Phases of the New Education

The new education has two parts: first, discovering the one best way to do work, and second, testing the individual and placing him at the demonstrated most appropriate work. By "work" we mean activity of any kind, whether physical or mental, for the investigations and the resulting methods are being made and applied in mental as well as physical fields of activity, as a result of our findings based on micromotion and cyclegraph records, which prove that the laws of habit formation apply equally well to mental and motion work.

The engineer is the natural person to whom the world now looks to find *the one best way*. This one best way is based

on accurate measurement not guesswork, personal opinion, bias, or the vote of a majority of a committee who have not measured.* The engineer's training in measurement fits him specially for doing the requisite work.

No Limit to Cripple Problem

To recapitulate, the *extent* of the cripple problem is, then, practically unlimited. When we come to consider the subject closely, we see that every one of us is in some degree a cripple, either through being actually maimed or through having some power or faculty which has not been developed or used to its fullest extent. The degree of crippling extends from the worker, who, through some accident, has lost his eyesight, his hearing, and the use of his legs, arms and hands except for the use of one finger—and, by the way, this is no imaginary illustration, as we have lately received a skilfully woven bag made by such a cripple maimed through a mining accident—to a man who is dependent upon glasses for reading. We can think of every member of the community as having been a cripple, as being a cripple, or as a potential cripple. Conversely, we can think of a badly mutilated man as not being a cripple during the period that he is at that work *the performance of which is not affected by the mutilation.*

As to the *nature* of the problem of the cripple, it is a problem of education, as has been said. *With the present state of the art of teaching, it is largely a problem of re-education,* since most of us, non-crippled as well as crippled, have received the wrong type of education, and must be re-educated even in the fundamentals. As education becomes more scientific, the problems of re-education will become simplified, and the process will become shortened.

Engineers Are Natural Solvers of This Problem

As to the natural solvers of the problem of the crippled soldier, these are, as before stated, the engineers, but only if the engineers will bring to the task the scientific attitude. As a profession, we have been too apt to be satisfied with half-way methods and half-way devices. We boast of the advance in engineering science, especially of the advances in the science of management, which have to date been, with few exceptions, the work of engineers, yet general knowledge and use of instruments of precision, even when such are available, are lamentably lacking. As a specific example of this, we may cite the use of the stop watch by experienced and earnest investigators in the field of time study. If the engineer, knowing as he must that it is an insurmountable barrier to obtaining *the best method*, or even knowledge of times that are transferable to others, is to discover *the one best way to do work*, he must use the best methods and instruments extant, and he must apply these with unremitting accuracy, persistence and patience. *The one best way* consists of elements of motions accurately timed and recorded, and synthesized into the best available method of activity.

If the engineers are, as a profession, ever to take the place that they should take in this work, they must start *now* to coöperate with those working in other phases of the subject. The various aspects of the problem are being assigned to those best able to handle them. For example, the task of making surveys as to what should be and is being done, and of the opportunities open to cripples, can well be undertaken by cities, towns and other civic organizations. This is being done, notably in Chicago, where we are assisting in the excellent work now under way under the leadership of Mr. Pike, Mr. Petterson, and others. The matter of furnishing money for the investigations and for the work itself is being excellently attended to by the Red Cross, as, for example, through the Red Cross Institute, New York City, with which we are coöperating, which has sent Dr. Edward Devine abroad for personal investigation and service in the field. There is also the work of Mr. McMurtrie, Acting Director of this Institute, who is collecting a bibliography on the subject of cripples. The matter of investigating the extent of the crippling and of providing the surgical and medical attention necessary is being admirably handled under the able leadership of the Surgeon-General and other Government representatives, already famous in the medical and surgical profession, in Washington. Too much credit cannot be given to Dr. Franklin Martin and Surgeon-General Gorgas for the progress that they have made in this great work in the short time since the day after the declaration of war, when they individually honored one of the writers by giving him an interview for the purpose of outlining possible work along these lines, since which time he has been honored by being appointed on Dr. Martin's committee reporting to the Council of Defense, and is now also coöperating with Colonel Owen and other famous doctors in the Surgeon-General's department.

The psychologists have appointed committees to investigate all branches of the subject that come within their field. The psychotherapists are working on their aspect of the problem, and Mr. George Edward Barton, of the Consolation House at Clifton Springs, Past-President of the National Society for the Promotion of Occupational Therapy, has spent years in theoretical and practical work concerning the convalescence period, and is contributing his experience and energies toward helping this cause. Educators are considering not only the training of the necessary teachers, but the training of the cripples themselves, notably Prof. Frank E. Sanborn of Ohio State University, and Prof. Wm. S. Ayars of Nova Scotia Technical College—the latter an American engaged for years in teaching in Canada—both of whom are members of this Society.

A Government Bureau Will Come

A Government bureau for collecting and conserving all these data will come naturally as a development of the activity in other fields, and of the present activity of various Government departments along various lines. This bureau should contain a museum that would include among its exhibits models of artificial limbs and appliances for cripples. This, supplemented by state and municipal museums along similar lines, would bring first-hand knowledge to the cripple, who too often buys the first artificial limb that he sees, and usually averages three or four purchases before he gets the one best suited to him.

Such a national museum should also contain fatigue-eliminating devices which would enable all workers to become more productive with less accompanying fatigue. The writers first called the attention of this Society to this need in 1910, feeling that fatigue study, like accident prevention, is a function of the engineer. We have, since 1913, started several small museums of devices for eliminating unnecessary fatigue, hoping that the movement would spread, and in the winter of 1915 tried to get the National Museum at Washington to start such a department, but apparently were not able to arouse much interest, though we were asked and thanked for a collection of wire models of motions. Recently Colonel Owen became interested, and now a definite start has been made.

The great need for fatigue elimination for the crippled soldier will undoubtedly lead to interest in the subject in this country as it has in England, for until recently we have had much more encouragement in our campaign for fatigue study from Englishmen than from our own countrymen. Mr. James F. Butterworth, ever ready to disseminate information relating to managerial economics, was the first to bring the matter to the attention of the British public. Prof. A. F. Stanley Kent incorporated his investigations of fatigue of munitions workers in reports, written by order of the King, since reprinted by this Government and obtainable at Washington. Prof. Henry J. Spooner wrote a series of articles on Industrial Fatigue in its Relation to Maximum Output for *Co-Partnership* (London), since issued as a booklet, which should be in the hands of every engineer and employer, and should also be reprinted by our Government and put on sale by the Superintendent of Documeuts.

The data for such reports and articles come from investigations of present conditions and realization of their significance. If the present chairs and work benches now to be found in all parts of this country, as well as abroad, were collected and put beside such efficient devices as the Barney chair and foot rest, and the Marshall traveling chair, they would look as out of place and cruel as do the devices of torture of the medieval period. Observing this, and with the cripple in mind, it will be noted that the principles underlying the adapting of chairs and foot rests to the industrial worker's measurements and to the needs of the cripple are identical.

Cripples Eager to Coöperate

This profession as a whole has not given the full benefits of its education, training and ingenuity to the industrial cripples of the past. The more we investigate the problem of the cripple, the more we marvel at their patience and the fortitude with which their calamities have been met and endured. They have made so few demands. They have been so pitifully eager to coöperate in this new work. They are, throughout the entire country, for the first time seeing the opportunity to do constructive work for their fellows, not only by showing what the maimed and handicapped can do, but by acting as examples of cheerfulness and continuity of purpose for all to follow. They are seizing this chance to do their bit for the war and for their country, and have shown such intelligent coöperation that we are led to agree with Mr. Fred J. Miller, Past Vice-President of this Society, that a man who has lost a limb becomes thereafter more active both physically and mentally.

Now the needs of our industrial cripples are supplemented by the more pressing need of the crippled soldiers. The crippled soldier is at a disadvantage, as compared with the industrial cripple, in that he is often at a distance from aid of various kinds at the time that the crippling takes place, and thus misses the chance for the early re-education that is desirable and necessary. Second, in that through mistaken kindness he is not taught work of any kind during his convalescence and during the period immediately after his return home; in fact, he is often encouraged by misguided friends to remain idle until the possibility of teaching the maimed member and the mind that has stopped learning, has decreased, and re-education becomes more difficult, if not actually impossible. Third, through the terrible physical and mental anguish that often precedes, as well as follows, the crippling.

The crippled soldier has the advantage over the industrial cripple in that he is the object of great interest and patriotic sympathy, therefore is a member of the community to be courted rather than shunned; in that he suffers in the limelight, and therefore is practically assured of assistance as soon as the world is convinced as to what he needs; in that he will have, if he has not now, expert training at his disposal; in that he has the consolation of fame and of having done something worth while, even though he had to pay the penalty of being crippled for having done it.

The Engineer and the Crippled Soldier

For these reasons it is advisable that the engineer turn his attention immediately to the problem of the crippled soldier, supplying the new education in the form of re-education for this soldier, with the assurance that when the methods and devices have been supplied, the industrial and other cripples will benefit exactly as will the crippled soldier.

We have already brought out, in papers on progress in crippled-soldier work, the various needs that must be met. One is the need of adapting methods and devices to the cripple, and another the need of adapting the cripple to existing methods and devices. The engineer has a part in meeting both these needs, that is,

a In inventing or adapting detached devices that will make it possible for cripples to do various kinds of work, such as various devices furnished us by the makers of the Remington, Monarch and Smith Premier typewriters, that enabled a one-eyed, legless, one-armed and one-fingered typist to write many more short letters in a given time than can the unmaimed champion typist of the world;

b In providing artificial limbs to replace those missing. Particular attention is called to the possibilities of inventing countless designs of articulated limbs controlled by systematized use of the trunk muscles controlling the joints of the limbs by means of wire and springs for replacing other muscles and tendons;

c In inventing or adapting devices that may be attached to the cripple himself, not to replace missing limbs, but in effect to supply new ones, i.e., additional limbs that will enable him to use existing equipment and thus accomplish work.

Use of Supplementary Limbs

Artificial limbs may therefore be supplemented or supplanted by what we have called "supplementary limbs," for examples, (1) a ring or loop attached to the suspenders or belt for assisting a one-armed man to handle a shovel, as suggested and used practically by Dean Cullamore of Delaware University; (2) yokes, special belts and grasping devices operated by pressure of the body against the work bench; (3) "the third thumb" for holding a magnifying glass.

Undoubtedly for all-around and general purposes it would seem to many people presumptuous to attempt to improve much upon nature in the question of the design of the human being. There is a resemblance here to our educational systems. Our educational systems are extremely good in many cases for all-around purposes, but they can be easily improved upon by any one who knows exactly what is needed for a special case. We therefore urge all who undertake this work of specially fitting the cripple to perform an activity not to hesitate to "improve on nature" at any time. This new viewpoint will help to handle many difficult cases. We hope soon to present a paper showing in detail practice of putting an extra number of limbs at the disposal of the unmaimed worker, a development of this work for cripples.

Simultaneous Cycle Motion Chart

We have been much assisted in adapting both devices and cripples by the use of our Simultaneous Cycle Motion Chart.[1] Through the elements there listed, such as "search," "find," "select," "grasp" and "transport," we have been enabled to invent or suggest, in highly repetitive work, some contrivances that are creating a new era in efficiency, as can be easily realized when the comparative simultaneous cycle motion charts before and after the investigation are studied. It is but necessary to call attention to the facts that all "grasping" is not done by the hand; that "positioning" may even be a function of the mouth; that the ordinary workman's apron with its many pockets may be used to relieve working members of the body, and that "inspection" for quantity and quality is by no means always a function of the eyes. There is an opportunity in "the device to handle the device" that will satisfy the yearnings of the most ambitious mechanical and inventive mind, a field almost without end that will eventually make the new era in industry date from the sacrifices of this war.

[Major Gilbreth here showed some pictures of methods and devices already in use, valuable as suggestions of what can be done along these lines.]

DISCUSSION

The paper called forth discussions so wide and varied that one speaker suggested that the objects of The American Society of Mechanical Engineers might well be redefined so as "to include every subject in the world." At least, the subject was taken up from many different angles and held the interest of a large audience throughout.

Col. W. O. Owen wrote that Major Gilbreth had struck the true note when he referred to the new education. It will be used not only for the training of the cripple, but for the training of the more active man. He will be taught to do his work in a better and more economical way, so that the fatigue of labor will be materially lessened. He approved of the suggestion that the motions of individual men who do their work better than their neighbors should be analyzed with respect to time, distance and motion, and said that if the best parts of these motions should be combined into a new motion the apprentice who learns this new motion will be able to do the work in shorter time and with less fatigue than those whose motions he has combined. He agreed with the author that the one best way seldom, if ever, exists in the consecutive-motion, cycle units of any one individual.

In speaking of the relation between the medical man and the engineer Colonel Owen wrote: "I believe that there is but one difference between individuals which makes one prefer to be an engineer and the other to be a medical man. It is purely a matter of receiving suggestions one on top of the other until an individual finally drifts into one or the other profession.

"I do not agree with Major Gilbreth that the engineer is best fitted to determine the 'one best way' or to formulate it into methods. I cannot help but feel that the medical man is the best fitted for these purposes. The engineer tried his hand, and a most expert hand it was, at Panama, some years ago, and failed, and I rather suspect that the engineer would have failed this time at Panama had it not been for a medical man coming to his assistance."

George Edward Barton[2] wrote that while the author's paper presents ideas that were new to many, the subject had occupied his entire attention at Consolation House for several years. In his work he was endeavoring so to combine the engineer and the cripple by re-education that, by making a virtue of necessity, the cripple was assisted to health and remunerative labor. This inevitably became a part of the work of the engineer and not of the doctor—or even of the orthopedist—for it was essentially treatment not by "physic" but by "physics."

To illustrate, he considered the case of a man who, as a result of shock, had what might be vulgarly called "a spasmodic sidewise jerk" of his arm, a case which he would analyze as follows:

"What have we got?"

"Well," says the doctor, "we have an hysterical condition of incoördination."

"D——n," say I. "That's a liability. What have we for an asset?"

"Nothing," says the doctor.

"But let us examine. What is it? What is this 'spasmodic sidewise jerk'?"

"Analysis shows that at least we have motion. Well, motion is of value throughout the entire industrial world, is it not?"

"What kind of motion have we got?"

"An irregular, intermittent, horizontal motion."

"Very good. Now, how can such a motion be used to the therapeutic advantage of the patient, resulting in some useful product? Or, if that motion cannot be so used, how can it be transformed into some other motion which can be so used?"

Mr. Barton continued: "All of us in the engineering world know that the problems of the engineer are essentially human problems; but those in the world who are not engineers regard his heart as being as hard and cold as that of the stone and metal with which he works."

W. S. Ayars wrote that the fact must not be overlooked in the problem of re-education that the raw material to be worked with is human. The task is not to select and train men for certain jobs so much as to select jobs for certain men, and then to train the man and modify the job so as to make them fit mutually. In the scientific selection and employment of men, it is admitted that one of the strongest points in favor of assigning a man to his job is the man's *appetite for the job.* It is all very well to make an expert typist out of a legless one-armed man who has a natural bent toward clerical work, but suppose he happens to have been an electrical lineman before enlisting, and had then lost two legs, or even one? Many such men have had their minds bent toward electrical work in general, and are agreeably surprised when they learn that there are plenty of branches of electrical work where the worker can sit at a bench and earn as good or better wages than they ever earned climbing poles and splicing wires.

Professor Ayars went on to describe the re-education work that is being done in Nova Scotia when the men return from Europe. First, in the convalescent hospitals, classes were organized in such work as boot and shoe repairing, automobile repairing and driving, novelty and jewelry work, etc., in addition to English branches and practical mathematics. This sort of work is vocational training.

What we call re-education is the intensive training given to men whose wounds or disabilities are such that they can no longer earn a living at the occupations they had before enlisting. Any man who is so disabled that he is entitled to discharge and pension, may come before a board consisting of at least one regular army officer, one medical officer, and a properly qualified civilian, and be passed for re-education,

[1] See Applied Motion Study, Sturgis & Walton Co., New York.

[2] Director, Consolation House (Vocational school for convalescents), Clifton Springs, N. Y.

should he so desire; and every effort is made to induce the man to do so. He must then decide what line of work he wishes to take up. He is given all the advice and help and encouragement possible, and is frequently persuaded, but never *forced*, to attack some lines of work that he had never thought of before. When he has made his choice, he can get his discharge and his pension, and in addition will receive pay and allowances as long as he is engaged in his re-education.

The Nova Scotia Technical College contemplates the following courses: drafting, garage or automobile mechanics, machine-tool operation, electrical wireman, steam-engine operation. These are intended for men of good common-school education, and others who can get enough of elementary mathematics in the vocational training classes before taking up re-education.

Then for men of mechanical taste, but not enough elementary education for any of the above courses, there is a course in boot and shoe making. This course will not turn out "cobblers" but real "mechanics in leather," and the progress made by some of the men is remarkable. In addition to all the usual hand and bench tools, there is a fine equipment furnished by the United Shoe Machinery Company, and the men are taught to build a shoe from the bottom up. As fast as they become skilful enough, they are given regular work and paid for it, the pay going into a fund to pay for a complete "kit," so that upon completing the course the graduate has a full outfit wherewith to set up on his own account.

Men who desire to take up certain other courses are accommodated by placing them in existing schools or commercial establishments where they can learn what they require. A course in janitor work is now being worked out for such men, covering the care and operation of boilers and heating systems, a little elementary arithmetic and English, and the simple knowledge of repairs to wiring, steam pipes and plumbing that a good janitor should possess.

One of the many difficulties encountered in this work is the fact that the men cannot be handled in anything like groups or classes. The work is practically tutorial: each man is a unit. They are assigned to the instructor each one in turn as he is passed by the board; they are of all "sizes," mentally speaking: what is hard for one man is easy for another.

Thus in the face of such conditions, how are we going to stop and apply Mr. Gilbreth's tests and studies? And where are we to get the men and the money to perform these tests? And how do we know that after A has been studied and tested for six months, and satisfactorily started on his course, that the data gained by such a test will have the slightest bearing on B, with a similar injury?

One point to be considered is the necessity for getting these men started *promptly*. Here again we encounter the difficulty of applying Gilbreth's personal studies and tests. Where shall we ever find the number of properly qualified motion-study experts to handle not dozens but thousands of cases?

It might be argued that a few specimen cases could be intensively motion-studied, and the data applied to all similar cases. It is conceded that motion study offers the best method of finding the standard way for a standard man to do any given piece of work, skilled or unskilled. But when the number of different possible injuries is considered; and the number of different possible personalities; and the number of different possible trades, jobs, or subdivisions thereof, then the number of permutations and combinations would startle the most hardened mathematician that ever lived, and the job of properly fitting the men to the jobs would require a small army of highly paid experts.

The work with the crippled soldier is very inspiring and congenial. The men are alert, cheerful and responsive; absolutely square and honest in their work, and with the unconscious courtesy and respectfulness bred into them by military discipline. They are likewise scrupulously neat and clean, always clean shaved, with clothing, buttons and boots in spotless order; all but two or three still wear their uniforms, and even those who have donned civilian garb have retained the little gold "wound stripe" on the sleeve, and always wear the little copper button of the returned soldier. A great many of them, to paraphrase from one of Gilbreth's other papers, will bless the day they were wounded, for already we have placed men who have finished their courses in far better paid jobs than they held before enlisting, or would have held at present had they never enlisted.

Prof. Frank E. Sanborn [1] was of the opinion that the work with the crippled soldier should be begun while they are still in the hospital, and as early as their nervous conditions will allow. The men have all left some occupation to take temporarily that of the soldier. As they lie in the hospitals and think of their wounds, they cannot but wonder how they are going to get on in the future, what they will be able to do for a livelihood. The outlook is decidedly blue.

There is nothing better to inspire these men, to cheer them up and to set their thoughts in a constructive channel, than to have brought to their attention those things which other cripples have done. These things can be illustrated by moving pictures and explained by talks. Information should be given about schools for their re-education for some occupation. These pictures need not necessarily be the one best way to do the work, but they will serve their purpose if they make the cripples hopeful and implant the thought that what one cripple has done another may do. When the men are able to begin their re-education along the lines of either their old work or a new occupation, what is more natural than to teach them the very best way of doing the work, a best way that is not entirely dependent upon someone's whim or say but a way that can be shown to be the best by means of measurements, scientifically obtained—measurements of motion, time, quality and quantity of output and fatigue.

In learning a way of doing work, the cripple or the whole man usually follows the motions of his instructor. These may be made so quickly that the learner can neither catch them nor visualize them. Until he can do so, he will make no progress. It is not enough or even right that the instructor go through the motions slowly, for slow motions are not in the same path as quick ones and a learner should learn the quick ones at the start. Therefore, pictures of the path desired are helpful and still more so are the wire models of the paths and the speed.

The Government is planning for reconstruction hospitals in this country and for re-education centers connected therewith. It is hoped that it will follow out the suggestions of the author and find the one best way for each part of an occupation and the one best way for the different classes of cripples, and have that way taught in the centers.

A. L. Curado [2] wrote of the willow furniture industry as affording a remunerative occupation for the cripple. It is an occupation in which a man sits while at work on a bench similar to a cobbler's bench. There is no machinery, the tools are few, the work is not too heavy and is very healthy. There

[1] Ohio State University.
[2] Manager, Massachusetts Commission for the Blind, Broom and Willow Shop, Cambridge, Mass.

is a very great opportunity for creative work in this line of industry, as the uses to which willow may be put are innumerable.

In picking out an industry for a cripple, the willow furniture industry as well as any other, four fundamental factors must always be considered: (1) Can this work be done by a cripple? (2) Is there an economic value to the work? (3) Can the cripple compete with a non-cripple in the work? and (4) What about teachers?

Horace B. Drury[1] commended Major Gilbreth's power of seeing very vividly possibilities of which the world at large is hardly aware. He has given a tremendous stimulus to thought along the line of motion study. In its relation to the re-education problem a field has been opened in which, fortunately, there is no set order but in which it is possible and necessary to reconstruct rapidly and freely. There are a thousand different ways in which men are crippled and a thousand complexities of occupation to which they may or may not be fitted. There is no other way of approaching this problem except by charting and measuring, by gathering all sorts of data and by making the most careful study, all of which offers, besides, a great opportunity and need for comprehending the psychological and physiological basis.

Dr. W. R. Dunton, Jr.,[2] was greatly impressed by the author's desire to educate the industrial cripple, as the society of which he is president is at present perfecting an organization of individuals and social agencies to assist the industrial cripple in finding his proper niche.

Dr. Dunton went on to say: "If we could refer to a National Museum such as Mr. Gilbreth describes for labor saving, fatigue eliminating and prosthetic appliances, we would be spared much of the effort which we are now expending. In a recent inquiry concerning prosthetic appliances we were amazed to find how very difficult it is to obtain information. Here alone is a subject in which the engineer should coöperate with the surgeon. The latter's knowledge of mechanics, or even physics, is usually not so extensive that an engineer cannot give him much aid. On the other hand, the specialist in nervous and mental diseases can best appreciate that any effort which tends to eliminate fatigue from our daily lives tends also to decrease the waste of human energy, diminish the number of dependents, and generally improve economic conditions.

"Part-time workers would help to solve many of these questions. A convalescent from pneumonia, a heart case, or a neurasthenic is undoubtedly a cripple in the sense used by Major Gilbreth. Many such cases may be capable of a half day's work or a half hour's work four or five times a day. Two such men could make one day on a machine, so that the latter would not be idle."

Dr. H. E. Holsey[3] thought that from a psychological viewpoint the phrase "disabled soldier" would be preferable to "crippled soldier," as the latter implies entire loss of function whereas the former suggests the loss of certain parts that function but are not of necessity incapacitated or incompetent. Otherwise the author has combined his philosophy and his psychology admirably. He has understood the importance of satisfying the mental as well as the physical benefit. "It is one of the greatest satisfactions to the human that he can feel, though disabled, that there are ways by which he can remain on the pay roll of the world.

"To achieve extraordinary results, to cultivate efficient habit forming is the important part in re-education. To measure and guide the habit and give it character is the problem presented by the disabled human." Intensive education by means of micromotion produces such results. It is rapid and understandable and at the same time can be applied to the able as well as to the disabled.

[1] Ohio State University, Columbus, Ohio.

[2] President, Maryland Society for the Promotion of Occupational Therapy, Baltimore, Maryland.

[3] Phoenix Bldg., Springfield, Mass.

Willard E. Hotchkiss[1] pointed out that too much emphasis could not be placed on the necessity of analyzing problems and finding out how to proceed before attempting to solve them. The Gilbreths' work in substituting photography and psychology for the stop watch and their development of motion study with the finer instruments and with the more intensive methods of analysis were cases in point.

Professor Hotchkiss felt that the phrase "the one best way" should have both a time and a subject-matter limitation, for the reason that the method which appears to be the "one best way" of doing a thing today may not appear so tomorrow, as a new invention in a field apparently quite remote from the one in which a particular process has been developed may entirely change the relevancy and effectiveness of that process.

Edward Cassidy,[2] who became blind some years ago, wrote that he has been able, nevertheless, to transfer some of his technical knowledge and experience to the blind in Massachusetts and from his connections with them he realizes the ever-growing need of the knowledge of the active-sighted man or woman. These people can be of help in securing for the blind a great many positions in manufacturing plants which they could fill successfully if it were not for the fact that the employers' liability act prohibits them from obtaining positions such as packing shoes in boxes, packing candy in boxes, pasting on labels, private switchboard operators, taking messages by telephone, timekeepers, even stenographers taking shorthand minutes of meetings—positions that blind people are amply able to fill. Mr. Cassidy is of the opinion that the time is not far distant, due to the ever-increasing blindness among our people, when business men will be forced to recognize the capabilities of blind persons and to secure for them self-supporting work.

Dr. F. L. Marshall[3] wrote he had discussed with the author the possibility of employing cripples in prophylactic dentistry and was led to believe from his experience in helping demonstrate that it was possible for a cripple with one eye, one arm and no legs to thoroughly clean a patient's teeth, and that this field would be adapted for the crippled. The manual dexterity and knowledge required for this class of work would not be difficult to acquire, and in a few months' time a man of ordinary intelligence should be in a way to become self-supporting.

Professor J. B. Miner called attention to the fact that Major Gilbreth's paper and his basic contribution to motion study suggested three ways in which the science of human behavior comes in touch with this important movement. The oldest of

[1] Professor, University of Minnesota.

[2] Blind Welfare Union, Inc., Boston, Mass.

[3] 39 Fairfield Street, Boston, Mass.

these points of contact between psychology and the better adjustment of man to his work, is in the study of fatigue. The mass of accumulated data has recently been illuminated by Thorndike's experimental demonstration of the difference between the feeling of weariness and the decrease in output due to exhaustion which is only corrected by rest.

The second broad field, which is perhaps more worked by the psychologist than by any other scientist, is the study of the learning process. Dr. Thurstone has recently developed an equation for the learning process which promises to enable us to foretell an individual's limit of ability early in the practice curve.

The third point of contact is in the selection of men for particular jobs. Methods for selecting salesman, which have been worked out by the Bureau of Salesmanship Research at the Carnegie Institute of Technology have proved to be not perfect, but enough better than those previously used to cause them to be adapted to the purpose of selecting officers for the national army.

The rehabilitation of cripples will become a lasting contribution to all workmen. Groups of cripples afford a rare opportunity for experiments under controlled conditions which are so difficult to provide in normal industrial life. The importance of this strategic chance to study selection and learning problems under standardized conditions has been emphasized at present by the opening at Carnegie Institute of about the first school for training wireless operators for the army, as distinct from service in the navy or in the aviation corps. Thus far about 200 of the applicants for the school have each been tested for an hour by a carefully arranged series of mental and motor tests. In helping to improve the selection and training of wireless operators, there will be an opening for certain types of cripples which should place them in line for skilled work after the war.

John Younger dwelt upon Major Gilbreth's proposition that virtually we are all cripples, or conversely, there are no cripples. He went on to say: "It is an interesting philosophy to carry this out, and reason that man at present has actually crippled himself throughout the ages, and as a tool-using animal has actually improved on nature to the extent of providing himself with all sorts of extra limbs and organs. The telephone, for example, is in its fundamental sense nothing more or less than an extended ear, by which we can listen to conversations between New York and San Francisco. The pencil and the pen are peculiarly shaped fingers with which one can make marks. Man himself—the animal—cannot cut steel, but with the machine tools, etc., he uses, he has provided himself limbs whereby he can mold the metals according to his fancy.

"One great result of the work of Major Gilbreth and his colleagues will be that the cripple will no longer be relegated as an outcast. He will be treated as an honorable member of society, for just as there is no stigma attached to the manufacturer who is out of date with his deficient machine tools, so there should be no stigma attached to the man with deficient limbs.

"In order to deal with this problem constructively, each engineer, each designer should take his own particular work and see what he can do in his sphere to make his machine available to those crippled. It is possible to design very simply and very cheaply the slight modification to the existing motor truck, so that it can be operated by a legless man or a man with one leg, or a man with one arm, or similar variations."

Eugene R. Pike[1] related some of the experiences of the city of Chicago in its endeavor to re-educate its crippled citizens. An investigation and survey of the question was made with the object of determining the best methods that would serve the purpose, the probable expense of installing such methods, and also the securing of an estimate of the advantages which might reasonably be expected to accrue from the establishment of such methods of organizations.

Mr. Pike further continued: "During our investigations we found in one industrial plant alone, where an average of from 5000 to 10,000 men have been steadily employed, that the records in the office of the company's surgeon show that during a period of 30 years' operation there were 35,000 surgical cases resulting from injuries received within this plant. This indicates that one out of every seven or eight of the employees received an injury requiring surgical attention, and when the fact is stated that this plant is one of the modernly equipped plants in regard to safety appliances, we commence to realize what this question means to the average equipped industrial plant and the country as a whole. Most of these cases, we found, left the victim of the accident usually 'crippled for life' in some degree, ranging from the loss of a portion of a finger to the total loss of a hand, or leg; loss of sight in one or both eyes; of even the loss of several members, and in practically all cases it seems to be the irony of fate that the injured or lost member was the member that was chiefly relied upon by the victim in the earning of his living and the performance of his work."

The investigations have led to two conclusions, namely: (1) The problem should be handled as a re-educational problem along local lines, because local conditions vary throughout the country, but each local organization should coöperate with a national association of a similar nature; (2) the re-educational requirements of this class of work are very closely related to the present public-school system, in which manual training is provided for both young and old.

The Board of Education of Chicago has already under consideration a plan submitted by the Comptroller's Department that contemplates the use of technical high schools, and the employment of qualified experts for the following purposes:

1. The training of instructors in this new education and science;
2. The manufacture and instructions of the use of artificial limbs;
3. The adaptation of mechanical appliances to the adjusting of the cripple's remaining physical members, so as to replace those that were lost and assist the artificial limbs in the furtherance of physical functions;
4. The re-educating and scientific analysis of any crippled persons so as to fit them to do work for which they are best suited, mentally and physically, thereby still retaining for the use of the country the brains and ambitions that are not injured, for which there is an ever-increasing demand in industry.

The Department of Public Welfare of the city of Chicago has undertaken the making of a survey of the civilian crippled and the maimed of the city of Chicago, and also the making of arrangements for the placing of the re-educated cripple when he has been properly equipped and re-educated by the re-educational school in occupations of worth.

C. W. Rice outlined the work of the reclamation of cripples in France. The work is centered in the so-called National

[1] Comptroller, City of Chicago.

Office of Cripples and Re-Formed Men, an organization belonging to the Ministries of Labor, Interior, and War.

The work is carried on along very broad lines, and its importance is fully realized. After the war of 1870-1871 in France there were only a few thousand wounded and only 2700 men who had undergone amputations. It is estimated that in the present war by March 1, 1916, in all the belligerent countries there were about 3,000,000 cripples, and, in round figures, 10,000,000 wounded.

The professional re-education of cripples is based on the following principles: In the first place, all cripples are divided into two main classes; those capable of such re-education and those who must be taken care of by various forms of assistance, such as pensions, soldiers' homes, etc. The division is along purely economic lines; those capable of re-education being the men who, in spite of their crippled state, still represent a social value close to normal. It is estimated that about 80 per cent of wounded belong to this class.

The treatment of such people is divided into the following branches:

1. Purely medical treatment, in the widest sense of this term, with the view to bettering conditions.

2. Development of artificial organs to take place of those lost or incapacitated.

3. The invention or development of new tools or even new methods of production, so designed as to utilize the limited ability of the cripples.

The vocational selection, or, as it is called in France, industrial orientation of the cripples, which means direction of their efforts into lines where they may be most useful, together with means for finding jobs for re-educated cripples, forms an important part of these new activities.

The entire spirit of the work is to give men wounded in the defense of their country means to continue a useful existence and take part in the industrial life of the nation, and it is believed that this effort will be materially helped out by the great impending scarcity of labor throughout the world.

C. N. Underwood gave an interesting talk, illustrated by motion pictures, upon the remarkable case of a crippled employee at the factory of the Remington Typewriter Works. For thirty-seven years he was afflicted with sciatica and inflammatory rheumatism, and now he is a cripple from bust to knees, with the exception of his arms. After being given up to die by a council of five physicians, four of whose funerals he has since attended, he learned the trade of jeweler. Previous to his affliction he had been a machinist. He is now an operator in the experimental department of the works, and runs any kind of a machine. He works sitting or standing.

The motion pictures showed the man at his work as an inspector of typewriters, and also dexterously performing some of the everyday operations of life, such as dressing and undressing, for which purpose he has designed very clever devices. The joints of his body are rigid, so that he is unable to bend, and therefore he has devised tongs for picking up articles from the floor, for drawing on his socks, etc. He uses the point of his crutch for removing his shoes and socks. The crutches are of his own design. At the top is a ring on swivels which enables him to let go of the crossbar of the crutch and work at the machine without any danger of the crutch getting away from him. By letting go of the crossbar and supporting himself by his forearm on the ring, he can carry objects which he could not otherwise grasp with his hands on the crossbar.

Mr. Underwood said the man was not only one of the most skillful workmen in the factory, but one of the happiest, and the only thing that arouses his anger is the sight of some cripple begging.

Mr. Underwood also showed the rapid work of a one-armed clerk in sharpening his lead pencil, making entries from time cards on to schedule sheets, making entries in a small book, on tags, small cards, etc. He holds the paper on which he writes with the little finger of his hand.

Dr. A. Cullamore[1] held that the problem discussed by Major Gilbreth was not as simple as his treatment might seem to indicate. The problem in reality is twofold: first, training the cripple to function in the economic life of the community by making him capable of doing productive work and earning his daily bread; and second, which is perhaps of even more importance to the cripple, and to some extent to the community in general, making it possible for him to take his place in the social life of his community. He should be able to derive real satisfaction from life and to enjoy the fruits of his labor on a par with his fellows.

Dean Cullamore continued, "In training a cripple to earn his living, intense specialization is the keynote. We must not strive to ape or duplicate nature in any degree, but, as is pointed out in the paper, to find the one best way on the basis of merit alone. We must transcend nature in every case, and that is the job of the engineer. This is perfectly possible. One instance will suffice. The human eye is good, perhaps best, for general purposes; but when a high degree of specialization is desired, we turn to the telescope, the microscope and the camera. In this specialized work the man with two normal eyes is a helpless cripple—that is, from the standpoint of a cripple.

"What we want in vocational education is abnormality. Specialization seeks to produce abnormality along predetermined lines. Abnormality means specialization. Our problem is not to make a man normal, but to take advantage of his abnormality for his own benefit. These cripples are then forced specialists, that is, their specialization has been forced upon them. Therefore, let us treat them as such and see that we devise instruments to make their specialization commercially possible and profitable. That is our whole function in this regard.

"For years we have made clumsy attempts to equip men who have lost limbs in a way to produce normality, believing that this solved the problem. Nothing could be further from the truth. Economically, specialization or abnormality is success.

"Why not be scientific, and determine the equipment on the basis of the merits of the case. The wheelbarrow was invented for a two-armed man, with one wheel and two handles. The express wagon, however, has one handle and four wheels, and will maintain its balance. Our purpose should be to determine the case on its merits alone.

"Another point not generally taken into consideration is the change in the normal psychology of an individual which comes with the crippling. To every man who has been crippled two things must be shown which are of equal importance to him: first, that he can earn a living; and second, that he can enjoy the living thus earned normally with his fellows.

"The time to do this is before the psychological change has been formed—to forestall it rather than later to have to modify it. It should be done in the hospital, and it can be done by these moving-picture studies, if they are put across in the right sort of form."

[1] Dean of Engineering, Delaware College.

D. McMurtrie,[1] director of Red Cross cripple work, discussed some of the factors that must be generally taken into consideration in fixing up the cripple.

There are the human considerations. The war cripple is extremely discouraged at first, and the friendship and confidence of each individual must be gained before anything further can be done. He must be started along the right path by the right people. There are a good many difficulties in getting a man to come around to the position where he wants to go out and earn his living and do his full duties. Soldiers especially have been leading a life that is absolutely different from that of the civilian. They have been relieved of certain responsibilities, and have shouldered other responsibilities, so that when a man comes back who has been three years at the front, he has been where he has not had to think where his breakfast will come from, nor of where he would get his next suit of clothes. The first task will be to rebuild his initiative and his economic responsibility.

Another point is that the cripple's difficulties are not always of his own making, but are caused by the attitude of the community. First it pities him, and offers to extend charity instead of giving him a chance to hold a job. Until that attitude of the public changes, war cripples will have a very difficult time.

In considering the choice of trades for a cripple, the general principles to be followed are that the trade must first be a growing trade, not one in which employment is growing less rather than greater. It must be a trade that the man can follow in spite of his handicap, and it must be one in which he can hold not one job only, but a thousand. There has been a tendency in providing work for war cripples to devise special lathes and machines for the cripple; but if that is carried too far, a man who loses his position will be unable to go out and get another job in the labor market.

The man's former experience and education must also be considered, and if he is to be prepared for work that his past experience has equipped him for, he is being done an economic good. The day of the pension is past, and it is realized now that the first duty of the nation toward the returned man is not to pay him a pension, not just to entertain him and regard him as a hero, but to give him the best possible chance to get and hold a good job. Plans are now under way so that the American soldiers will be treated in that way rather than in the way that they have been treated in the past.

Fred J. Miller recalled a statement by a medical authority that a great many men who have amputations of a limb were thereby improved physically and mentally; that they were apt to be more vigorous and better men than they were before. The theory underlying this seems to be that the human machine was first devised for an entirely different life from that which we now lead; limbs were given us for the purpose of actively pursuing game by our own strength, running and leaping and tussling in a general way, and climbing trees. We do not do that very much any more. In consequence, we have an engine department, so to speak, consisting of the stomach, lungs and heart, designed for a different kind of work from that it now does; and if we amputate a limb, we have still the same department for producing energy that we had before, and the result is that a greater amount of energy is poured into the remainder of the body and evinces itself in greater activity. Mr. Miller cited a number of cases that he had found in confirmation of this opinion. He also believed that this had a bearing on the question of whether a maimed limb should be amputated or whether the surgeon should choose with the consent, and usually at the earnest request, of the patient to save the limb if he possibly could. He cited a case where a man's leg was seriously injured. He kept the leg: it was saved by skillful surgery, but was not much of a leg, and it bothered him a good deal for years and sapped his energy. He finally had it amputated, and he is in better health today than ever before. Thus from the layman's viewpoint, Mr. Miller said, there is perhaps too much anxiety to save limbs that have been injured when the patients would be much better off without them.

Dr. C. A. Waldo[1] pointed out that some method must be found to conserve, analyze and carry to a proper conclusion the valuable work in the re-education of the cripple that so many national organizations have begun. The value of the work of the efficiency expert and the importance of the investigations of the particular expert who, for mechanical ends, is trying to make man himself a better physical machine is self-evident. "Our human efficiency engineer is thus our best altruist, as he is never happy unless he is making his neighbor happier."

Obviously, in no direction at this particular moment can the services of the efficiency engineer be more welcome than in his efforts to rehabilitate and save the crippled soldier. There is a great volume of material already prepared along these lines, both at home and abroad. This material should be analyzed, arranged properly and in logical order, tabulated and indexed. It should be published by some nationalized center and should be distributed gratuitously from a national center.

The nation should be deeply interested in this work simply as an economical and paternal duty. We cannot at present reasonably expect to see the end of this gigantic struggle as victors until at least two millions of our men have been under fire. In that event, according to present statistics of casualties at the front, from three to five per cent of the forces will be disabled. If the number is placed at the average estimate of four per cent that would mean almost eighty thousand cripples. If the Government can partially or wholly restore these cripples to the productive ranks of society this would save a pension per man, say, of $250 per annum, or a total pension tax of $20,000,000 per annum or interest at four per cent on half a billion dollars, and as a result this army of 80,000 would be changed from a horde of dependents left to fade away in sickness, gloom and despair into a happy, contented group of cheerful, hopeful citizens.

Edward Robinson spoke approvingly of Dean Cullimore's suggestion that in the education of the cripple, not only should his vocational education be considered, but his general education as well, to fit him for the social life of the community. He regarded education as one thing and vocational training as another. The former is a general thing that takes a long time, the latter a specific thing that can be done very quickly with the aid of efficiency methods.

He was interested in the problem because of his connections with the University of Vermont, which he believed has received a request from Washington to prepare to take up the work of educating crippled soldiers, and he desired suggestions as to how a university could best handle the problem.

Dr. E. E. Southard,[2] speaking from a psychopathic viewpoint, said that he pretended at least to be a social engineer,

[1] Editor, *American Journal of Care for Cripples*, New York.

[1] New York City. Formerly Dean of Engineering, Washington University, St. Louis, Mo.
[2] Psychopathic Department, Boston State Hospital, Boston, Mass.

being a director of a psychopathic hospital. He pointed out how abnormal and unusual conditions have given educators opportunities to open new fields along educational lines and he thought that the crippled soldier afforded good material for study not only in the mechanical field but also in the physical direction. The study of mental disease is going to be pushed into general practice. Everyone is going to talk in terms of mental cripples and is going to realize what he suspected long since that he himself is some particular kind of mental cripple. He said:

"In working with the feeble minded it has been my problem to try to find, so to speak, the minimum amount of brains with which one could do the maximum amount of work. The schools for the feeble minded are precisely the places in the world where the best work is being done with the least brains. The normal school child is not being taught up to the normal, but the feeble-minded children are. We have got to work in that direction in the crippled-soldier problem."

From the viewpoint of psychology the speaker believed that Major Gilbreth's method of analysis corrected a fault of psychologists. These men do not believe that matter exists, or, at least, they do not like to talk of matter, which is tantamount to the same thing, and they, therefore, measure nothing but time, and all their work, therefore, appears to suffer from lack of measurement of space. The author not only points out the theory that we must make measurements, but he goes ahead and measures both time and space.

Dr. Southard took issue with the speakers who said that one of the great problems was to make the crippled soldier contented. There are many people who do not want to be contented. They take pleasure in being blue. There is no happiness that can be regarded as what we all want. In his experiences with psychopathic cases he had found this to be exceedingly true, and he believed that it would also be the case with the cripple. The primary emotions of fear, anger, sorrow and joy, as outlined by the behavorists, have each to be treated differently, for each reacts according to its inherent composition. Combinations of these emotions need very careful attention. At the Psychopathic Hospital he had had the opportunity to observe how differently people of the types mentioned above reacted in the face of certain stimulus.

In conclusion, Dr. Southard said that the work upon the deficient, upon the crippled, upon the people with the minimum of capacity, with the maximum output for that capacity was the big problem of efficiency, and it was the relation of the output to the amount of energy put in that would have to be studied along research lines from the viewpoint of sociology.

Miss Sarah Cox Johnson[1] emphasized the importance of the psychological side, which, she said, could be expressed by the homely old saying that you can lead a horse to water, but you cannot make him drink. Likewise we may prepare what we think is the right occupation or industry for a crippled or maimed man, with the aid of such expert advice and help as Major Gilbreth is able to give us, but all of that will miss its mark unless the man is saved from himself while he is in the hospital during the period of convalescence.

In a demonstration which Miss Johnson had been conducting on Blackwell's Island during the past year, she found the most difficult problem to be the human element—human emotions, the human mind. A man may come to the hospital and after having been relieved of the responsibility of earning a living and realizing that he, perhaps, may have to go through life maimed and crippled, must have his courage buoyed up and his self-reliance helped at the right moment, otherwise his despondency will settle into apathy and his apathy into a state of willing dependence and he will become thoroughly institutionalized. Here is where a woman's intuition plays an important part.

Alluding to the question of occupations for cripples, Miss Johnson said that handcrafts had generally been used. A great deal of misdirected energy was put into that field since people generally thought handcrafts to have been without craftsmanship. In so far as the craftsmanship is poor, the therapeutic value fails. It is important that in the hospital the occupations of the soldier should be taught by people who themselves are craftsmen, and in addition have a general knowledge of the facts of nursing and health, and a good grounding in psychology.

Whereas occupational therapy has been used for more than a hundred years, it has only recently begun to come into its own, and there are no places in the country for training teachers in therapeutics outside of the few institutions which have trained their own teachers. It will be of interest to know that Columbia University, Teachers' College, is the first college in this country to put in a course for the formal training of teachers along these lines.

Miss Edith M. Valet[1] spoke of the work of the New York Branch of the Association of College Alumni, which has recently offered its services as a committee to help the work of the Red Cross Institute. Their aim is to try to deal with the cripple in the ways Miss Johnson, Mr. McMurtrie and others have suggested.

David Beecroft[2] stated that for some time we have been confronted with the problem of the dilution of unskilled labor, which is closely related to the subject of handling the maimed, and as a consequence of the war both problems are going to demand our attention in the near future.

L. P. Alford suggested at this point that perhaps it would be well to redefine the objects of The American Society of Mechanical Engineers, as the session on management, with its discussions on psychology, physiology and allied subjects, showed, as Professor Kimball said, that mechanical engineering included everything in the world.

F. A. Hannah said that thus far the discussion on the subject had been from the point of view of the supply of cripples. He was interested in it from the point of view of the demand for cripples. As a consulting engineer, he had some clients who had anticipated a shortage of labor due to the draft and the demands of the Government for all employes who could be used on the special war activities.

Mr. Hannah further continued: "I have one client in particular whose business is well adapted to the use of cripples. He has a continuous process, consisting chiefly of machine-tending operations, which turns out a food product. The operations are comparatively simple and thoroughly standardized. We are now analyzing the operations on this machine and are drawing up certain specifications for a cripple. For example, we take a machine and we study it as carefully as we study men. We say that it should be tended by a man with one good leg and one peg leg, one arm with a good hand on it, twenty-five per cent of his sight and no hearing. Thus in a fairly standardized process we can go all the way through

[1] Department of Charities and Corrections, New York City.

[1] President, New York Branch of the Association of College Alumni, New York City.

[2] Directing Editor, *The Automobile*, New York, N. Y.

a plant and draw the specifications for every single operation on every machine."

Mr. Hannah then asked if anything had been done by the author along these lines.

Major Gilbreth answered that the simultaneous motion cycle chart was gotten up with the idea in view of showing all the faculties and all the limits of the worker, who is considered as a society of working members rather than as an individual, and thus a survey of the machine as a demand for motion and a survey of the cripple as a supply of motion will enable one to see whether the two coincide.

W. E. Symons also discussed the question, emphasizing the part women will play in the re-education of cripples and citing a number of his experiences with men who had been improved both materially and mentally by having been crippled.

Walter N. Polakov believed that the problem of the crippled soldier was absolutely inseparable from the problem of the labor market at large, and he thought that the Society, and Governmental and Red Cross institutions that are interested in the work, should submit the question to the labor organizations.

Arthur C. Jackson was of the opinion that it was necessary to create public opinion favorable to the employment of the cripple, and this could be done, he thought, not by having the deliberations of this meeting limited to technical publications, but by writing extracts for popular literary magazines which would create public opinion favorable to the employment of the cripple, so that it would be considered a patriotic action to place the cripple in a workshop especially prepared for his occupation.

Major Gilbreth replied to the salient points of the discussion, particularly emphasizing the fact that the crippled soldier is only a very small part of the crippled population of the country. The industrial cripples, the cripples from birth, from disease and from accident in reality comprise the problem that is ever growing in importance, a problem that includes wide and varied considerations.

MACHINE SHOP SESSION

Topical Discussion on the Subject of Inspection, Which Has Developed a Great Importance in Connection with the Matter of Inspection of Munitions

A SESSION was held under the direction of the Sub-Committee on Machine Shop Practice, Prof. Howard P. Fairfield, Chairman, for the discussion of one of the subjects most pertinent to the successful production of munitions—the subject of inspection. This meeting was arranged as a result of the unusual interest at the last Spring Meeting in problems of munitions manufacture which were discussed at that time; and in order that there might be a better understanding between manufacturers and government officials of the requirements of inspection and of its proper functioning with the other processes of manufacture.

The discussion was opened by three introductory talks: by A. L. DeLeeuw on the Logic of Inspection; by F. A. Waldron on the Relation of Inspection to Product, and by Colonel B. W. Dunn (presented by Major A. W. Erdman) on General Principles of Government Inspection and Relations Between Inspectors and Manufacturers.

THE LOGIC OF INSPECTION

By A. L. DeLeeuw, Plainfield, N. J.

Mr. DeLeeuw held that inspection is logical and necessary in our present mode of manufacturing, advantageous to manufacturer and inspector alike. Speaking first of interchangeable manufacturing, he said that while Americans had been patting themselves on the back because they thought they excelled in this direction, the fact was that the war requirements had shown that deficiencies existed in the matter of inspection.

Interchangeable methods of manufacture is a broad term, because it refers to two rather different things. Products can be interchangeable as far as design or use is concerned; or as far as individual details are concerned. For instance, it makes very little difference when we get a refrigerator of a certain size and make; whether it is this or that one or the other one. All of them will fill the bill equally well. So it is with a kitchen stove. In this sense refrigerators are interchangeable. To a certain extent even, perhaps different refrigerators of different makers are interchangeable. This is merely interchangeability of function.

But there is another kind of interchangeability. For instance, take the kitchen stove. If one of the lids breaks one simply sends to the maker for another lid which is interchangeable with the previous lid. Again the maker of pipe organs builds in groups or units, and he can build up a more or less complete organ by assembling a greater or less number of these groups. This is interchangeability of design.

On the other hand, two lathes of the same maker will interchange as far as use is concerned, yet may not fully interchange as far as the parts are concerned. He would hesitate to take a carriage from one lathe and put it on another and expect to produce a good turned-up piece. He would be rather afraid of doing the same thing with the headstock, or even with the spindle. He was not absolutely sure that he could do it with the leadscrew, although in some cases he might be able to. He would be more certain of replacing one of the gears with a new one but he was not quite sure that he could use the same key.

So here are different degrees of interchangeability: interchangeability of the entire product; interchangeability of groups and completed details; interchangeability of the pieces; and then interchangeability of the details of pieces, such as keyways, screw threads, and so on. In order to accomplish the highest possible in interchangeability, we must take up the matter of inspection.

The Beginnings of Inspection

The speaker then traced the development of inspection methods, beginning with the "olden times—not so very old either," when a complete machine was built and inspected by one man with the only criterion that it should do the work satisfactorily that was assigned to it. Later came the con-

tract system with the foreman as inspector; still later the system of progressive inspection where each workman was the inspector of the previous operation done by another workman; and finally the modern method where inspection is considered an actual operation in the production of parts.

As inspection became an operation in the shop, there was a natural tendency, also, to consider it among the burdens of the shop, due to the fact that "the man who holds the bag" likes to cut out things, but doesn't like to cut them in. While inspection as an operation makes it possible to produce on a large scale with less labor expense, this does not interest the man who holds the bag half as much as the fact that he has to pay actual cash to "fellows who take a lot of good stuff and throw it into the scrap heap."

Another thing that has set our minds against inspection is the fact that some fellow who can't even run a lathe and doesn't know the difference between a headstock and a tailstock, actually takes a piece on which an A1 lathe hand has spent two hours and says it is no good, and out it goes. Now, that is very aggravating. Nevertheless, we really ought not to blame the undertaker for the death of the man who is to be buried. If anybody must be blamed it should be the doctor. Neither should we blame the inspector if a piece is bad, although it is the inspector who buries it.

There is, however, some reason behind our dislike of the average inspector. There are cases where the inspector shows a woeful lack of intelligence. But if an inspector lacks intelligence, we should blame ourselves, because we expect something from him for which we do not pay. The man who does the detail inspecting for instance, takes a shaft, which he sticks in one end of the limit gage and then turns the gage around and tries it on the other end. If it goes on at both ends, he says it is no good. He takes another shaft and it goes on at one end and not at the other, and he says it is all right. That is all that that inspector is paid for. He is in effect an unskilled laborer who has been taught that one little repetition operation; and if one puts the proposition up to him to decide whether he should reject a shaft when it doesn't go in the gage, we are expecting from a laborer what an engineer should decide. If there is doubt as to whether the rejected shaft could not have been used, we should blame the man who set the limits or the man who made the gage, and not the inspector.

SPECIFICATIONS AND INSPECTION

Mr. DeLeeuw further said: "This brings me to the main point of what I want to bring out, and that is that the great trouble in the line of inspection is not so much with inspectors as with specifications, and in this connection I am speaking of the detail inspector who makes the interchangeability of manufacture possible. This is a serious subject, and it may not be amiss to tell a few of the things that are required of the inspector, for which he has absolutely no training.

"A few months ago I was in one of the biggest aeroplane factories in this country, and saw a man testing the long beams which form the main beam of the wings. These beams are of spruce, and generally speaking, are in the form of an I-beam. It receives most of the load. The man inspecting these beams had half a dozen laid out on a pair of horses. The beams were perhaps twenty feet long, and th horses nine or ten or eleven feet apart, a distance that might easily vary from day to day. The inspector laid the I-beam flat—not the way it was to be loaded, but flat. The man was very vigorous and took hold of the beam in the middle and punched it down three or four times. Sometimes it cracked before he got tired and sometimes he got tired before it cracked. If it cracked before he got tired he would throw it out, that is to say, he would throw it out if it was completely broken. Out of six that I saw him inspect, two broke and two cracked, but his ears were not as good as mine, he probably did not hear them crack, so the two cracked ones were passed along. Of course one can blame the inspector, but is not the real blame to be placed upon somebody above him who made him do this thing? Here is inspection without any inspection whatsoever."

Then, the speaker said, there is sometimes inspection according to specifications, which is a little bit worse. He illustrated this with anecdotes relating to specifications for belting which he said had been drawn up by the engineering force of some of the biggest concerns in the country, "not all the jokes coming from one concern." The specifications abounded in requirements which it would be impossible to check, as for example, that "all butts used in belting shall be of No. 1 selection; that the belting shall be of native packers' steer hide class; that the leather shall be stretched on straight-edged clamps; that centers and sides must be stretched separately; that the scarfing, joining and cementing shall be done by experts; that the finished leather shall be smooth to the touch on both sides; that the leather shall show no excess in the amount of material soluble in water or in ash, etc." Upon these he gave interesting running comments showing the futility of any specifications so phrased that it is impossible to check the requirements by a proper inspection of the finished product.

This kind of inspection, based upon indefinite or impossible specifications, becomes a matter of much annoyance when it relates to the finish of machine parts. "In a way we have grown used to a beautiful finish on various kinds of machines. The style of beauty varies somewhat. The style of beauty most appreciated in a self-binder, for instance, is a bright red with yellow streaks or green stripes; the style of beauty most appreciated on the bearing surface of a milling machine column, where a perfectly smooth bearing is wanted, is one which has spots on it and has been hollowed out by the use of a scraper. It is up to the inspector to say whether the finish of the machine or of the machine detail meets the ideals of beauty that the public has in its mind. It is exceedingly difficult for an inspector to do this without a standard by which to inspect; and yet I do not believe there are many shops that have standard pieces of finish which from time to time are renewed and inspected by the man who is to be responsible for selling the products."

STANDARDS AND INSPECTION

Another instance that had come within the experience of the speaker further illustrated the difficulty encountered where dependence had to be placed on the judgment of the inspector without an adequate standard for his guidance. He said in part: "A new machine was put into use for making a certain kind of screw heretofore done on another machine. As far as I could see the screws were all right, but the inspector promptly rejected the first one hundred. I sent them upstairs again with the request to hang tags to the individual screws showing which were wrong and which were right. Sixty-seven were wrong and 33 were right. I numbered the tags and made a list of those that were wrong. I got out another one hundred screws from the stockroom done on the old machine, and all inspected, hung also 100

tags on them, numbered them from 1 to 200, and made a list of them so that I knew exactly which were the old and which were the new. I sent the 200 screws up to the inspector and he sent them back with his mark as accepted or rejected, and I found that out of the 100 new ones there were now 33 rejected and 67 accepted; just the reverse of the other figures, and of the 100 old ones, which had once been all accepted, 75 were rejected. Now, that is the sort of thing that has to be checked. Really, the inspector was not to blame, because the ground on which he rejected them was roughness of thread. It is a very hard matter to say exactly twice in succession whether a thing is rough or smooth enough, especially when one considers that he may have accepted some of them Saturday morning and some Monday morning. There is a big difference there.

"One thing must be remembered when talking about inspection: Inspection does not aim at perfection; the aim of perfection is imperfection. Its aim is to make the imperfect serve the purpose required. We set limits beyond which the piece shall not go and set as wide limits as possible within which we will receive imperfection. Looked at from this standpoint, it will be found that the office of the inspector is not merely the office of a trouble maker but that he is really a useful member of society.

"The things that I have mentioned are merely surface indications of a great problem which we have before us. Most of us believe that inspection is absolutely necessary, but as a whole, the problem of inspection is still in the dark and we have not so far tried to put it on its feet. We have not, for instance, laid down standardized rules as to what specifications should be given, say on the drawings, to enable the inspector to do intelligent inspection without being a professor or a Solomon. We have got to the point where we are willing to make plus and minus allowances, but we have not got to the point yet where we are willing to make the plus and minus allowances as big, or, I should say, as convenient as possible, because the mere making of an allowance big enough does not always solve the problem.

"This is an engineering problem pure and simple. It is the problem of subordinating every piece and every detail, every dimension of the piece to our system of manufacture. Before the drawing is sent to the shop we should have a special inspection in the drawing room, going over every dimension with a view to subordinating it to the system of manufacture in vogue in that shop, and we further should scrutinize that system with a view to its being the most economical possible. There are certain things in inspection which make it more apt to be a failure than almost anything else. In the first place, it is a repetition operation. In the second place, there are many things the inspector has to inspect for which he has no absolutely definite data, and he has to follow his own ideas or notions. It is therefore necessary that the inspector should be controlled, and that his inspection should be inspected and checked.

"We ought to select our inspectors with great care. As a rule we can find them among our workmen. We sometimes find workmen who are not very productive just because their ideas are a little bit strict. Such men may easily be trained into detail inspection. We should try to get the chief inspector as broadminded as possible, but I do not believe it will ever be possible to depend on the broadmindedness of the detail inspector. There should be in the inspecting organization, either in your own shop, or among Government inspectors sent to a job, some man who is enough of an engineer, and also enough of a human being, to have the broadmindedness to look at things not merely from the standpoint of filling certain specifications, but from the broader standpoint of whether or not a piece is useful, because even in Government specifications there are cases where a piece may be useful and still might be rejected on technical grounds."

In conclusion, Mr. DeLeeuw spoke of the importance of gages, which, like the pieces they were to measure, should have limits, and should be checked by master gages verified from time to time by some authoritative source of the Bureau of Standards at Washington.

THE RELATION OF INSPECTION TO PRODUCT

By F. A. Waldron, New York, N. Y.

In continuing the discussion upon the subject of Inspection, F. A. Waldron mentioned that one of the disappointed contractors on munitions work, who had recently called at his office, had remarked that nothing could be said on "the relation of inspection to product," because no such relation existed. Another engineer had said to him that the relation of inspection to product was like that of son-in-law to mother-in-law, which suggested to him the possibilities of the subject. Then he began to think. While in every domestic circle there is the question of mother-in-law and son-in-law, if trouble exists it generally is on both sides; so he considered that, after all, the subject of his discussion was not as barren as it might seem.

Mr. Waldron said he would start at the beginning, aud, accordingly, indicated the necessary steps in the production of a commodity by the accompanying headings:

IDEAL
IDEA { Invention
       Engineering Design
DEMAND
MANUFACTURE
       Purchase
       Inspection

Imagination, which Napoleon contended "rules the world," takes form in the *ideal*, and ideals are what men fight for and what we are fighting for. The *idea* is the next stage to the ideal; one tries to make it approach the ideal. The idea is developed by *invention*, followed by *engineering design*. Then comes the *demand*. Before the thing is manufactured by any one there must necessarily be a demand, otherwise no one would manufacture. Following the demand comes the *manufacture*. Then follow two very important items: one being the purchaser, or *purchase*, and the inspector, or *inspection*. The purchaser desires some article and creates the demand; the manufacturer makes it, and the purchaser, in order to be protected, necessarily brings in the inspector to see that he gets what he is paying for.

The idea, as conceived by the inventor, becomes transformed into the design or engineering device. In the mind of the designer exists broad imagination; otherwise he would not be a designer. He conceives questions of space entirely from an academic standpoint. The question of whether it is ten feet or ten one-thousandths of an inch has no real definite meaning beyond the carrying out of the idea or invention upon which he is working. "There," he said, "is the keynote of the principal trouble in inspection, and the relatiou of inspection to product, simply substantiating what Mr. DeLeeuw has said."

Having established the design of a particular machine or piece of munitions, the question of manufacture comes up

where some of the biggest troubles occur; and in respect to these, Mr. Waldron said that as he had been both inspector and manufacturer he would try to be fair to both sides. He wanted to emphasize, however, that when a manufacturer who does not know what a snap gage is, nor what one-thousandth of an inch is, takes a contract for hundreds of thousands of duplicate parts, he is making a mistake. Under such circumstances he did not blame an inspector for "kicking" and compelling the plant to produce the goods according to specifications. Such action would do the concern good in the long run. One of the greatest difficulties in the way of the inspector is the manufacturer who is not familiar with the details of his business.

Relations of Manufacturer and Inspector

In the relation between manufacturer and inspector there is what one might call academic manufacture and inspection; and commercial manufacture and inspection. Academic inspection is where the inspector goes back to the original idea of the inventor and designer, neither of whom may have had any practical experience, and insists on absolute accuracy in accordance with the specifications. The result will be no product manufactured. This represents one extreme.

The other extreme is where the designer understands what dimensions mean; is one who can discriminate where thousandths and where ten-thousandths of an inch are required; who can visualize the processes of manufacture as he writes his specifications; and who is able to prepare the specifications so that the manufacturer and inspector can understand them. Under such conditions the inspector will be helped by the specifications rather than hindered, and if the manufacturer understands his work he will be able to turn out the product.

Trouble is sure to exist where the inspector and designer fail to get together, since the manufacturer, caught between the two, will be at the mercy of the conflicting functions. As an illustration, a concern which has been making hundreds of thousands of scabbards for the government had an inspector who was a specialist in scabbard leather, and as long as he was on the job the production was as regular as the clock. After some time this inspector was transferred, and another inspector was put on the work who had been a specialist in harness leather. Now, harness leather must have considerable grease content and bend easily in order to resist weather conditions and be flexible wherever it is used. This man cut open a piece of scabbard leather, and because it lacked the characteristics of harness leather he rejected all the scabbards. That was a question of the wrong viewpoint, but, fortunately, the difficulty was corrected by referring the matter to the man in charge of that division, who had the inspector changed to some other work. In the meantime the product was stopped for three or four days, which, with a production of ten or fifteen thousand scabbards a day, was quite a serious matter.

Conditions Rendering Inspection Difficult

The principal condition of design from the standpoint of inspection is to have reasonable tolerances determined in reference to the final functioning of the article to be manufactured. For instance, there may be certain conditions which have no effect whatsoever on the functioning of an article that must be held to very closely because the design so specifies. The inspector is helpless in such cases. It is only in questions of visual inspection that the personal equation of the inspector comes in.

The evil effect of too small tolerances in design goes further than the pocketbook of the manufacturer. It first of all reduces the number of pieces sent to the front for our troops; and in making that statement the speaker said he was not arguing for defective material.

The effect on the cost, however, is serious. The closer the tolerances the greater the cost of tools, gages and fixtures required to maintain the product, especially in the volume that it being manufactured at the present day. When the Government was ordering forty or fifty thousand pieces at a time, and only one order in two or three years, and they were being turned out in their own arsenals, it was easy to meet academic tolerances. But when turning out parts by the million and tens of millions, quantities unheard of before, the wear and tear on the tools and gages is enormous, and the making of gages is becoming an industry almost as large as our producing functions prior to the war. Enormous supplies of steel are required to replace the tools and gages which have worn beyond the limits of the small tolerances established by the department of design, or the engineering department, and we are in the economic position of a possible dearth of tool and high-speed steels. There is already a dearth of tool makers. A man came into a New England town recently and took away nine tool makers at $10 a day each and traveling expenses. Why did he do that? Simply because in some cases the design demands such close tolerances that it is impossible to furnish enough gages and taps and dies to keep up the production of the shop.

What the Inspector Lacks

While the inspector cannot be blamed entirely for conditions such as outlined, there are some other conditions for the existence of which quite a little blame can be placed on his shoulders. The solution would appear to be, as already pointed out, that inspection should be in closer touch with design—not necessarily in a functional or organization way, but in a "spiritual" way, if one so chooses to call it. Then the inspection department knows just how far it can go without having to refer back to the design. It knows what a piece is used for, and that if a thread is a little rough, but will go into the piece properly, no harm will be done. By such knowledge the inspector will be able to maintain an economic condition of manufacture.

On the other hand, if the manufacturer is trying to take advantage of the inspector and deliberately push through inferior or cheap work, it is then necessary for the inspector to put the screws on for the time being. Some inspectors will lay aside a pile of material, in the initial stages of a contract, for some minor defect; they will not pass it and the equivalent of a large sum of money may lie idle for a considerable time. After the manufacturer has had his lesson the inspector will then gradually take material away from the pile and accept it. Meantime the manufacturer may have lacked funds to meet his payroll. Where such conditions exist, unquestionably there is blame on both sides.

In conclusion Mr. Waldron said it was his purpose to try to bring out fairly the troubles of inspector and manufacturer alike so that in the subsequent discussion each might have his say, make their complaints, and in the end both might be able to get a little closer together, so that the spirit of the design might pass to the inspection department, and the mental attitude of the manufacturer be brought to such a stage that, instead of looking upon the inspector as a disturbing element, he would regard him as a helper.

GENERAL PRINCIPLES OF GOVERMENT INSPECTION AND RELATIONS BETWEEN INSPECTORS AND MANUFACTURERS

By COL. B. W. DUNN, U. S. A.[1]

In accepting the invitation of your Secretary to open briefly your discussion of this subject, it was not my thought that I could add any new facts to your knowledge of the subject. It was my hope, however, that I might succeed in some degree in preventing between our inspection service and our manufacturers at the present time a repetition of some of the misunderstandings that are known to have existed in the past between the inspectors representing foreign governments and our American manufacturers.

It is of the first importance at this critical stage in our history that harmony should prevail among all important elements engaged in promoting our national defense. Differences of opinion are bound to occur frequently between an inspector and a manufacturer. There is no reason why such differences should be at all serious when both parties are actuated by a desire to be just and reasonable. The differences have been most serious in cases where mutual distrust existed between the parties before the differences occurred. In many such cases this previous absence of confidence has been the principal cause of the difficulty. For example, it has been stated that the inspectors of a foreign government, while on their way to America, would drill daily on the steamer for the purpose of enabling them to detect dishonest practices that it was assumed the American manufacturer would adopt. About the same time these American manufacturers were assuming that the foreign inspector would be a grafter. Approaching each other in this spirit, it is not to be wondered at that serious trouble developed in many cases between these inspectors and our manufacturers.

Government Contracts and Inspection

It seems advisable to explain to you briefly the ordinary development of Government contracts and our methods of inspecting the product. The drawings and specifications for the desired product having been completed by the Design Section located at Washington, the next step is for the Purchase Section to select the manufacturers and negotiate the contracts. In the selection of these manufacturers, the Purchase Section is aided by reports from the Production Section relating to the equipment of manufacturers under consideration, their general standing, their technical personnel, their financial standing, etc. Competition among acceptable manufacturers is of course a controlling feature. The contract having been signed, a copy of it, with drawings and specifications, is sent to the Inspection Department and constitutes a notice to this department to take charge of the interests of the Government from that time on.

Our Inspection Department at the present time is made up almost entirely of men taken from the manufacturing industry. Any branch of the Ordnance Department is lucky at the present time if, in its personnel, it is able to show more than 1 per cent of officers who belonged to the Ordnance Department before the declaration of war last April. As a rule, the reserve officers are men who have come into the service purely for patriotic reasons. In accepting these patriotic offers, the preference of the Government has been for college graduates with the degree of mechanical engineer, and with a practical experience in machine shops after graduation of five years or more, during which the applicant has received a salary materially in excess of the salary paid by the Government for his grade. Many of these officers are now wearing the uniform and receiving a salary considerably less than one-third of their salaries in civil life. The assistants of these officers are civilian employees of the Government obtained through the Civil Service Commission.

The inspecting force at a single plant constitutes a field unit. It consists of one officer in charge, known as the Inspector of Ordnance, at the plant. He has as many assistants as necessary, consisting of junior commissioned officers, chief inspectors, assistant chief inspectors, and inspectors. To bring about uniformity in the action of these field units, we have a number of supervising inspectors, made up, as a rule, of men of large experience and mature age, combined with tact and good judgment. These supervisors have a number of plants assigned to them, and they circulate among them, charged with the duty of thoroughly investigating any complaints made by contractors and observing with great care the activities of inspectors to detect any weaknesses. Twice a month these supervisors meet the officer in charge of the inspection service at headquarters to discuss general features of the work and to promote uniformity in the action of the supervisors themselves.

From the above, it will be seen that any contractor who has the slightest reason to complain of the action of the Government inspector, can secure at once a complete investigation, and, it is believed, a correspondingly just decision. The inspector of ordnance in charge of the plant is required, in case of a complaint, to immediately get in touch with the chief inspector of the plant and to make a joint investigation. Granted that both minds approach such an investigation in the proper spirit, a satisfactory conclusion should be reached in more than 90 per cent of the cases. The supervisor should settle at least 90 per cent of the remaining cases, and when he cannot secure a settlement, only a few hours are needed to bring to the scene of trouble the principal technical assistant at headquarters, and, if necessary, the officer in charge of the entire service.

Differences Between Government and Commercial Contracts

It seems pertinent to analyze to some extent the differences between Government and commercial contracts. The most important one is believed to be the fact that a contractor cannot sue the Government. This is combined with the fact that in practically all Government specifications the contractor is required to satisfy the inspector. The manufacturer who considers an inspector unreasonable must be prepared to prove the accuracy of his charge. If we grant that an inspector is unreasonable, and possibly dishonest, and that his superiors belong to the same family, it is quite evident that the contractor is without adequate protection. The possibility that he may be placed in this position is a source of most of the manufacturer's imaginary troubles, which to him seem anything but imaginary. The absence of personal interest of the inspectors in completion of the contract is another difference between a Government and a commercial bargain. As a rule, the Government inspector has only one responsibility, that of seeing that the quality of the manufacturer's product is up to the prescribed standard. It is no concern of his that the product may be short in quantity. To stimulate produc-

[1] Inspection Section, Ordnance Department.

tion is the duty of another department, the Production Department.

Another very important difficulty to the manufacturer relates to the delays that frequently attend the receipt of funds from the Government. With millions to his credit, the Government paymaster cannot deliver the much-needed check until all requirements of rigid red-tape regulations are complied with. This is the cause of frequent trouble to the contractor who undertakes a greater volume of work than his financial backing justifies.

Another important difference is found in the fact that in commercial work the contractor is generally more accurately informed on technical matters relating to the product produced than is the purchaser. In the case of Government contracts, it is usually the other way. Few of our manufacturers are ordnance engineers, or have on their personnel staff men who understand the reasons for the requirements of Government drawings and specifications. The barrage fire, which constitutes such an essential part of military operations today, is seriously interfered with by any difference in the action of one fired round from another. Our soldiers will march confidently a short distance in the rear of this wall of bursting fragments, their lives depending upon this uniformity in the ammunition. Any material difference in the weight, exterior form, or location of center of gravity of the projectile, in the action of the fuse, or in the uniformity of the propelling powder charge, would be liable to cause one or more of these projectiles to burst well short of the intended point, and in the midst of, instead of safely in front of, our troops. The contractor who honestly thinks that some nicety of dimension called for by the drawings is introduced solely to allow the inspector to exercise his power, may, in this ignorant way, be objecting to one of the features essential to the efficiency of the ammunition.

Requirements from Government Inspector

The product of the manufacturer is divided by the Government into lots, and for each lot the Government inspector is required to sign a formal certificate, stating in substance that all units of the lot comply in quantity and quality with the requirements of the specification and drawing. It is impracticable for the inspector to inspect each and every unit for each and every requirement. The manufacturer does make a 100 per cent inspection of the product for all dimensions. The plan of the Government inspector is to check the manufacturer's inspection to the extent found necessary, the checked inspection for the more important feature being of course much larger than the less important. The certificate for the Government inspector is required before the voucher for payment of the contractor can be completed. As an illustration of the kind of coöperation that should exist between the inspection departments of the Government and the contractor, I am reproducing below two circular letters that have been issued from our Inspection Department to all contractors manufacturing artillery ammunition.

(COPY)

October 1st, 1917.

From: Inspection Section, Gun Division, Ordnance Office

To: (Name of contractor)

Subject: MANUFACTURERS' CERTIFICATE OF PERFORMANCE

1. It has been suggested that I request manufacturers to submit for each lot of finished product presented for official inspection a certificate on some convenient form signed by a responsible representative of the firm, and reading in substance as follows:

"I certify that Lot —— ———— —————— has been
(No.) (Article)
manufactured strictly in accordance with standard machine shop practice; that the components have been inspected carefully by the inspectors of this Company; and that to the best of my knowledge and belief this lot complies with all requirements of the drawings and specifications that apply to it."

2. Some of the arguments supporting this suggestion are:

(*a*) The certificate does not require any change in the present standard practice other than the signing and filing of the certificate.

(*b*) Very exceptional instances have occurred where over-zealous or dishonest subordinates have attempted to resort to questionable practices in repairing or salvaging defective material; and where their immediate superiors have disclaimed responsibility because they were ignorant of the practices.

(*c*) The responsibility of the firm in such cases will be acknowledged by no one more promptly than by the management, whose duty it is to take the steps necessary to avoid this ignorance.

(*d*) It is believed that this certificate will assist the management in establishing in the minds of all of its employees, and especially in the minds of its shop superintendents, foremen and inspectors, a correct appreciation of this responsibility. It is not conceivable that any of these responsible employees can remain ignorant for any length of time of anything relating to the work and practices under their supervision, if they make proper efforts to keep informed.

(*e*) The writer desires the establishment of the most cordial coöperation possible in the efforts of our inspectors and of the contractors to detect and eliminate all defective material, and to prevent errors of judgment in the rejection of good material. Mutual confidence is a necessary foundation for this coöperation. Suspicion will supplant confidence in any plant that does not detect and eliminate the employee who is inclined to conceal rather than to discover and report defects. If it is at all possible to correct the defects and salvage the material by proper, as distinguished from secret or questionable, practices, the Government inspectors will coöperate with the management to that end.

3. About the only criticism presented against the suggestion is:

(*a*) Any dishonest contractor or employee would not mind signing a false certificate, and the honest ones are liable to resent being asked to certify to their honesty.

4. Commenting on the above criticism, it is thought to be superficial. An honest man does not object to being placed on honor. Army officers have a just pride in their reputation for honesty, and they certify daily to the correct performance of various duties. The value of all these certificates is to a great extent educational. They concentrate the honest man's attention on important matters that require special treatment by him. In the production of ammunition for use by our soldiers on the firing line, the prime responsibility to conserve the safety and efficiency of the ammunition rests equally upon all concerned with the production, and all agencies tending in any degree to promote this conservation should be utilized.

5. Please give this subject your careful consideration, and let me have the benefit of your views.

(*signed*) B. W. DUNN,
Lieut.-Col., U. S. Army, Retired, Commanding.

Letter No. 2

November 21st, 1917.

From: Inspection Section, Gun Division

To: (Name of Manufacturer)

Subject: MANUFACTURERS' CERTIFICATE OF PERFORMANCE

1. In a former circular letter I asked for comments on the suggestion that we require from manufacturers a certificate similar in substance to a certificate signed by Government Inspectors. While some of the replies reflected some doubts as

to the necessity for such certificate, the suggestion did receive the hearty approval of the majority of the manufacturers.

2. This correspondence indicates that the certificate should be signed by the Chief Inspector in the employ of the manufacturer and countersigned by the Shop Superintendent. The original suggestion was indefinite in this respect, and stated that responsible representatives should sign the certificate. It is evident that the Chief Inspector and the Shop Superintendent are the chief representatives of the company who know most about the actual work in the shop. A slight change is advisable also in the wording of the certificate, substituting "good" for "standard" in describing machine shop practice.

3. General William Crozier, Chief of Ordnance, whose attention was invited to this correspondence, suggested that good results should also follow the placarding of his plant by the contractor with notices inviting attention to the obligation that should rest upon each individual employee to do everything in his power to insure that the product of his plant is of the proper quality to insure the safety of our soldiers and our success in the war.

4. I am therefore inviting manufacturers to submit for all lots of their product completed, after date of receipt of this letter, the following certificate:

> "We certify that Lot ——— (No.) ———— (Article) has been produced by the use of good and modern plant practice; that the components have been inspected carefully by the Inspectors of this Company, and that to the best of our knowledge and belief this Lot complies with all Government requirements that apply to it.
>
> (*signed*) ....
> *Chief Inspector for* .... *Co.*
>
> *Countersigned by* ....,
> *Shop Superintendent.*"

5. It should be understood that the above Certificate is not required of any manufacturer who prefers not to furnish it. When furnished, it should be forwarded directly to this office through the Inspector of Ordnance at the plant.

(*signed*) B. W. Dunn,
Lieut.-Col., U. S. Army, Retired,
Commanding.

It is my hope that this discussion will result in developing other practical methods for promoting this coöperation.

DISCUSSION

Sir Charles Ross said that two months ago there had been criticism in this country of a matter in which ammunitions were concerned. While it was not to the point of the meeting he desired to take the opportunity to say that after 16 years of close study of the American Government's Ordnance Department he was filled with admiration for it, and if the details of the ammunition question had been known to the public he felt that the work of the department would have been applauded instead of criticized.

Speaking of the troubles and difficulties which arise between inspectors and manufacturers, he said that he would propose a solution as a basis for discussion, so that if the fundamental theory on which it was based should meet with the approval of the engineers of the Society some practical means might be worked out for accomplishing the desired results. At present there is no means by which the inspection department of the Government can have matters explained to it by some quite impartial persons; and if the manufacturer has complaints to make the odium is at once thrust upon him of making complaints in respect to the inspector, which is a very undesirable thing to do.

In order to overcome that unjust obligation on the manufacturer, the thought is that an independent body should be created, called *X*, in the diagram below. Such a body might be composed of the elected representatives of the engineering societies of America, whose functions should be as follows: (1) to hear the complaints of both the manufacturer and the inspector; (2) to advise both the manufacturer and the inspector, and (3) to make reports to the Secretary of War and the Secretary of the Navy.

PUBLIC OPINION
PRESIDENT
CONGRESS

SECRETARY OF WAR }	X	{ SECRETARY OF NAVY
MANUFACTURERS }		{ INSPECTOR-CHIEF

The speaker believed that such a plan would secure the coöperation of and be welcomed by the Government. With such an organization, questions of proper toleration and finish, questions of samples, etc., could all be passed on.

At a later point in the meeting he presented a resolution for the appointment of a committee whose duties should be as outlined in the foregoing discussion. This finally led to the drafting of a resolution as given below, which was voted upon favorably.

Resolved: That the Council of the Society be requested to recommend to the Government the creation of a Board which shall be intermediate between the manufacturer and the inspector, and the Secretaries of War and Navy—the functions of this committee to be as detailed in a resolution offered by Sir Charles Ross and unanimously recommended, viz.:

That authority be given to a committee as follows:

(1) It shall hear complaints:
  (a) From manufacturers.
  (b) From inspectors.

(2) It shall advise inspectors as well as manufacturers upon the proper application of gages and standards of acceptance and rejection.

(3) It shall report and have access to the Secretary of War and the Secretary of the Navy.

R. H. Danforth pointed out that while the question of gage inspection is undoubtedly the question of most importance to those concerned with machine-shop work, difficulties are encountered in the inspection of material which could have been partly eliminated if there had been preliminary inspection. The parts which depend primarily for their acceptability on machining do not usually depend on the material, except in so far as the material determines the usability of the products. To illustrate, a manufacturer of small tools, taps and dies purchased steel under usual specifications and had made practically all of it into taps which were heat-treated and hardened in the usual way. Customers complained that the taps did not wear. An examination showed that ten per cent of the taps were not hard at all, and a chemical analysis of the soft taps proved that instead of being of tool steel they were of cold-rolled stock that had gotten in by mistake.

Another instance was in the manufacturing of automobile parts and drop-forgings, which have to be heat-treated in order to provide the necessary strength with the minimum of weight. A great deal of difficulty was encountered in getting alloy steel within a reasonable tolerance of composition so it would be amenable to heat treatment. In one case a shipment of fifteen-point carbon steel was mixed in with a lot which had been ordered as a thirty-five-point carbon and fifteen-point vanadium steel. After heat treatment, instead of getting 75,000 lb. elastic limit, only 40,000 lb. was obtained. As a result the manufacturer put in a complete inspection department for his raw material. He bought in lots of from 50 to 100 tons and made a chemical analysis of at least every ton.

A great many specifications today are practically impossible to meet. They call for certain chemical requirements and also for certain physical requirements, and unless the latter have sufficient leeway to allow for the maximum allowable variation in the former, or unless the former have an allowance sufficient to take care of the maximum allowable variation in the latter, one cannot produce material with proper characteristics. Thousands of specifications in use today do not take that point into consideration, and therefore are a constant source of trouble to both the manufacturers of the raw material and the finished product, to say nothing of the inspectors who act as the go-betweens.

W. S. Huson said that while we are working for the standardization of products and the standardization of production we are also awakening to the fact that we must have standardization of inspection. This is all the more important, as Mr. DeLeeuw pointed out, because of the kind of labor which must be employed, but the thought had come to him that it is not so much the inspection itself that must receive attention as it is the specifications; particularly for the guidance of the younger inspectors, who lack the necessary experience. Drawings and blueprints should be made to convey intelligent information to worker and inspector; and care should be taken in the designing of a machine to avoid useless and needless precisions.

He further said: "In discussing the broad field of inspection I believe that common sense is not a bad thought to give expression to. The inspector must feel that he is not hidebound by the instructions and the pictures that he has. He must use some gumption and common sense of his own.

"The chief inspector must communicate to those who are under him those qualities which govern proper and intelligent inspection. The day has gone by when 'jacking up' men is the thing to do. A man must be agreeable, even if only in a subordinate position such as that of a junior inspector. He must try to judge the work without bias or partiality and must steer clear of two things: he must not permit the workmen to agree among themselves as to what constitutes the quality of work they turn out, and he must avoid getting into argument with them as to whether it is right or wrong. He must go to the chief inspector, who must be intelligent and efficient enough to know what constitutes the right kind of work, and how far the tolerances can go one side or the other. In other words, today the principle of good shop inspection is not to point out why work is wrong, but rather to try to point out to the men why it should be right, and thereby gain their cooperation."

As contributing to this, the speaker raised the question as to what had been done for factory organizations similar to that which is being done in other fields by technical journals and house organs. Have we to any extent given to the men engaged in manufacturing operations the "whys" and "wherefores" of the work that a machine does, of the products produced and their requrements? While some workmen would profit by such printed matter, others would undoubtedly not, but nevertheless he felt that some consideration should be given to the development of such means of communication to at least show the workers that their services are appreciated.

Forrest E. Cardullo contended in answer to Mr. DeLeeuw that a set of specifications could not be gotten out that would cover entirely, completely and satisfactorily what was needed. No man had sufficient foresight to cover everything that would come up in materials and workmanship and various other things that affect the usability or non-usability of parts. The Constitution of the United States is a set of specifications for government, and there are about 110 volumes of interpretations of it. One cannot prepare a set of specifications for a motor, including materials and parts, or for an aeroplane or a gun, and cover it completely. Room has to be left for the inspector to use his judgment, and the inspector that does not is one of the best allies that the Kaiser has. The inspector should be given authority to waive the specifications. For example, it is all very well to say that a thing should have no surface defects, and it is wise to follow out this specification if the defect of the part is such that it affects its suitability for use. If there should be a tiny sulphur seam in the main bearing of a crankshaft of an aeroplane motor the crankshaft should be rejected, but if the defect is in the crankpin of a certain type of motor the pin should be accepted. In short, it all depends on whether the thing is just as good for use as if it met the specification in every respect, and if it is it should be accepted.

The war cannot be won by specifications or by inspectors. The only things that can do it are guns, ammunition, aeroplanes and various other agents of destruction. The purpose of inspection must be to produce the largest possible volume of military implements and munitions that are suitable and usable for their purpose, and the inspection that fails to do this is radically defective. In his connection with the Curtiss Aeroplane Company the speaker had heard young men in the American Inspection Service say that it was immaterial to them as to what the product was or whether, for example, ten or sixty aeroplanes were produced per week, as long as they saw to it that the "stuff" met the specifications; and if because of that attitude on their part production was delayed, it was unfortunate, but it was no concern of theirs. Such an inspector is a grave danger to the country. The purpose of the inspector should not be simply to reject certain pieces that pass on one side of an imaginary line, and accept certain other pieces that fall short of a certain imaginary line; but it should be to keep up the general quality and quantity of the product.

Inspection should be reorganized on the basis of quality and quantity. We are apt to fall into error in believing that our inspection has to be complete. Our inspector, whether connected with Government or plant, should bear in mind when he is inspecting the product of outside manufacturers that he is there primarily to help bring up the general quality, and when he has reached that point he has then done his duty.

Philip Reynolds[1] stated that he had been connected with ammunition manufacture from three different standpoints; from that of government inspector, the manufacturer and the shop inspector. He had worked on Russian and British work since the crack of the first gun. He had seen pictures of guns that had burst, with all the men either killed or wounded, just because some inspector used too much judgment. He believed that inspectors should live exactly up to the requirements, up to the gages, and that they had no right to use their own judgment at all. Matters of judgment should be submitted to their chief.

Coming down to shop work, he believed if everybody worked on restricted tolerances, that is, lower tolerances than the Government required, there would be very little trouble. He had had no trouble in meeting Russian and British requirements. The boys at the front must be protected. There must be no "prematures," or anything like that taking place.

C. B. Hamilton, Jr., also from Canada, endorsed the re-

[1] Supt. of Inspection, Lymburner, Limited, Montreal, Canada.

marks of the last speaker, and said: "We have been in this war longer than you have, and we are having our boys come back minus arms and legs, and we don't want any of that done with our own shells. We have been accustomed to the barrage fire for some time, and we are beginning to realize the niceties that are required in shell work to make sure that we are not going to have some shells burst in our own ranks; and shell work is only one of the items. There isn't any 'good enough' in this munition business. There have been quite a number of us finding that out, and you people will find it out, too."

With regard to tolerances, he said that it is the practice at his plant to make the limits in the earlier stages of the work less than the government requirements, and to increase progressively as the latter operations are approached until finally they equal the government requirements. If the limits in the early operations are made as wide as they may be, there will be trouble all down the line. The limits in the early operations should be as close as the men can work, even if it costs more money. The money will come back by less trouble in the secondary and later operations.

Mr. Hamilton said that it is further the practice in inspecting materials to do as Mr. Danforth suggested. In some cases analysis is made of a specimen from every half ton of steel, and in a few cases every bar is analyzed. Discrepancies are not all due to accident by any means. A lot of plain, ordinary negligence existed on the part of steel manufacturers.

In this matter of specifications we had better assume that the man who wrote the specifications knows more about the work than those who are just starting the work. The modern progress of shell fire calls for closer and closer limits. We will be working to closer limits next year than we are now. While the production may be reduced, we must have shells that will produce results in Germany and not in our own ranks.

He felt that the specifications quoted by Mr. DeLeeuw with regard to belting must have been selected in a way that gave a wrong impression. There are two kinds of specifications: guidance specifications and inspectors' specifications. The specifications such as Mr. DeLeeuw read are in the nature of guidance specifications, for the manufacturer to take into consideration in bidding, to know whether he is going to be able to produce that kind of goods. The inspector has nothing to do with such specifications.

While he did not want to be misunderstood in referring to things made in the United States, he had been told that shells had been sent to the British Government that were so rough that the revolution or spinning of the shell made the steel act as a rotary file on the explosive block, and produced premature firing.

In response to a question by Mr. Cardullo, he said it had been found that there were a large number of premature explosions among shells that are rough, but when they are polished there is no trouble from that cause.

Major A. W. Erdman said that as far as the Inspection Section of the Gun Division of the U. S. Government is concerned, the contractors are expected absolutely to live up to the specifications as they are written. If there are any points in the specification that can be advantageously changed, if they are called to the attention of the department the officers will be glad to coöperate with manufacturers, but the Government must proceed along these lines. It cannot proceed on the theory of getting a general average of good product.

Philip Reynolds advanced the theory that such explosions, which sometimes shattered the guns, killing every man on the crew, were due to faulty fuses rather than to the cause advanced by Mr. Hamilton. Mr. Cardullo also confirmed this opinion, saying that the consensus of opinion among those at the front was that the cause of premature explosions is defective fuses.

C. E. Coolidge reported that he had spent two strenuous years in the manufacture of munitions in Canada, and had gone over about as many of the hard spots as any of his confreres. Fortunately, his plant, one of the largest in Canada, was located in a district where there was a broadminded chief inspector. They had a large contract for eight-inch howitzers, and they probably had as much reason to find fault with government inspection as did similar plants, but the policy adopted was a broad one.

It was recognized at the start that they must first of all protect the boys on the firing line; secondly, they must protect the government; and thirdly, they must protect the manufacturer. This must be accomplished through a spirit of coöperation all around. While it is an ancient tradition that the operating and the inspecting organizations must be arch enemies, with a sort of dead line between them over which neither must step, such a spirit can produce only unsatisfactory results. It is the policy in this particular plant to consider that the government inspection corps and the shop inspection corps are practically one.

The speaker said that he had organized the shop inspection corps and had made it plain to every one of the inspectors that they were part of the government staff, and also advised the chief inspector for the government to take under his wing to a certain extent the company's inspectors. In that way they constituted one happy family. In order to overcome ill-feeling between inspectors and the machine operators, inspectors were assigned to each machine and they were told that they must be friendly to the operators and should coöperate to the limit. The spirit in that plant is of this kind. Every one feels that he is doing his little bit, and each one that he is the man behind the man behind the gun.

Charles E. Davis had found that when the fact was established in the minds of the inspectors that the truth was wanted from whatever source it could be derived, friction disappeared and production increased. He had found this to be particularly the case in connection with fuse construction for the British Government. Their assistance on many questions was needed and invariably when a point was reached where there was a question in regard to the product, they were told "We want to make this test, and we want your inspector with us when we make the test." They coöperated and gave every opportunity, and the result of their experience at every point, and the percentage of loss was reduced to a very low percentage. To his mind it was first necessary to establish in the design of a piece or a machine the vital functioning points of the product to be produced; then to establish the limits of variation that will give these results reliability. Hold to them rigidly. On non-essential points cover the matter as carefully as you can.

Major A. W. Erdman said that inspecting the functional points as outlined by Mr. Davis, was exactly the line along which their Inspection Section was working. For instance, on the twenty-one-second time fuse he thought there were 45 distinct metal parts, and there were something like 240 gages required. In the factories which have had years of experience in making these fuses the government was inspecting with thread gages to be sure the fuses would screw into any shrapnel.

Philip Reynolds[1] wrote that from his experience with the manufacture of Russian and British shells he believed that in the inspection of munition quality could be held to the set standard. As for quantity production this also could be obtained granted that the manufacturing department was tooled to perform each operation with the human element reduced to a minimum and with positive stops and machines which are kept up, combined with a perfect sequence of operations. The inspection must be organized so that the product of each machine is safeguarded thus preventing the possibility of a run of bad work.

In connection with the above Mr. Reynolds outlined the organization of his plant, as follows:

The superintendent of inspection has chief inspectors for each eight hours' shift, with their assistants controlling each floor or battery of operations. Gaging is performed at the back of machines, the work being conveyed by gravity to inspection bench. Care is taken in the allotment of the quantity of machines for each inspector. All prime dimensions received 100 per cent inspection. Final shop inspection is not necessary with efficient machine inspection except to check parts which are liable to be affected at subsequent operations. All machine inspection is made with restricted tolerances, ensuring the acceptability of work by government with their larger limits. This method has proved must successful. The superintendent of inspection is responsible for quality of product to the general manager.

The superintendent of inspection is held solely responsible for the quality as the shop superintendent is for production, all differences being settled by the general manager.

Each inspector is provided with a small personal stamp which he or she stamps on a location allotted by the government inspector and which does not interfere with the product. By this means any faulty inspection is traced. The assistant inspector checks up his inspectors frequently. Given limit gages which are right, inspectors have no excuse to wrongly gage. All gages are checked daily and twice daily, where necessary, by the gage and standard department, who are held responsible for a sufficient supply of gages and their accuracy. The head of this department is the chief draftsman and he reports direct to the general manager. This complete system of inspection has proved very satisfactory in meeting the conditions which exist in the plant.

The writer thought that interchangeability applied to a machine or a mechanism was the attainment of producing standard units of mechanism which guarantee without selection the assembly of the machine. To illustrate, a projectile and its component parts are designed with limits which allow of shell fuse and cartridge case to assemble without selection. It therefore seems correct to assume that it is practical to maintain interchangeability in munitions without sacrificing the quantity of production.

R. F. Bryant[1] contributed a written discussion, which will be published in full in the next issue, covering the experiences of the Yale & Towne Manufacturing Company regarding several important phases of inspection, particularly of fuses.

[1] Supt. of Inspection, Lymburner Limited, Montreal, Canada.

[1] Supt. of Productive Efficiency, Yale & Towne Mfg. Co., Stamford, Conn.

PUBLIC MEETING OF GAGE COMMITTEE

Culminating in a Proposal to Government to Cooperate in Munitions Contracts by Requiring Certification of Gages by Bureau of Standards

REPRESENTATIVES of important Government departments, both Army and Navy, the British Ministry of Munitions of War in the United States, the Canadian Munitions Board, leading munitions manufacturers and makers of gages, met at the call of the Joint Committee on Gages of The American Society of Mechanical Engineers and the Society of Automotive Engineers on Tuesday afternoon, December 4, not for a technical discussion, but to consider in a broad, patriotic way what could be done to accelerate the manufacture of munitions and to provide means by which all munitions, wherever manufactured, should be interchangeable. Costly blunders in the handling of the gage question by this country during the Civil War and by foreign countries during the present war were responsible for serious delays and loss of effectiveness.

The Chairman of the joint committee, Harry E. Harris, President of the H. E. Harris Engineering Company, presided at the hearing, and called upon Major L. A. Fischer, in charge of the Gage Design Section of the Ordnance Department, to state the purposes of the meeting by reading a brief résumé of the work of the committee up to this time.

Inception of Society's Gage Work

This phase of the Society's war work had its inception at the Spring Meeting in Cincinnati last May. So clearly was the vast importance of this matter brought out by extended discussion that a resolution was adopted calling upon the Council to appoint a committee to coöperate with the Government in laying down a sound foundation for the tremendous munitions-manufacturing program upon which the country was about to engage. Representatives of the Society sent to Washington at the time, however, found that immediate action would be premature, but two months later conditions were considered sufficiently favorable and a committee was appointed. At a meeting on August 23, the committee agreed that there should be one central bureau for the certification of gages, and that the best place for such work was the Bureau of Standards at Washington. The inspection of all master gages should be made at the Bureau of Standards, but, if possible, some of the working and inspection gages be tested in the vicinity of the factories making munitions, or at the plants of the gage manufacturers. This meeting was followed by visits of the members of the committee to such department officials of the Government as were particularly affected by and interested in the question of gages. In general, these officials expressed their entire approbation of the plans of the committee.

Society and Government Officials Get Together

In order to get a concerted understanding in the matter, the

Society gave an informal dinner to a number of high Government officials and members of the Council of National Defense, following which those present joined in a general discussion of gage certification and standardization, displaying considerable unity of opinion and appreciation of the work the Society was endeavoring to do. While many phases of standardization were considered, especially as applying to raw material, manufactured products, and gages, the discussion centered around the absolute necessity of having all gages made to the same standards, to insure correct standards and interchangeability.

Following the dinner, a letter was sent to all present asking that each department concerned appoint a member of its staff with whom the committee might confer in working out a satisfactory program. This letter was well responded to by the various branches of the service. As a result, the committee now has serving with it official representatives of the principal departments concerned. The coöperation of the Society of Automotive Engineers has been secured in the form of a committee to serve jointly with our committee. All are agreed that standards of measurement, master gages, reference gages, inspection gages and Government inspection gages should be certified at the Bureau of Standards so far as is physically possible.

At a meeting in Washington, on October 30, it was ascertained, through correspondence and representatives of Government departments present, that many of the departments were conforming to the recommendations of the committee in having gages certified at the Bureau of Standards, that there was close coöperation in many instances, but not according to any universally accepted plan. It was recommended that the various bureaus recognize officially the Bureau of Standards as the technical source for the certification of all master gages, and as many of the inspection and working gages as possible. A sub-committee was appointed to prepare a clause for the consideration of the full committee, which could be incorporated in all Government orders for gages, and in contracts for war supplies in the manufacture of which the supplier would be required to make or purchase gages. Such a clause was submitted to the joint committee on November 10, and has been the subject of much discussion and correspondence. All comments and suggestions were considered at a meeting on Tuesday morning, December 4, and a final form adopted for submission to the Government departments if approved by this public meeting.

Gages Must Be Checked Against Standards Under Unified Supervision

Chairman Harris stated, in further explanation of the work of the committee, that while a proper handling of the gage situation was of the utmost importance at the moment in securing certain supplies, such as airplane motors, truck engines, guns, small arms, ammunition, etc., the committee had no intention of proposing that on other material, such as fire buckets, for example, orders and specifications should require the sending of the gages to the Bureau of Standards. In order to produce war supplies of a mechanical nature on a large scale, in widely distributed plants, that will be correct to specifications, interchangeable and function properly, it is an established fact that universally correct gages must be had, and that the only way to have them uniform is to check them against the standard of measurement under unified supervision. Hence the recommendation that all gages be made to the standards of the National Bureau of Standards. This involves no change from existing standards, but insures the correct duplication of existing standards under the direction of technical experts equipped with instruments of precision such as few factories possess. Referring all gages to this central agency for verification would also prevent duplication of measuring equipment and technical staff, thereby conserving our most valuable resource, skilled man power. In conclusion, Mr. Harris called upon all present to unite in the single purpose of assisting the Government, setting aside private interests, desire for profit, prejudice and selfish pride, remembering that the recommendations made by these two great engineering societies, representing the vital forces of mechanical engineering in this country, would command the support of manufacturers, Government officials, the general public, and receive considerable attention from Congress.

Important Gages To Be Certified by Bureau of Standards

The Chairman then called upon Mr. William A. Viall, Secretary of the Browne & Sharpe Mfg. Co., to read the clause proposed by the committee, which in its final form is as follows:

> The master and reference gages and standards of measurements, with which are to be compared the gages and measuring instruments used in carrying out this contract, are to be certified by the Bureau of Standards of the Department of Commerce, Washington, D. C.

The committee also proposed the following form of memorandum to be used by heads of various Government departments in notifying the branches and officers under their jurisdiction of the adoption of the Bureau of Standards as the official agency for gage certification:

> The Bureau of ———— designates the Bureau of Standards of the Department of Commerce, Washington, D. C., as the place at which all master and reference gages and standards of measurements are to be certified. This is intended to include all such master and reference gages and standards of measurement as are used by the ———— for the work coming under the cognizance of the Bureau, both in manufacturing and inspecting.
>
> All master and reference gages and standards of measurement used by private manufacturers in carrying out contracts for the Bureau, where certification is called for by the contract, shall be certified by the Bureau of Standards.

As pointed out by Mr. Viall, this memorandum does not call for the certification of unimportant gages. Each bureau prepares its own contracts, and thus has complete control of the extent to which certification shall be required. The master gage, in the mind of the committee, is the one gage or set of gages used as the ultimate reference in a factory on a certain piece of work. The reference gages are the gages distributed throughout the plant with which the working gages are to be compared from time to time. The reference gages are subject to wear, relatively small but possibly appreciable, while the master gages are not subject to wear during the life of the contract. If every gage could go through the Bureau of Standards it would be desirable, but since this is not a physical possibility, the committee has included in its recommendation

only the master and reference gages. Regarding the objection that this method of certification divides the responsibility for the correctness of the finished product between the Government and the manufacturer, the committee does not regard the proposed plan as any sharing of responsibility whatever. The Government furnishes the standard and the manufacturer must work to it.

Meeting Opened to Discussion

The Chairman then declared the meeting open to all present, and called upon a number of those present to lead the discussion. Naval Constructor S. M. Henry heartily endorsed the proposals of the committee, and stated that they met the views of the Bureau of Construction and Repair.

Major L. A. Fischer, in charge of the Gage Design Section of the Ordnance Department, announced that the plan, practically as proposed, had been in operation for some time by the Ordnance Department on contracts for munitions which call for the manufacturer to supply inspection gages. The Government furnishes a set of master gages to the manufacturer and to the Government inspectors. These are kept at the factory and all inspection gages referred to them.

That there would be no delay in submitting gages to the Bureau of Standards, and had been none up to this time, was brought out by Major Fischer, who organized the gage-inspection service of the Bureau during the time when he was in charge of the division of Weights and Measures. Based on the experience of our allies, the gage-inspection division has been organized on generous lines.

Major Henry W. Torney, Inspection Department, Equipment Division, Signal Corps, said that his department had already made considerable use of the Bureau of Standards for gage certification, and expected to continue doing so.

Experiences of Our Allies

An international note was added to the meeting by the presence of a representative of the British Ministry of War in the United States, Mr. H. J. Bingham-Powell, Inspector of Gages and Standards, who emphasized the importance of advising gage makers in advance what they would have to meet in the inspection of their product, and the importance to gage makers of having facilities for knowing that their product is correct. He extended a cordial invitation to all present to inspect the facilities of the British Ministry for the certification of gages.

The experience of Canada was outlined by Capt. Richard J. Durley, of the Imperial Munitions Board. At one time the Canadian troops in France were being sorely pressed through lack of sufficient ammunition, and it was necessary to speed up the manufacture of a certain fuse. Upon studying the situation, it became evident that the date on which a supply of fuses could be obtained was entirely dependent upon the dates at which inspection gages could be had. This has been the case also on most other work. Every day which passes without a sufficient supply of inspection gages means another day on which there will be no product. The present practice in Canada and in Great Britain is to have all gages pass through the Imperial Munitions Board and the National Physical Laboratory, respectively, for certification. They are then given a serial number, issued to the inspectors, examined at intervals and when worn down to the permissible limit are returned, reëxamined and scrapped.

In reply to a question from Major A. W. Erdman, Inspection Division, Ordnance Department, as to the meaning of certification as used in the proposed clause, Major Fischer stated that this was understood to be the certification by the Bureau of Standards that the gage was within the tolerances permitted to the manufacturer of the gage by the bureau in charge of the work on which it is to be used. Verification, on the other hand, means that the size of the gage is determined regardless of whether this size is proper for the intended use of the gage or not.

An interesting point brought out by Major Erdman was whether, in view of the fact that there are not available enough highly skilled gage makers to furnish the very large quantities of gages, especially thread gages, now required, it would be advisable to utilize a large number of less skilled men. This would no doubt result in less accurate gages, but if within the limits allowed the manufacturer who is to use the gages in producing munitions, it would simply result in reducing his manufacturing tolerance without affecting the quality of the product. This might involve difficulties in some cases, but many manufacturers would be able to get into production quicker and a great increase in the output of gages would be possible.

Advantages to Manufacturers of New Plan

The advantage to manufacturers of gages of having their factory standards approved by the Bureau of Standards, or of having sub-stations at important points throughout the country, was brought out by Mr. Frank O. Hoagland, Assistant Works Manager of Pratt & Whitney. Where a gage maker has an order for a set of duplicate gages, subject to certification, he cannot make up more than one set until the first has been approved unless his standards have been approved. The first having been approved, it is readily possible to duplicate it and to check it. All purposes would therefore be served if only the first gage were sent to Washington for certification and the duplicates passed upon at a sub-station more accessible to the place of manufacture.

Then followed an exceedingly interesting discussion of numerous phases of the gage question, participated in by men of large experience on such matters with the Government, gage makers and munition manufacturers. Among the topics covered were the standardization of gages, the fixing of tolerances fair to the maker and user, means of securing greater production of gages and of regulating the flow of production, greater publicity in the technical press concerning the design, manufacture and use of gages, and other valuable suggestions now available for the use of the committee in the stenographic notes of the meeting. One hundred of America's leading men in this field freely contributed from their rich experience to the end that the industries of the country might make a prompt and satisfactory response to the call for enormous quantities of those mechanical products so essential to the successful prosecution of the war.

At the conclusion of the discussion, the contract clause and the accompanying memorandum prepared by the committee were approved by a unanimous vote of the meeting. The committee will now be able to present the matter in final form to the Government departments with the full approval of the two great engineering societies qualified to pass an authoritative opinion on this subject. There is every reason to believe that the suggestion will be promptly adopted and the committee will then be able to turn to other phases of its work.

SOCIETY AFFAIRS

A Record of the Current Activities of the Society, Its Members, Council, Committees, Sections and Student Branches; and an Account of Professional Affairs of Interest to the Membership

PRESIDENT TAFT said that the engineer, equally with the physician, was essential to the winning of the war. The Council of this Society, together with the boards of management of the other societies and the representatives of the engineering colleges, have persuaded the Secretary of War to make similar provision for engineering students who may be drafted to the provision made for students in medicine and dentistry who may be drafted; namely, that the students under the draft be reassigned to their respective colleges, to complete their technical courses. This is most impressive.

With the recognition by the nation of the opportunity for service goes the responsibility of rendering that service. The loyalty of the members of the Society and of the profession in general has never been questioned. The only unsatisfactory feature has been the inability of a large proportion of our members to find the opportunity for expression. Whereas approximately ten per cent of the membership is now in the service, several times this number would gladly join if they were only permitted.

I am happy to report the splendid progress of the Engineering Council, and the spirit of coöperation which is being developed between the engineering societies and the committees which have been engaged in war work. There seems to be every prospect now of having a joint committee at some time in the very near future.

The conspicuous service which the Society has been rendering is in its Engineering Resources Committee, whereby the Government or any industry or individual can obtain the names, addresses, and accomplishments of specialists of every variety. These the Society has been able to furnish to such an extent that over fifteen hundred members have been suggested for important service. A corps of experienced assistants loaned by this Society has undertaken now the classification of members of other societies who are coöperating in the movement. This is an activity which all members of the profession may report with considerable pride.

Calvin W. Rice,
Secretary.

THE NEW OFFICERS OF THE SOCIETY

ALL the officers listed on the ballot prepared by the Nominating Committee appointed by the President and consisting of L. E. Strothman, *Chairman,* Willis H. Carrier, Frederick W. Gay, A. M. Lockett and Paul B. Morgan, were elected at the opening session of the 38th Annual Meeting on Tuesday evening, December 4, 1917. The elections were: President, Charles T. Main; Vice-Presidents, Spencer Miller, Max Toltz and John Hunter; Managers, Fred A. Geier, D. R. Yarnall and Fred N. Bushnell; Treasurer, William H. Wiley. A brief biographical note of each of the new officers is given below.

Charles Thomas Main

Charles Thomas Main was born in Marblehead, Mass., on February 16, 1856. He attended the public schools in that town and was graduated from the Massachusetts Institute of Technology with the degree of S.B. in the department of mechanical engineering.

He remained at the Institute as an assistant in the department of mechanical engineering for three years after graduation.

In the fall of 1879 he went to the Manchester Mills, Manchester, N. H., as draftsman. From there, on January 1, 1881, he went to Lawrence, Mass., as engineer for the Lower Pacific Mills. In March 1886 he was made assistant superintendent and in July 1887 superintendent of the mill, having in charge the engineering work also during the latter periods.

During this period of eleven years he had charge of the reorganization and the rebuilding of a large portion of the above-mentioned plant, and for something over five years had charge of its operation.

About this time Mr. Main decided that he preferred to follow engineering rather than administrative work and resigned his office at the Pacific Mills. After one year in Providence, R. I., spent in engineering and mill work, he formed an association with Mr. F. W. Dean and conducted a business under the name of Dean & Main, devoted largely in the early days to textile, mill work, but gradually broadening so as to include other industrial plants. This association existed from January 1893 to January 1907, when it was dissolved. Since that time he has conducted an engineering business under the name Chas. T. Main.

During the period from 1893 to the present time a large number of industrial plants have been designed and constructed under his direction and many others reorganized. The steam engineering for industrial plants developing into steam-power-plant work, and the water-power work into hydroelectric developments.

Among the largest undertakings in the industrial plants are the Wood Worsted and Ayer Mills in Lawrence, Mass., and in the hydroelectric work four developments for the Montana Power Company, aggregating about 280,000 hp.

He has acted as consulting engineer on many projects and as expert witness or referee in many important cases and has placed valuations on many industrial plants for various purposes.

He was elected to membership in The American Society of Mechanical Engineers in 1885 and has been a manager for three years. He is also a member of the American Society of Civil Engineers, the American Institute of Consulting Engineers, the Boston Society of Civil Engineers (past-president), and of other technical societies; is president of the Engineers' Club in Boston, and is serving his second term as term member of the Corporation of the Massachusetts Institute of Technology.

He has written several papers on engineering subjects, some of which have been presented at meetings of the Society.

Mr. Main has been interested for many years in public

affairs and has served in several municipal offices for the purpose of advancing the idea of good government and doing his share of public work.

Spencer Miller

Spencer Miller was born at Waukegan, Ill., April 25, 1859. He was graduated at the Worcester Polytechnic Institute in 1879, and after tutoring for a few months at Amherst College, entered the shops of the U. S. Wind Engine & Pump Co., of Batavia, Ill., where he remained for nearly a year. He then became a draftsman with the Link-Belt Machinery Co., Chicago, where he designed a number of rope drives, and a novel equipment for handling cargo by continuous systems of conveying for the Union Steamboat Company. He made important improvements in rope driving with grooved pulleys of different diameters by varying the angle of the grooves. This invention was the subject of a paper entitled A Problem in Continuous Rope Driving, presented by him before the American Society of Civil Engineers in 1897.

In 1886 he became associated with the Lidgerwood Manufacturing Co., of New York, which was then manufacturing a crude overhead cableway system involving fall-rope carriers of the chain-connected type, and he developed an entirely new fall-rope carrier system, which eventually resulted in obtaining a conveying speed of 2000 f.p.m. Mr. Miller continued the development of the cableway, added automatic dumping features so that loads could be dumped at the will of the engine operator, made towers self-propelling, traveling on tracks so that a great area could be covered, and adapted the cableways to the use of grab and scraper excavating buckets, so that today the cableways will convey single loads up to thirty tons over spans exceeding 2000 feet. The most noted installations were on the Panama Canal, where they were used for the construction of the locks. He developed the cableway as applied to the removal of logs from the swamp lands, reducing the cost of the logs at the mills 50 per cent, and adapted the log-skidding cableway for mountain work, skidding logs from the crests of the mountains, and out of gorges and ravines, enabling logs to be taken out of timberlands hitherto inaccessible by previous methods, one of the latest machines spanning 4200 feet.

Mr. Miller's latest adaptation of the cableway was on the Mississippi Levee Construction work. This machine is a straight-line cableway excavator, span 700 feet, operating a 3-yard drag scraper bucket.

One of the early problems of the Spanish-American War was presented to the Navy Department in the question of coaling ships at sea, and Mr. Miller designed a marine cableway that made it possible to transship coal under headway at sea. In coaling ships in harbor his method of broadside handling has increased the capacity from 25 to 150 tons per hour, and one man now does the work which under the old system required eighty. Many new colliers of the U. S. Navy, notably the *Jason*, *Orion* and *Neptune*, are equipped with this transfer system, for delivering coal to ships alongside in smooth water. In 1911 he made the refueling of warships at sea the subject of a paper read before the Society of Naval Architects and Marine Engineers. One of the most revolutionary devices invented by Mr. Miller is his breeches buoy cableway apparatus in use by the U. S. revenue cutter service, by which passengers can be rescued from any ship in the heaviest sea.

The greatest problem presented in these marine cableways was the maintenance of a constant tension in the supporting cable and also in the conveying cables, the surging of the ships tending to produce a variation of 600 per cent in the tension of the cables. Mr. Miller developed an engine which automatically maintained within 10 per cent a constant tension on these cables, compensating the varying strains produced by the wave motion affecting the ships. With this automatic-tension engine, Mr. Miller successfully solved the problem of bunkering fuel oil at sea, a supporting cable for the oil hose being held at constant tension by the engine.

His final development of this automatic-tension engine is for use as a towing engine. Its use eliminates the shock effect on the towing hawser and permits the use of lighter hawsers, of much shorter length, and limits the tension on the cable to a predetermined amount well within the safety limit of the cable, thus providing against excess strain.

In view of Mr. Miller's many activities in marine matters, it was natural that he was selected as a member of the U. S. Naval Consulting Board at its inception, and of which board he is now a member. He is chairman of The Fuel and Fuel Handling Committee, and also of the Life Saving Committee.

Aside from his engineering activities, Mr. Miller is greatly interested in civic and municipal improvement, especially in the establishment of public libraries, parks and playgrounds. He is a Vice-President of The American Society of Mechanical Engineers; member of the American Society of Civil Engineers, American Institute of Mining Engineers, Society of Naval Architects and Marine Engineers, and the Canadian Institute of Mining Engineers.

Max Toltz

Max Toltz was born in Coeslin, Germany, in 1857, and was graduated from the Royal Polytechnic College of Berlin in 1878. He came to the United States in 1882 and became associated with the St. Paul, Minneapolis & Manitoba Railway, now the Great Northern, serving successively as draftsman, assistant engineer, bridge engineer and mechanical engineer. In the latter capacity he had charge for four years of the motive-power department.

From 1903 to 1905 he acted as consulting engineer of the Canadian Pacific Railway, during which time he built the Angus Shops near Montreal and also those at Winnipeg. He also acted as consulting engineer for the Erie Railroad during this period. In 1905 he became vice-president and general manager of the Manistee and Grand Rapids Railway, acting also as consulting engineer for different railroads at the same time. Since 1908 he has conducted a private practice, including the work of consulting engineer for the Great Northern Railway, the Northern Pacific Railway, the Chicago, Milwaukee & St. Paul and the Butte & Anaconda railways, reporting especially upon the electrification of steam roads, and also specializing in power plants, grain elevators and large handling plants, and iron-ore docks.

From 1900 to 1913 he was Captain of the Engineer Corps, Minnesota National Guard, and since 1913 Major of the Engineer Corps. He is now engaged in camp construction for the Government, his first camp having been Camp Robinson at Sparta, Wis. He is now at Camp Dodge, Des Moines, Iowa, where he has charge of the installation of the heating of the entire camp.

John Hunter

John Hunter was born in Scotland in 1866, and was educated in public schools, serving his apprenticeship as a mechanical engineer before leaving Scotland.

The first twenty years of his career were spent in marine

service. In 1885 he joined the Red Star Line, *S. S. Westerland,* as junior engineer, sailing between Antwerp and New York, rising to first assistant of the *S. S. Friesland* of the same company in 1891. In 1895 he transferred to the new *S. S. St. Louis* of the American Line, running between New York and Southampton, as senior first assistant engineer, and at the outbreak of the Spanish-American War in 1898 was appointed chief engineer of the *S. S. St. Paul,* with the rank of Lieutenant, U. S. A.

The *St. Paul* was taken over by the United States Navy, equipped as an auxiliary cruiser and fitted out with twenty 5-inch guns, and under the command of Admiral Sigsbee saw much active service during the war which bore heavily on the crew. When the *St. Paul* went back in the North Atlantic service, Mr. Hunter continued as chief engineer until August 1905, when he gave up his naval career to enter consulting work.

During his twenty years of sea service he had traveled 1,500,000 sea miles, and had seen an interesting development in marine engineering. The steam pressure carried on boilers in his ships had risen from 10 to 200 lb., and the old low-pressure engines had given place first to the cross-compound type, with 80 lb. pressure, then to the triple-expansion three-cylinder engine with 165 lb., and finally to the six-cylinder quadruple expansion engines and twin screws of the *St. Paul,* with their 200 lb. pressure.

In August 1905 he went to St. Louis to take the position of chief engineer of the power plants of the Union Electric Light and Power Co. At that time the Ashley Street plant was under construction and changes were being made to increase the capacity of the station. In the early part of 1907 he was given charge of the construction work of the company and the completion of this plant, including the last section of the east river wall, where it was found necessary to sink two caissons to bed rock, 22 ft. below the zero stage of the river. He was also in charge of the steam-heating plant of the company.

He has recently been called into the service of the Government in the capacity of district manager for the Emergency Ship Building Corporation, with headquarters in New York City.

Mr. Hunter has been prominent in the affairs of national societies, having served for three years as a member of the Prime-Movers Committee of the National Electric Light Association. He served also as president of the Engineers' Club of St. Louis and for two years as president of the Caledonian Society.

Frederick August Geier

Frederick August Geier was born in Cincinnati, Ohio, on June 23, 1866, and at the usual age entered the public schools, wherein he continued his studies until graduated from Woodward High School with the class of 1884. Two years later he engaged in the banking business in Newton, Kansas, but returning to his native city in September 1887, became connected with The Cincinnati Milling Machine Company as bookkeeper. He now owns a controlling interest in, and is president of, this company, which is generally acknowledged to be the largest plant in the world devoted exclusively to the manufacture of milling machines and accessories.

Some years ago, when The Cincinnati Milling Machine Co.'s business had grown beyond the capacity of the old plant (located on Spring Grove Avenue), Mr. Geier conceived the idea of organizing a factory colony grouped about a central power plant. Three other companies joined at once in the project, and the outcome of the idea is the present factory colony at Oakley, a suburb of Cincinnati.

The C. M. M. Co. now has one of the most modern plants in existence and employs about 2000 people. It provides ideal factory conditions as to light, heat, ventilation, and sanitation, maintains an employees' service and medical department, and provides space and equipment for a cafeteria, which is operated for the employees by a committee chosen by themselves. It also recently started a coöperative store for the benefit of its employees.

Mr. Geier is also president of The Factory Colony Co., The Modern Foundry Co., and the Factory Power Co., is a director of The Cincinnati Rubber Mfg. Co. and The Cincinnati Bickford Tool Co., also a director of the Lincoln National Bank of Cincinnati and also the Central Trust Co., Cincinnati. He is a director of the Ohio Mechanics Institute. He is at the present time also president of the Council of Social Agencies of Cincinnati. He is a member of the board of managers of the National Society for the Promotion of Industrial Education. For five years he served as trustee of the University of Cincinnati and chairman of its board. He served two years as president of the National Machine Tool Builders' Association, and served as chairman of the Cincinnati Section of The American Society of Mechanical Engineers for the term 1916-1917.

D. Robert Yarnall

D. Robert Yarnall, member of the firm of Yarnall-Waring Co., and also vice-president and general manager of the Nelson Valve Co., Philadelphia, was born in Delaware County, Pennsylvania, in 1878. He was educated at the University of Pennsylvania, receiving the degree of Bachelor of Science in 1901, and that of Mechanical Engineer in 1905.

For a short time after graduation he was engaged in engineering work in connection with the design of cement plants, and for the five years just prior to 1906 he was superintendent of construction for Mr. Charles Edgerton, consulting engineer, Philadelphia. For the next four years his efforts were devoted to the interests of the Stokes & Smith Co., manufacturers of box-making machinery, during which time he assisted in installing the Taylor system of scientific management.

In 1910, Mr. Yarnall, with Mr. B. G. Waring, organized the Yarnall-Waring Co., manufacturers of power-plant devices, which company operates and manages the works of the Nelson Valve Co., of which Mr. Yarnall is also vice-president and general manager.

In 1911, Mr. Yarnall introduced into America the first V-notch weir meters for measuring rates of flow, and subsequently he invented a number of improvements on this device, including the now well-known heater-meter combination which is used extensively in power plants. He is the author of the paper entitled The V-Notch Weir Method of Measurement, presented before the Annual Meeting of the Society in 1912; and has just presented a paper before the Philadelphia Local Section, entitled Recent Developments in V-Notch Weir Measurement. He is also the inventor of a number of successful power-plant valves and other steam specialties.

He has taken an active part in the Engineers' Club of Philadelphia, being a member from April 18, 1903, and vice-president from February 1916 to date. During this period he was active in bringing about the broad plan of affiliation of the Engineers' Club with the local sections of national societies, the plan of affiliation now being familiarly referred to by other cities as the "Philadelphia Plan."

He entered the Society as a Junior in 1903, and was elected to full membership in 1911. Mr. Yarnall has been a member of the Society's Committee on Sections since its formation, and during the past year has been chairman of this committee.

He is a member of the Engineers' Club of Philadelphia, The University Club and The Franklin Institute.

Fred N. Bushnell

Fred N. Bushnell was born in Saybrook, Conn., in 1867. He received a high school education, and in 1883 moved to Providence, R. I., entering the works of the Providence Steam Engine Company, where he acquired his shop experience. His early education was supplemented by a special course of study in engineering subjects under private instruction, and he entered the drafting room of the Providence Steam Engine Company in 1885, where for several years he was engaged in designing engines, boilers, bolt-forging machines and other miscellaneous products of this company.

In 1889 he entered the employ of Robert Wetherill & Co., of Chester, Pa., returning to the Providence Steam Engine Company in 1890 as superintendent.

The mechanical equipment of many of the early electric power stations was built and installed under Mr. Bushnell's supervision. The rapid development of the electrical industry impressed Mr. Bushnell as offering unusual opportunities for young men with engineering training, and he decided to give up manufacturing and to devote his energies to electric-power-station work.

In 1893 he accepted a position as chief engineer of the Narragansett Electric Lighting Company, of Providence, R. I. In 1902 he was appointed chief engineer of the Rhode Island Company, which controlled the electric railways in Providence, Pawtucket and other towns in that vicinity.

He occupied these positions until 1907, when he entered the employ of the Stone & Webster Engineering Corporation of Boston, and was given charge of extensive power-station work for the Boston Elevated Railway Company. After this he was engaged for some time in making special investigations and reports on engineering projects, and in 1909 was appointed engineering manager of the Stone & Webster Engineering Corporation, in charge of all engineering work in its Boston office. In 1912 he was appointed vice-president and engineering manager.

Some of the recent works with which Mr. Bushnell has been identified are the alternating-current power system of the Boston Elevated Railway Company, comprising a large generating system, sub-stations and underground transmission; the power station of the Republic Railway & Light Company near Youngstown, Ohio, and the new River Station of the Buffalo General Electric Company, Buffalo, N. Y.

Mr. Bushnell became a member of the Society in 1891.

William H. Wiley

William H. Wiley was born on July 10, 1842, in New York City, and received his A. B. degree from the College of the City of New York in 1861, and the degree of C. E. from Rensselaer Polytechnic Institute in 1866. He also studied as a special student at the Columbia School of Mines in 1868.

At the outbreak of the Civil War, in 1861, he joined the 7th Regiment, New York State Militia. In March, 1862, he was enrolled as First Lieutenant in the Independent Battalion, New York State Volunteers, mustered into the service, and served under General McClellan. When the regiment was mustered out in 1864, he was given the title of Major, U. S. Volunteers, for services under General Gillmore, on Morris Island, S. C.

Since 1876 Major Wiley has been a publisher of scientific works. He served as a member of the 58th, 59th and 61st Congresses from New Jersey. In 1897 he was president of the International Jury of the Brussels Exposition, and was a member of the Superior Jury, Brussels. He was a commissioner from New Jersey at the St. Louis Exposition in 1904.

Major Wiley is the author of a book on Yosemite, Alaska and Yellowstone, published in 1888, and has acted as New York correspondent for London *Engineering*. He is a member of the American Society of Civil Engineers, the American Institute of Electrical Engineers, the American Institute of Mining Engineers, the American Association for the Advancement of Science, the National Geographic Society, the Order of Leopold, Belgium, and the Loyal Legion.

Major Wiley has been a member of the Society since its organization. He was appointed on the Finance Committee in 1882. While serving as Chairman of this Committee he was elected Treasurer of the Society, in 1884, and has been regularly nominated and elected for the period of thirty-three years which has since elapsed.

COUNCIL NOTES

NOVEMBER 16, 1917

A MEETING of the Council was held on the afternoon of Friday, November 16, 1917,[1] in the rooms of the Western Society of Engineers, Monadnock Block, Chicago. The following members were present: Ira N. Hollis, *President*, Max Toltz, A. M. Greene, Jr., D. S. Jacobus, Charles T. Main, W. F. M. Goss, John A. Stevens, C. H. Bierbaum, R. H. Fernald, William B. Jackson, F. R. Low, *Chairman of Publication Committee*, Charles Russ Richards, representing the *Sections Committee*, Alex. D. Bailey, Arthur L. Rice, George R. Brandon and Philip N. Engel, officers of the Chicago Section of the Society, attending the meeting by invitation, and Calvin W. Rice, *Secretary*.

[1] The November meeting took place after the December JOURNAL went to press.

The Council was welcomed by Mr. D. W. Roper, vice-president of the Western Society of Engineers.

Anglo-American Conference. It was voted to authorize the Executive Committee to accept the invitation of the Aircraft Production Board to the London conference, and to authorize the President to appoint a delegate.

A.S.M.E. Boiler Code. The Boiler Code Committee submitted a Revision of the Code which was received and ordered printed in THE JOURNAL. This was published in the December issue.

Gas-Power Committee. It was resolved that the existing committee be discharged, with thanks for their services, and a new Gas-Power Sub-Committee was appointed, as follows: C. H. Benjamin, *Chairman*, Harte Cooke, E. J. Kane, W. T. Magruder, H. R. Setz, H. F. Smith, J. H. Spitzglass, W. V. Stout, and D. McCall White.

Committee on Technical Schools. A committee of W. F. M. Goss, *Chairman*, A. M. Greene, Jr., and D. S. Jacobus was appointed to formulate for presentation to the Council at its next meeting a statement of the policy which in the opinion of the committee should be observed with reference to the maintenance of the activities of the technical schools as an agency for promoting efficiency in war.

Western Society of Engineers and Chicago Section. It was resolved that the Council extend a vote of thanks to the Western Society of Engineers for the use of their rooms and also to the Chicago Section for their hospitality.

Adjournment was taken to meet in New York on December 4, 1917, at the Annual Meeting.

December 4, 1917

At the meeting of the Council on December 4, 1917, preceding the 38th Annual Meeting, the following members were present: President Ira N. Hollis presiding, John H. Barr, C. H. Benjamin, R. M. Dixon, *Chairman of Finance Committee*, R. H. Fernald, W. F. M. Goss, Arthur M. Greene, Jr., W. B. Jackson, D. S. Jacobus, Julian Kennedy, F. R. Low, *Chairman of Publication Committee*, C. T. Main, Spencer Miller, H. de B. Parsons, C. T. Plunkett, Max Toltz, William H. Wiley, *Treasurer*, Past-Presidents John A. Brashear, James Hartness, Robert W. Hunt, F. R. Hutton, Jesse M. Smith, Ambrose Swasey, Worcester R. Warner, S. T. Wellman, by invitation, Dr. C. R. Mann, of the Carnegie Foundation, and Professor Gardner C. Anthony, of Tufts College, and Calvin W. Rice, *Secretary*.

Coal Conservation. President Hollis gave a resume of the matters leading to the request from Fuel Administrator Garfield for coöperation in the matter of coal conservation, and announced that the following appointments had been made: As consulting engineers to the Bureau of Mines, Charles L. Edgar, L. P. Breckenridge, R. H. Fernald, and Charles Russ Richards; for the U. S. Chamber of Commerce Fuel Committee, the request being made that Dr. Ira N. Hollis, President, serve as one of the members, the President appointed in addition: J. W. Lieb, L. P. Breckenridge and F. H. Clark.

Aircraft Standardization. In response to the invitation from the Aircraft Standardization Board, James Hartness, Past-President, was appointed the representative of the Society to the joint conference shortly to be called in London on the matter of standardization of aircraft production.

Boiler Code Interpretations. Interpretations covering Cases Nos. 177-180 were approved with slight changes and ordered published in The Journal.

The Council expressed its appreciation of the magnificent offer of Dr. Brashear to secure for the Library the works of Professor Langley, and ordered this offer communicated to the Library Board for appropriate action.

The thanks of the Council were returned to the retiring President, Dr. Hollis, for his uniform courtesy and untiring interest and efficient direction of the work of the Society during the past year.

Adjournment was taken to meet on Friday, December 7, as the Council for the year 1918.

December 7, 1917

The first meeting of the Council for the year 1917-18 was held Friday, December 7, on adjournment of the Annual Meeting. There were present C. H. Benjamin, A. M. Greene, Jr., F. A. Geier, W. F. M. Goss, John Hunter, R. H. Fernald, Ira N. Hollis, F. R. Hutton, W. B. Jackson, D. S. Jacobus, C. T. Main, *President*, H. de B. Parsons, D. R. Yarnall, Wm. H. Wiley, *Treasurer*, by invitation, H. A. Harris, Chairman of the Gage Committee, and Calvin W. Rice, *Secretary*.

The Technical Schools in War. Dr. W. F. M. Goss, Chairman, presented a revised report of his committee on the subject of technical schools in the war, and resolutions passed by the Engineering Council and the Society for the Promotion of Engineering Education were also read.

It was then voted that:

1. The Council of The American Society of Mechanical Engineers recognizes the serious responsibility of the engineer in the prosecution of the war, not only in the corps of engineers, but in the many other branches of the national service where highly trained engineers are required. It urges the importance, as a war measure, of utilizing to the fullest the present engineering ability, and of maintaining unimpaired the engineering strength of the nation for the successful prosecution of military operations, and for the support of the sustaining industries.

2. To this end the Council of The American Society of Mechanical Engineers points out the necessity for establishing an agency for coördinating the military needs for technically trained men, the available supply of such men, and the sources of training. It urges that schools of engineering as the principal sources of this training be regarded as closely allied in the national purpose with the Military and Naval Schools of the nation, and that in the further administration of the draft the attitude of the Government toward them be such as to maintain the efficiency of these schools.

3. The plea for attention which is herein urged is not made in the interest of schools or of students, but is made solely for the full utilization of existing engineering resources and the preservation of a source of supply of engineers.

It was resolved that copies of these resolutions be sent to the Secretary of War and to the Provost Marshal General, that the Council earnestly support and approve the resolutions of December 6, passed by the Engineering Council, and that such endorsement be included in the communication sent to the Secretary of War and to the Provost Marshal General.

Sections. On recommendation of the Committee on Sections, it was voted to approve the following appointments on local committees:

Cincinnati: George Galbraith, *Chairman*, Henry Ritter, *Vice-Chairman*, J. T. Faig, *Secretary*, E. A. Muller and A. J. Baker.

Connecticut: C. K. Decherd, *Secretary-Treasurer*.

Buffalo: F. E. Cardullo, *Chairman*, W. A. James, *Vice-Chairman*, E. B. Neil, *Secretary*, J. W. Gibney, *Treasurer*.

Student Branches. On the recommendation of the Committee on Student Branches, it was voted to approve the establishment of a Student Branch at Tufts College.

Dues of Men in Military Service. It was voted that the procedure under B 16 (*b*), suspending the dues of members in active service, be as follows: In each case the Secretary shall require a written application from the member or a request in person or by representative, stating the facts of his service. Second, the Secretary shall refer each application to the Membership Committee with a request that the Committee report to the Council, after considering the facts in each case, the names of those members whose dues, in the opinion of the Committee, should be remitted.

Power Test Committee. In response to the request of the members attending the public hearing on the Power Test Codes at the Annual Meeting, the President appointed three members of the Society as its representatives on a Sub-Committee on Water Wheel Code, to act in conference with the appointees from the National Electric Light Association, the

American Institute of Electrical Engineers, and the American Society of Civil Engineers.

Boiler Code Committee. E. R. Fish and F. R. Low were appointed on the Committee.

Further Appointments. It was voted that Ambrose Swasey be appointed to succeed himself for a term of four years as a representative on the Board of Award of the John Fritz Medal.

W. F. M. Goss was appointed to succeed himself for a term of one year as the representative appointed by this Council to the Engineering Foundation Board.

R. M. Dixon was elected Trustee of the United Engineering Society to serve for a term of three years, to fill the vacancy caused by the expiration of the term for which John R. Freeman was elected.

Charles Whiting Baker was appointed to succeed himself for a term of three years to represent the Society on the Engineering Council.

George J. Foran was also appointed to represent the Society on the Engineering Council to fill the unexpired term of John H. Barr, who asked that his resignation be accepted due to the demands of Government work in which he is engaged.

Executive Committee. Chas T. Main, *Chairman,* Ira N. Hollis, D. S. Jacobus, Arthur M. Greene, Jr., Spencer Miller and John Hunter were appointed an Executive Committee of the Council under the provisions of B 26.

Adjournment was taken to meet in New York on Friday, January 18, 1918.

Calvin W. Rice,
Secretary.

WELCOME TO CIVIL ENGINEERS

In the Auditorium of the Engineering Societies Building on the evening of Friday, December 7, the American Institute of Mining Engineers, The American Society of Mechanical Engineers and the American Institute of Electrical Engineers, the three original Founder Societies, joined in a formal welcome to the American Society of Civil Engineers, the fourth Founder Society, which has recently removed from its former home on 57th Street, New York, to new quarters in the Engineering Societies Building.

Mr. Charles F. Rand, President of the United Engineering Society, presided. He said that the coming of the Civil Engineers rounded out a plan made by wise men some fifteen years ago. The association of the four national engineering societies was born of a very general desire to secure the full advantages which come from complete coöperation. These advantages had been realized in many previous examples, such as the John Fritz Medal Board of Award, the Engineering Foundation, the backing furnished by the four societies for the International Engineering Congress and the Joint Committee of Engineering Societies which preceded the Engineering Council.

He said the societies' obligation to Mr. Andrew Carnegie for his gift of over one million dollars used in the construction of the Engineering Societies Building should never be forgotten. He sometimes thought that the signing of a check for that sum may not have been very difficult for Mr. Carnegie, but he was able to certify that the provision of the remaining amount, through the efforts of the Founder Societies and their members, was surrounded by some difficulty, although now fully accomplished. The property of the Founder Societies, including the real estate, the Library, the reserve and endowment funds, exceeding two and one-quarter million dollars, all free and clear.

He referred to the administration of the United Engineering Society, which occupies the unique position of standing not over but under the Founder Societies, having been formed by them to perform certain specific acts governed by contracts. The Engineering Foundation, which has an endowment fund for research, the Engineering Council and the great Library under the care of the Library Board, are all administered as departments of the United Engineering Society.

If the administration of the United Engineering Society has been satisfactory it is because its officers have followed the footsteps of a former leader who shaped its policies and guided the Society for a number of years. He referred to Mr. Gano Dunn.

Welcome of Electrical Engineers

Mr. Gano Dunn, selected to express the welcome of the youngest Founder Society, the American Institute of Electrical Engineers, to the oldest, the original engineers, said that his welcome was all the more agreeable because it was made in a moment of enthusiasm and in the inspiring presence of all the other societies.

He thought that the occasion would mark the most eventful day so far in the history of the engineering profession in America, for on it had come to all the accession of the American Society of Civil Engineers, with its prestige and leadership. We in turn, under the influence of that prestige and leadership, should ourselves contribute to the joint result each day more and greater things, so that from now on the dream of those in all the societies that have seen in the days ahead a great and united engineering profession, would come one step nearer realization.

Welcome of Mechanical Engineers

Dr. Ira N. Hollis, speaking for The American Society of Mechanical Engineers, said that the union of the Founder Societies had come at a time when every man's and every woman's heart is moved at the danger before our country. We could be nothing else but brothers whether we were together in this building or not; but we are now thrown so much nearer together that we can make ourselves more effective in the service of our country by being under the same roof.

He emphasized the responsibility of the engineer for the industrial order of the twentieth century, and pointed out that it is his task to help make the world safe for democracy even as his instrumentalities are now adding to the horror of the great war.

He welcomed the Civil Engineers as brothers and as companions in the work that we shall jointly give our country.

Welcome of Mining Engineers

Dr. Rossiter W. Raymond, representing the American Institute of Mining Engineers, said that it was with personal as well as with representative pleasure that he, in the name of the American Institute of Mining Engineers, resigned the title of senior of the Founder Societies to the great and famous organization of the American Society of Civil Engineers.

Dr. Raymond spoke in his happiest vein and showed how the Civil Engineers, plus the Mechanical Engineers, plus the Electrical Engineers, made the Mining Engineers, and the work of the Mining Engineers gave to each of the other branches its greatest opportunity for displaying its capacity.

Mr. William L. Saunders, Past-President of the American Institute of Mining Engineers, speaking "at large," as the Chairman put it, expressed the view that the occasion celebrated not merely a physical union but a spiritual uniting of forces for participation in civic affairs.

Replies on Behalf of Civil Engineers

Mr. George H. Pegram, President of the American Society of Civil Engineers, responded on behalf of the new tenants. He averred that the Society moved to the joint house because service to our fellow-men, the interests of engineers and of the membership demanded it. The public, in his opinion, had not been informed on the work of the engineer, and not until it is so informed can engineers expect the recognition they deserve. In the closer coöperation of the four great societies he saw an opportunity for placing the engineer rightly before the public.

Dr. George F. Swain responded to the addresses of welcome on behalf of the members of the American Society of Civil Engineers resident outside of New York. It was his opinion that the society should have been in the union house before, and that it was there now in order that it might pull together with the other societies. In his opinion engineering organizations had heretofore confined themselves to two of four important purposes that they should forward. They had tried to advance engineering knowledge and to erect high standards for professional work and conduct. There remained now the work of making the engineer felt as a member of the community, and of working out plans by which the societies should do more for the individual member.

Annual Meeting Smoker

The Smoker of The American Society of Mechanical Engineers, held on the evening of December 5, attempted a radical departure from the two held at previous annual meetings. It was felt necessary to plan for 800, and to provide for the maximum sociability and intercourse it was decided to dispense with chairs. Arrangements had been made for an illustrated talk on Japan by Past-President John R. Freeman, who in the year had visited that country, together with Past-Presidents Brashear and Swasey, and the Auditorium of the Engineering Societies Building was secured for this feature. This allowed for assembling the members and guests before conducting them to the assembly rooms on the fifth floor. The features of the latter part of the smoker, when the participants were required to remain on their feet, were unfurling of a service flag showing the then 433 of the membership in active service for the Government, an auction of eight posters of past-presidents, the secretary, the honorary secretary and the treasurer, and the serving of refreshments. A combination march and snake dance was provided for getting the 750 or more who participated from the auditorium to the fifth floor, and as members and guests filed into the fifth floor rooms they were given a special box containing cigars and cigarettes and a card inviting contributions for smokes for the engineer regiments abroad. Altogether, including the money obtained from auctioning the posters, $313.86 was raised for this purpose. The idea of providing a maximum opportunity for mixing by omitting the chairs appears to have been eminently successful.

W. W. Macon.

Annual Meeting Excursions

Although conditions due to the war badly handicapped the Excursion Committee this year in arranging trips for the visiting members and guests at the Annual Meeting, yet four delightful trips were taken.

On Wednesday afternoon, December 5, a small party visited the Montgomery Ward Company's mail-order plant in Brooklyn and found much of interest there.

On Thursday afternoon a party of ladies took a sightseeing trip through downtown New York. Another party visited the Samuel L. Moore's Sons Corporation shipbuilding plant at Elizabethport, N. J.; this plant has been rebuilt and enlarged to take care of the increased demand for shipping and had ships in various stages of completion on the ways.

On Friday afternoon the Society was loaned the boat *Correction* by the New York Department of Correction for a trip around Manhattan Island. This trip was participated in by about 100 members and guests and was a most enjoyable occasion. Mr. Colwell's first-hand account of the trip is appended.

John H. Norris,
Chairman Excursion Committee.

BOAT EXCURSION

An exceptional excursion around Manhattan Island and through the bridges was provided for the members and their guests at the Annual Meeting. As some of the party expressed it, the trip "showed New York by daylight, twilight and dark."

Through the courtesy of the Department of Correction of the City of New York, a large and comfortable boat was at the disposal of the Society for this interesting and well-attended trip. A congenial party, including quite a few college men and a bounteous supply of lunch, left the city dock, East 26th Street, about 1:30 p.m. The day was ideal.

After passing under all the bridges, fifteen in number, during daylight, the Hudson River was reached under a full red setting sun, a little larger and brighter than Dr. Brashear's; but the Doctor's was a close second.

The good boat *Correction*, with Captain Parkerson in command, steamed up the East River, passing under the Queensborough Bridge and through Hell Gate Rapids, and approached the new bridge and viaduct of the New York Connecting Railway slowly so that all had a fine view of that magnificent and massive engineering masterpiece. The Captain turned the boat around directly under the bridge which gave an opportunity to see the steel span directly overhead, then proceeded south and went through the upper part of Hell Gate, to the west arm, and was shortly blowing four long blasts for the Harlem River Bridge to open. The city flag, blue, white and yellow, at the bow of the *Correction*, was like a magic wand as the drawbridges, eleven in number, were swung open in turn—Washington Bridge and High Bridge allow clearance and were not opened.

At High Bridge, which is one of the most artistic bridges in the world, the tide was running strong and Captain Parkerson did some nice maneuvering to take his boat between the piers that support the arches, there being very little clearance.

Many points of interest were passed including Blackwell's, Ward's and Randall's Islands where many city institutions are located. Many large power and large manufacturing plants, the Speedway used exclusively for trotting horses, New York University with the imposing Hall of Fame and Library located on a prominent elevation, were all passed in turn. There were some shipyards "doing their bit," and last but not least the Ship Canal, which required skill to navigate a large boat like the *Correction* on account of the strong current and the crooked and narrow channel.

Going south on the Hudson River, the old familiar points were in view—Riverside Drive, Trinity Cemetery, 129th Street Viaduct, Grant's Tomb, the Soldiers' and Sailors' Monument as well as the Palisades and the large manufacturing plants on the Jersey shore, also some of our own and the Allies' grim fighters and cruisers in the river looking real business-like.

James V. V. Colwell.

AMONG THE LOCAL SECTIONS

FOLLOWING the Business Meeting of the Society on Thursday morning, December 6, of the 38th Annual Meeting, there was held in the Auditorium of the Engineering Societies Building a "Sections Session," presided over by Mr. D. Robert Yarnall, Chairman of the Committee on Sections, and devoted to three-minute reports by those delegates from the Sections present. The reports, which are here published, were preceded by a statement from Mr. Yarnall of the accomplishments and aspirations of the Committee on Sections. As each delegate was making his report, a slide was thrown on the screen giving the history of the growth of his Section. Delegates were in attendance from Atlanta, Baltimore, Birmingham, Boston, Buffalo, Chicago, Cincinnati, Connecticut, Erie, Indianapolis, Milwaukee, Minnesota, New Orleans, New York, Philadelphia, Providence, St. Louis, San Francisco and Worcester.

Foreword by Mr. Yarnall

FOUR signal events this year will go down in this history of the Sections as marked developments in this activity. First, the new By-Laws, after two years' study by the Committee as to the requirements of the Sections and with due regard for the suggestions and comments made at the Sections Conference in 1916, were approved by the Council and are now in effect. The By-Laws were developed with the idea of granting all possible autonomy to individual Sections, and hence merely supply a skeleton on which to build Section activities. These By-Laws were printed in The Journal in November 1916, and have been distributed to the Sections' officers as well.

Second, a session of the Annual Meeting was for the first time this year given over to the discussion of Sections problems, thus recognizing the prominent place the Sections movement has in Society affairs. Delegates to this meeting were officially appointed by the Sections and the expense to the meeting paid by the Society.

Third, a most important development of the year has been the establishment of the first State Section—the Connecticut Section, with its five Branches at Bridgeport, Hartford, Meriden, New Haven and Waterbury. The president of the Connecticut Section, Mr. H. B. Sargent, will report further concerning this interesting development. Our Sections Committee would insert here a word of caution that we do not encourage the formation of other State Sections until this new plan has been thoroughly tried out.

Fourth, is the innovation of holding meetings of the Committee on Sections in the various cities where Sections have been established. During the autumn, members of the committee have visited in turn Bridgeport, St. Louis, Milwaukee, Chicago, Detroit and Philadelphia. All of the members of the committee have been present at these meetings with the exception of Mr. E. H. Whitlock who is now a major in the Engineer Officers' Reserve Corps.

Sections' Work Manifold in Phases

The phases of the Sections' work are manifold. In each center in which Sections are established opportunities for service arise at every turn. The new Sections' By-Laws govern the activities of each Section only to the extent of insuring that its procedure is in conformity with the Constitution of the Society; they leave the Section free to carry out the details of its coöperative work with other societies' sections and with the local engineering organizations and the public.

In addition to the short three-minute reports that will be given today, at this Sections' Session, delegates have come into personal contact with the Council and have thus had an opportunity to familiarize themselves with the parent Society's attitude towards its Sections. At both the Annual and Spring Meetings this year, as for the past few years, the Section delegates lunched with the Council and Past-Presidents, thus affording an opportunity for the officers of the Society to become acquainted first-hand with the spirit of the Section movement. These luncheons also afford an opportunity for the new officers representing Local Sections to become acquainted with the friendly attitude of the Council towards this important movement.

In order that this session may give all present an opportunity to carry away an idea of what has been accomplished by the Sections Committee during the past year, we will summarize briefly its activities, as some of these matters will not come within the scope of the very interesting reports which will be made by those present on "the firing line."

Progress by Sections' Committee

Since the last Annual Meeting the Committee has held nine meetings to discuss the manifold problems which have confronted the twenty-two Sections. In addition there have been a number of meetings of the Sub-Committee on By-Laws for Sections, this work being largely performed by Messrs. Marburg and Rautenstrauch, who are entitled to much credit for the painstaking effort they have devoted to it.

During the year the establishment of the following Sections has been approved: Baltimore, Erie, Connecticut and Ontario, Canada. The latter is the first Section to be established outside the domain of the United States; its headquarters are at Toronto, and its territory embraces the larger portion of the Province of Ontario, from which it takes its name.

We have prepared a few charts (exhibiting slides here) to illustrate certain phases of Sections development. The first of these shows that meetings of the Society are already fairly well distributed over the country, and I might add that during the last year over 150 meetings have been held by these Sections. At practically every one of these points the A.S.M.E. Section coöperates closely with the local engineering society or club. It is felt that this spirit of coöperation in these localities is one of the strongest elements for good work for which the Sections are responsible and it is not improbable that through it the much-prophesied combination of the national engineering societies may be effected. But of course the last thought does not come within the scope of the Sections' work. We do, however, wish to urge all Sections to cultivate the fine spirit of coöperation which is already manifest at so many points.

In the last few years there has been a wonderful increase in the number of those enrolled as members of the Society. Whereas the Committee on Sections does not hold that it is responsible for this growth, it is noticeable that the Sections movement was started just two years prior to the upward trend of the membership curve. There is no doubt that widespread holding of meetings throughout the country will encourage those at distant points to come into the ranks.

Sections and The Journal

The Sections Committee is desirous of having the Sections contribute their share to the upbuilding of The Journal through the development of high-grade papers and also to accept their share of responsibility for the much-needed development of research work as was discussed fully at the Sections Conference on Tuesday afternoon. With this aim it has recommended that the individual Sections appoint committees on papers and research. It is felt that a wealth of information is lying dormant and that this may be made available through two good live committees in each Section.

Thus far the Sections have not responded to these suggestions with as much alacrity as had been hoped. The fact that the British Government has recently appropriated fifteen million dollars for research work at a time when the very existence of the country is at stake shows how keen is the need for such work.

In this connection it is interesting to note that at two recent Sections' meetings the importance of industrial research has been emphasized; On October 18, at Cincinnati, Mr. F. O. Clements gave an interesting address on The Research Laboratory Applied to Industry, and again at Buffalo, on October 17, Doctor C. E. K. Mees, head of a well-known research laboratory, delivered a lecture before the Section on Scientific Research.

Other Good Suggestions

Another suggestion for Section activities is the opportunity offered to the Sections through the valuable group of papers presented yesterday at the Keynote Session. We might assign one of these subjects to each of the two or three Sections in whose localities the respective operations are being carried on, i. e., take the shipbuilding problem for instance, the Sections at San Francisco, Boston and Philadelphia might make it the subject of a symposium on shipbuilding, somewhat similar to the symposium on forging suggested by Mr. White of Milwaukee on Tuesday. By proper apportionment of the list we believe the Sections might contribute real aid to our country at the present time.

Each Section executive committee should consider the possibilities for increasing the membership of the Society during the coming year. We suggest that Chicago, for instance, which has about 417 members, might reasonably aim to add 100 new members, or make an increase of about twenty-five per cent. Some Sections might even be more ambitious, but there is no doubt that such an activity could be conducted upon lines so dignified as to leave no question concerning the high standard of membership which at present exists. That the time is opportune for such an activity is evidenced by the fact that over 1700 applications for membership in the Society have been received since January 1, 1917. The mechanical engineer is the engineer of the industries, and the industries are doing their share in making the world safe for democracy.

President Hollis, during his term of office, has visited practically every Section of the Society and has done much to create enthusiasm for the Section movement all along the line. Our Committee feels under great obligation to him for his constructive suggestions and his timely counsel. In our journeys among the Sections we have felt the impress of the ideals of professional and national service, and engineering democracy, which he has driven home. We are very glad to have him with us today to tell you personally of his conception of our Sections and the opportunities which are theirs.

Reports by Delegates

Mr. Poole (Atlanta): The influence of the Atlanta Section has accomplished a unique result. It has brought about the actual, practical recognition of engineering in municipal affairs. Of course, we know that all cities have their city engineering or equivalent departments. We also know that the city engineer or equivalent official is elected by popular vote, and therefore his department is honeycombed with politics, and that was true in Atlanta as elsewhere, but in Atlanta the influence of the Local Section of the A.S.M.E. has brought about the appointment of a non-political body known as the Board of Consulting Engineers for the City, composed of two civil engineers, one of whom is also a mechanical engineer, an electrical engineer, an architect, and a mechanical engineer pure and simple. The functions of this Board are purely advisory, but it has done some very unusual things. Disagreements between heads of the different departments on engineering matters, and on other outside interests, like the street railways, are all referred to the Board and its decision is final. That is an accomplishment we may be proud of.

Atlanta has also, due to the influence of the Local Section of the A.S.M.E., a mechanical-engineering department. I do not know of any other city in the United States which has that. The Department is non-political, the head of the Department is appointed by a non-political board, the members of which are prominent business men not connected with any of the big companies, but with engineering interests generally.

The Committee on papers has been promised three or four fairly good papers for the coming winter. Recently our Section has increased its membership from 30 to 35 per cent.

Mr. Varney (Baltimore): The members of the Baltimore Section are affiliated with the Engineers' Club. Some forty are now in active service.

We have had one meeting this season. We generally endeavor to have at our meetings one technical paper and one popular talk, so as to make the latter interesting to our visitors. In the notices sent to the affiliated engineers in our Section, we enclose a printed card setting forth the objects of the Section, and stating why they should contribute papers and attend in person, and the assistance they could give by their presence and their advice to the younger men coming in. If we had a number of such cards we could follow up by a telephone call and a personal visit that would add greatly to the effectiveness of our work. We have difficulty in getting our members out. New industries are being rapidly established in the suburbs around the water front, and we are not acquainted with the engineers connected with these enterprises. It is necessary at first to send them an invitation to attend our meetings, and a typewritten letter, signed personally by the Chairman, is sent to these engineers. I think our Sections Committee should furnish letters of this kind. The officers of the Section have limited facilities for getting around to widely scattered plants.

A large percentage of our members are at Annapolis.

Mr. Klinck (Birmingham): The Birmingham Section took a very active part in the formation of the Alabama Technical Association, the membership of which is only open to members of national societies. It is our intention at an early date to have a joint meeting under the auspices of the A.S.M.E., covering the conservation question, particularly of fuel, etc.

The Committee on Papers has a definite promise of three papers, with favorable prospects of securing more.

We endeavor to increase our membership entirely by personally discussing the matter with those whom we think should be with us, by inviting them to the meetings and getting them interested, and the results we are obtaining indicate that this is the right procedure for our territory. In addition, at our last meeting each member present pledged himself to get at least one new member during the coming year.

Our aim in getting members is to secure those whose membership will be active and permanent. We have from thirty to forty per cent of our membership at the meetings.

Mr. Starkweather (Boston): The aim of the Boston Committee is: First, to make the Section meetings of maximum engineering interest and value to the local members; second, to promote acquaintance and mutual regard among them; third, to

safeguard the Society from commercialism and to prevent control by any interest or group of interests, and fourth, to have in constant training a considerable number of sub-committeemen, so that there shall be true succession in office of able men well fitted for the duties involved.

For carrying out these four aims we have endeavored to make the meetings successful by having addresses on the vital questions of the present times, given by men eminent in their lines and with direct recent experience. The engineering features of the great war are legitimate questions of this kind, and for our first meeting this year on Trench Fighting and Modern Land Warfare we were fortunate enough to secure Lieut. André Morize, of the French Army, detailed for instructing the Harvard Regiment. At this event, the French and American colors were displayed, and the guests were prominent army officers. The meeting was preceded by a buffet supper and from 175 to 200 were present.

For the second meeting on Aeroplane and Air Fighting, the same general plan was followed with Lieutenant-Colonel Rees, of the British Royal Flying Corps, for the speaker. We used the British and American colors in this case, and made an effort to give some formality to the affair. There were probably 225 present.

The third meeting on Shipbuilding was even more successful than the preceding two from a technical standpoint. Mr. E. H. Ewertz, General Superintendent of the new Destroyer plant now nearing completion at Squantum, near Boston, and Mr. H. G. Smith, Vice-President and General Manager of the Fore River Shipbuilding Company, made addresses which were enjoyable and instructive. President Hollis presided, and we were further honored by having President-elect Main as our guest.

In all of these meetings some effort has been made to plan in advance for the discussion, but usually there is no lack of it, the subjects being of special interest to every one. Usually we begin at 7.30 and adjourn before 10.30, the luncheon or dinner being at 6.15.

To meet the requirement for the extension of acquaintance, we have reached the conclusion that if members and guests on meeting nights come direct to dinner from their offices and plants, much time is saved, their attendance is secured, and the hour or two so spent promotes the object sought. We are endeavoring to cultivate more cordiality at these lunches and dinners, so that by the time cigars are lighted every one has been repaid for coming and all are ready for the meeting. Because the Section really stands for the Society to ninety-five per cent of the members, everything possible should be done to emphasize and strengthen its influence and activities, and the social side should not be neglected.

Coming now to the delicate question of internal politics, our belief is that the greatest good to the greatest number should be the aim, and even further than this, that the Society has a positive function to perform (but not a mission) in maintaining the strictest standards possible of the ethics of engineering, untainted by commercialism. As this is a direct reflex usually of the personality of each Executive Committee, we desire as representative and broad-gage members as can be secured. In these days of large readjustments and shifting of capital and labor, nationalizing of industries, mobilizing of effort, saving of resources, etc., the Society has the opportunity of its existence, if it will but seize it, and each Section must take advantage of its local opportunities.

The appointment of three sub-committees of three members each on Papers, Sociability and Membership, and Research gives nine men who assist the Executive Committee, and who are possible nominees for the ensuing year. In this way we avoid carrying over old members of the Executive Committee. All the sections should be run with the same system and careful planning as any business, avoiding one-man rule, and with an eye solely to the enlargement of the usefulness of the Society to the community and to its members. We make it a point to encourage suggestions and criticisms, and in every way to enlist coöperation, and these three sub-committees are in line with this intent. We also provide combination meetings with other societies, and have an annual banquet.

In conclusion, while we do not claim the solution of all the problems which have tried the skill and patience of our predecessors, we believe their experience has been of value by indicating, at last, various things to avoid, and we shall endeavor to hand over to our successors a Section somewhat improved because of our connection with it.

MR. CARDULLO (Buffalo): Some five or six years ago the Local Section of the A. S. M. E. in Buffalo got together and started the Buffalo Engineering Society. The Society has a membership of several hundred and is increasing very rapidly. It holds a meeting every week. The Local Sections of the various engineering societies are affiliated with it, and our activities are carried out through the medium of the Buffalo Engineering Society, each local section being responsible for certain meetings of the Society. The A. S. M. E. Section is responsible for four meetings a year and the other local sections for a similar number.

I find that the greatest difficulty in the work of our Local Section of the A. S. M. E. is in the fact that the Section shows a disposition to elect as officers the busy managers of the biggest corporations in Buffalo, and in this way the younger men are rather left out of the game, and I think we are missing a good deal from the fact that we have not put the younger fellows into the places where they can bear the burden of the day.

The Buffalo Engineering Society is doing more for us than we are doing for ourselves, but in a way we feel that we are responsible for that, and as loyal and earnest members of the Buffalo Engineering Society we are doing a great deal for the community.

MR. ENGLE (Chicago): We held four general meetings, as usual, in 1917. They were informal, and were attended by from 100 to 180.

Recently we have taken up the matter of coöperating with the Western Society of Engineers.

MR. LANGEN (Cincinnati): We are affiliated with the electrical engineers and also the civil engineers, and we jointly elect a chairman, this officer usually changing about between the electrical and mechanical engineers each year. We aim to have eight good interesting papers each year. We have done this for the last two years, and the attendance of the meetings has increased considerably. The Chairman and Executive Committee of the Board meet once a week for a luncheon. We have no Papers Committee as the Chairman and Secretary of the Section take care of this. We invite the older students of the University of Cincinnati to hear specially interesting papers. Our membership is increasing and we have enough applications to increase it to from 111 to 150 this year. Twelve of our men have gone into the army in the last sixty days.

MR. SARGENT (Connecticut): The Connecticut Section is so young it has not much of a record back of it, except the record of the New Haven Section, now classed as the New Haven Branch of the Connecticut Section. The Section as organized consists of branches in Bridgeport, Hartford, Meriden, New Haven and Waterbury. It has held only one formal meeting.

We have been very generous, as we think we should be, in inviting those who are interested to come in, whether they are members or not, and some of them become members or applicants for membership in the Society.

The organization of the Connecticut Section began with an endeavor on the part of the engineers in Meriden to have a little social intercourse and get acquainted, and that acquaintance ripened into a belief that the members ought to have some recognition on the part of the Society. We met and devised a skeleton plan which the Committee on Sections approved, and that resulted in a kind of automatic organization, whereby, there being five proposed branches, the several Chairmen of these Branches should constitute the Executive Committee of the Section, and under that scheme we are now running.

We met under the auspices of the New Haven Branch at our last meeting. We will hold other meetings in different parts of the State, either in New Haven, Hartford, Bridgeport, Waterbury or Meriden, and the meeting will then be under the auspices of that Branch. We are trying to work out our organization to make it a sort of home-rule government within certain limits.

MR. SHERWOOD (Erie): I want to speak first about having notices issued by the Sections sent to the Chairmen and Secretaries of other Sections, so that we may see what means are taken to induce the men to come to the Sections meetings in the

various parts of the country. I have so far received no notice of meetings by other Sections, and I am frank to say that I have deferred putting the names of other chairmen and secretaries on our list.

Our Section is less than a year old, and as a consequence, we are not very strong yet, but we are gaining strength through coöperating with the Society of Engineers of Northwestern Pennsylvania, and on that account we are having fairly good meetings. An effort to increase the membership will be made, as at the present time we have only about twenty-six members.

Mr. Wallace (Indianapolis): The keynote of the Indianapolis Section has been coöperation. We have coöperated with the Indiana Mechanical Society at its annual meeting, by having one department of the program on one day.

The Indianapolis Section has been instrumental in organizing the Indianapolis Engineers' Club, which is a clearing house for all of the engineers in the city. Through the Club we fostered and organized the first battalion of engineers in the state of Indiana that has gone into the service.

Mr. White (Milwaukee): We have about one hundred members. Our activities can best be illustrated by saying that we have appointed a committee of twelve to draw up papers for the city of Milwaukee, in which they select engineers for city service. We have arranged for a meeting this month at which we will have a symposium on forgings, six speakers, and a visit to the largest forging plant in operation west of Pittsburgh. We are also doing something in research.

Mr. Brink (Minnesota): Our Section has about one hundred members. I think it is a mistake to have a Section to take in a whole state, because it is hard to get the members together at our meetings, although we have meetings alternately at St. Paul and Minneapolis, and occasionally, once a year or so, we meet in Duluth. We are trying to perform social work and also work on interesting papers. The Section this year has set out to get the A. S. M. E. Boiler Code adopted in Minnesota.

Mr. Hutson (New Orleans): Practically all of our work is done in coöperation with the Louisiana Engineering Society. That Society is about twenty years old, and a very live one. When our Local Section was first organized, we and the local Section of the A. S. C. E. held joint meetings in the rooms of the Louisiana Engineering Society, so that for all practical purposes they were extra meetings of that Society. One of those meetings was very successfully held about the time this country entered the war, and as the result of a paper on Preparedness the Louisiana Engineering Society made a roster of the engineers in Louisiana, with an entry of their capabilities.

This year it was arranged that we will be responsible for one meeting in the spring and one meeting in the fall, under the auspices of the Louisiana Engineering Society. Immediately after that meeting we have our business meeting, so that our business affairs are separate from those of the Louisiana Engineering Society, but all of our technical affairs are consolidated with it.

Mr. Prindle (New York): Our coöperation in New York with other scientific societies has consisted in our inviting the members of some particular society to meet with us at some of our meetings, where we had a paper which we thought was particularly interesting to the members of that Society, and such societies, on the other hand, have invited us to their meetings under like circumstances, and all have understood that the meetings of each society are open to the members of the other societies, but further than that we have not found it advisable to go as yet, because in New York the sections are so large the meetings become rather unwieldly where you combine two or more.

We have emphasized very much in the last year or two the get-together spirit, trying to break down the frigidity which exists in New York among people who do not know each other socially, and dinners and dinner dances and little buffet suppers just before the meetings have been used successfully.

Mr. Mudd (Philadelphia): We have the coöperation and affiliation idea in Philadelphia very nearly the same as the other Sections we have heard from. All the Branches of the National Engineering Societies have headquarters in the Philadelphia Engineers' Club. Last summer we had to raise a large amount of money to enlarge our auditorium, and the members of the Society succeeded in raising $32,000.

We opened the year with a joint meeting with the Engineers' Club, and the subject was The War in Its Relation to Shipbuilding. We had about 600 present, and probably one-third of those represented the A. S. M. E. Several of our papers were published in The Journal last year, and arrangements have been started to publish three of them this year. The remainder of the papers will be published in the Journal of the Engineers' Club.

Mr. Burlingame (Providence Engineering Society): Providence has a prosperous engineering society affiliated with the A.S.M.E. in a novel way. It was through the good offices of the A.S.M.E. that we enlarged our local society into a General Engineering Society which has now five or six hundred members, taking care of the general engineering interests in the neighborhood of Providence. That society is holding meetings under the leadership of a number of sections, eight sections hold meetings, so that we have about three meetings a week at our headquarters, besides the monthly meeting of the general engineering society. The local headquarters have been furnished by the liberality of a local member, who is also a member of the A.S.M.E., a lantern has been donated to us, and we have the nucleus of a very good library, so we feel especially indebted to the A.S.M.E. along all of these lines for the development and growth of our local work.

We have two local officers, a chairman and a secretary to each section, who divide the responsibility and give us a wide range of subjects. Our membership is increasing, and we feel that the society is a valuable factor in Providence in helping along the work of the Government. Many of our members are in the service, and others are working in connection with war committees on various kinds of work. I am a member of the New England Committee on the subject of intensified industrial training, the importance of which has been emphasized today.

Mr. Radcliffe (St. Louis): The St. Louis Section has about one hundred members. We are holding regular monthly meetings of a social nature, always followed by a paper or an address on an engineering subject. We are affiliated with the Engineers' Club, in what is known as the Associated Engineering Societies, which is made up of the local chapters of the national societies, with a total membership of about five hundred, but we still maintain a very strong individual identity as a local Section of the A.S.M.E.

If the Sections are to be the backbone of the Society, the best way that the Society can stiffen that backbone is to send members of the Council around to visit the members of the Section and stimulate their interest in the Section work. Only two or three of the local Sections can get in touch with headquarters, and the next best thing is to bring headquarters in touch with the members of the Society in their various localities.

Mr. Delany (San Francisco): The San Francisco Section, formed in 1910, is one of the oldest Sections in the Society. We have had one good meeting this year, for which we have to thank President Hollis. We invited the other sections of the various Societies to join with us, and they were quite enthusiastic in their responses. The meeting was very successful, and several members of the other Societies complimented us afterwards on the holding of this joint meeting, and expressed the hope that the other societies would do the same thing later.

We have had a good deal of difficulty in securing papers. We started by trying to secure papers by correspondence, and since then we have appointed a Papers Committee, and we expect results from that committee's work. We also have appointed a Research Committee, and during the present week there was to be a meeting of our Executive Committee with both the Papers Committee and the Research Committee, to find out just what progress is being made.

Mr. Fairfield (Worcester): The Worcester Section of the A.S.M.E. was formed to establish a means for engineering acquaintance and coöperation between the local members of the Society and the non-members who are engaged in our industrial firms. We have also established very close relations with the alumni and students of our local engineering college, the Worcester Polytechnic Institute.

Reports of Section Meetings

ATLANTA

November 6. The first meeting of the current fiscal year was held at the Hotel Ansley. The members were entertained at supper by the new chairman, Oscar Elsas, Mem.Am.Soc.M.E., after which Professor J. S. Coon delivered an interesting address on the subject of Aviation with Relation to the War. Following this routine business matters were discussed and most encouraging opinions were expressed regarding the remainder of the season. It was decided to hold meetings monthly and to have presented at each meeting either a paper or an address on an appropriate subject.

CECIL P. POOLE,
Section Secretary.

BOSTON

November 23. A dinner was held at the Engineers' Club, with President Hollis and President-Elect Charles T. Main, together with Mr. H. G. Smith, Vice-President and General Manager of the Fore River Shipbuilding Co., and Mr. E. H. Ewertz, General Superintendent of the Squantum Destroyer Plant of the Fore River Shipbuilding Co., as the guests of honor. After a short business session, Chairman Ashton turned the meeting over to President Hollis, who gave an entertaining and timely address, and then introduced Mr. Ewertz, who described the rapid building of the Squantum plant, which was an aviation field six weeks ago, but which is to deliver 35 submarine destroyers in sixteen months, beginning January 1, 1918. The plant is nearing completion at this time.

Mr. Smith delivered an address on the Recent Development of the American Marine Industry, approaching the subject not only from the engineering but from the production side, particularly with reference to the question of labor. He was later asked many questions as to various elements of the labor situation, and the discussion thus started, terminated in a very successful meeting.

W. G. STARKWEATHER,
Section Secretary.

BUFFALO

November 16. At the second general meeting of the Engineering ing Society of Buffalo, and its affiliated sections, Dr. C. H. Norton, Mem.Am.Soc.M.E., gave a talk on the Modern Cylindrical Grinding Machine. Dr. Norton illustrated his lecture and cited many interesting points in the design of grinding machinery.

L. H. Hart, engineer for Lupfer & Remick, Civil Engineers, spoke on the subject of Electricity on the Barge Canal, at the November 21 meeting of the society. Mr. Hart pictured a barge canal electrically operated by a push-button type of boat, and predicted that these boats would be run on the canal eight months of the year. This canal would relieve railroads of bulk freight and give them greater opportunity for development in carrying other lines.

At a meeting of the Automotive Section of the society, on December 6, G. Douglass Wardrop, Editor of the *Aerial Age*, talked on Aeroplanes, Uncle Sam's Infant Industry. He illustrated his subject by numerous lantern slides and several reels of films. Quoting Mr. Wardrop:

"A wedge will soon be driven through the lines of the German armies, and I believe that the point of that wedge of liberty will be the aeroplane.

"Young men in Buffalo will have the satisfaction of knowing that on many of those planes the name of Buffalo will be stamped somewhere in their mechanism.

"The aeroplane is the greatest factor we have now for the advancement of civilization. It is the wedge-point of liberty. Buffalo is now the leading aviation center in this country. In a short time it will be the greatest single aviation center in the world. But you Buffalo people will have to work hard indeed if you want to keep that supremacy. Detroit has got the automobile industry practically to herself, and she is trying to do the same with aviation. Detroit now stands second, and is rapidly increasing her importance as a producing center for aeroplanes and their parts."

Among the interesting applications of the aeroplane Mr. Wardrop showed the picture of a Montana ranchman using an aeroplane to round up his cattle. He flies over his wide plains and drops a smoke bomb when he finds the straying herds. The cowboys note the fall of the bomb and hurry to the spot. He showed pictures of inaccessible mining districts, wealthy in resources beyond present computation, but lightly worked now because of the enormous cost of transportation, that could be reached in an hour by the use of aircraft.

The society held another meeting on December 12, at which F. A. Parkhurst, Mem.Am.Soc.M.E., spoke on The Mobilization of Labor. A fuller account of this meeting will be given in the following issue of THE JOURNAL.

LOUIS J. FOLEY,
Assistant to Section Secretary.

CHICAGO

November 16. President Hollis and several members of the Council were present at the first meeting of the Section for the season. Dr. Hollis addressed the audience on the engineer's task in the present war. He said that the terrible effectiveness of modern warfare is due largely to inventions of the engineer, and it now lies with the engineering profession to say whether the results of its work shall be only to make war more horrible, or whether by its influence it shall be possible to make the present war the last one, and to determine that coöperation and the use of the engineering inventions shall be for the happiness of the people instead of their hurt. If increased efficiency of human effort is to mean simply an increase of population which will result in a greater struggle for dominion and greater effectiveness in killing, it is not worth having. Dr. Hollis spoke of the effectiveness which engineers may have in helping the officials who are charged with conservation or resources, by acting in consulting capacity on such matters as fuel conservation, and by acting as speakers to educate the public in the necessity for and the methods of preventing waste of food and fuel.

Major Peter Junkersfeld, Mem.Am.Soc.M.E., delivered the principal address of the evening on Cantonment Construction, giving much information and data in regard to his work in the cantonments. In his capacity as officer in charge of inspection, he had had exceptional opportunity to gather information and presented a most instructive paper, which will be published in full later.

Altogether the evening was a great success, the meeting being the most enthusiastic and best-attended since the inception of the Section.

ARTHUR L. RICE,
Section Secretary.

ERIE

November 13. Pulverized Coal and its Future was the subject of an address by H. G. Barnhurst, Mem.Am.Soc.M.E., at a joint meeting of the Section with the Engineers' Society of Northwestern Pennsylvania. The meeting was opened by Mr. Schumm, President of the Engineers' Society of Northwestern Pennsylvania. The speaker of the evening gave a most interesting account of the developments in the use of pulverized coal as fuel.

M. E. SHERWOOD,
Section Secretary.

INDIANAPOLIS

November 7. L. O. Armstrong, who is traveling under the auspices of the Bureau of Economics of the United States Government, gave an illustrated address. Mr. Armstrong is endeavoring to stimulate interest and enthusiasm for all efforts of the Government in carrying on the war. His talk was valuable, profitable and very much appreciated. His subject was Canada at War, and was well illustrated by motion pictures and lantern slides.

At the same meeting Captain Brown, of the Canadian Engineers, gave a short talk pertaining to his experiences in the trenches in France. Captain Brown is back in this country on a sick leave, and while here is the recruiting officer for the Canadian Government in the city of Indianapolis.

Captain Reeves, of the United States Army, also gave a very interesting talk concerning the qualifications required by young men for the aviation service. Captain Reeves is the local recruiting officer for the Aviation Section of the United States Army. He was for many years professor of economics at the University of Michigan at Ann Arbor.

L. W. WALLACE,
Section Correspondent.

LOS ANGELES

November 24. The meeting of the Technical Societies of Los Angeles took the form of an automobile trip to the top of Mt. Wilson, the occasion being a visit to the Mt. Wilson Solar Observatory. The exciting part of the trip was that of climbing from an altitude of 1500 ft. at the base of the mountain to 5600 ft. at the top, which is a distance of nine miles. The new one-hundred inch telescope, the largest in the world, proved the principal object of interest, as it is nearing completion. The greater part of the excursionists "stargazed" until after midnight.

T. J. Royer,
Section Secretary.

MILWAUKEE

November 14. B. E. Fernow, Jr., gave an illustrated talk on the Design and Application of Magnetic Clutches. Mr. Fernow showed a great number of interesting pictures and demonstrated an actual clutch.

Following the meeting there was a general discussion, after which a buffet luncheon was served.

F. H. Dorner,
Section Secretary.

PHILADELPHIA

November 27. This meeting of the Section was opened with a statement of the progress being made by the various sections, by D. Robert Yarnall, Chairman of the Committee on Sections. Mr. Yarnall emphasized the fact that some of the newer western sections are extremely active and progressive. Mr. Ernest Hartford, secretary of the Committee on Sections, spoke upon the subject of section activities. A motion made by Mr. L. H. Kenny was carried, directing that the chairman appoint a committee on papers. Prof. Walter Rautenstrauch, member of the Committee on Sections, presented the paper of the evening, entitled Manufacturing in Relation to Banking, Research and Management.

Offensive Against the Submarine, by Joseph A. Steinmetz, was the subject of the evening at a joint meeting of the Section with The Franklin Institute on December 11. A complete report of this meeting will be given in the following issue of The Journal.

John P. Mudd,
Section Secretary.

PROVIDENCE

December 10. Frederick J. Hoxie, Mem.Am.Soc.M.E., spoke before the Fire Insurance Engineering Section, giving a most interesting paper on the Fire Hazards of Celluloid. On Tuesday, December 11, the Designers and Draughtsmen Section listened to a paper by J. S. White, of the Morse Chain Company, Ithaca, New York, who talked mainly on the engineering of silent-chain drives; a very interesting discussion followed. On December 12, George F. Wheaton, of the J. & P. Coats, Ltd., read a paper on Boiler Efficiencies before the Power Section. The Brown University Student Section of the Providence Engineering Society held a meeting on this date, at which Professor Hardy Cross gave a paper on How an Engineer Gets His Facts.

James A. Hall,
Correspondent.

ST. LOUIS

November 9. The Associated Engineering Societies of St. Louis held a farewell testimonial dinner tendered to John Hunter, Mem. Am.Soc.M.E., who for the past twelve years has been Chief Engineer of the Union Electric Light and Power Company, and who has recently been called into the service of the Government in the capacity of district manager for the Emergency Shipbuilding Corporation, with headquarters in New York. The occasion found the Engineers of St. Louis meeting with mingled feelings; pride that one of their members had been chosen for this important work, and regret that they were to lose a man who had done so much for the profession during his many years' residence in St. Louis, and who had made a friend of every engineer with whom he had come in personal contact. Mr. Hunter has always taken active interest in the work of The American Society of Mechanical Engineers and has been elected Vice-President for the coming year.

The regular monthly meeting of the Section was held on November 23, at which the affairs of the Society were discussed, and a resolution adopted to the effect that the Executive Committee of the St. Louis Section extend to the Council a cordial invitation to hold a meeting in St. Louis at such time as may be found most convenient.

H. W. Radcliffe,
Section Chairman.

WORCESTER

November 22. The first meeting of the Worcester Section was held in the Electrical Building of the Worcester Polytechnic Institute, and the subject presented for discussion was Fuel Conservation. The section was fortunate enough to secure Dr. Ira N. Hollis, President of the Society, and Prof. L. P. Breckenridge, Mem.Am.Soc.M.E., to open the discussion. Dr. Hollis took up the broader view of conservation as it appertained to all our resources, emphasizing the point that some of our resources, such as our foods, are recurring crops, while others, like coal, once used are gone forever.

Professor Breckenridge dealt with the conserving of our coal supply. He displayed lantern slides, showing where the coal is used and what industries are the largest users. He closed his presentation of the subject by outlining the ways in which coal can be saved.

Previous to the discussion, a buffet luncheon was served at the home of Dr. Hollis.

H. P. Fairfield,
Section Secretary.

STUDENT BRANCHES

Conference of Student Branches

At the Student Branch Conference held on Wednesday, December 5, in connection with the Annual Meeting, much was developed of interest, and although it was found that our Branches have lost a great percentage of their members due to the war, plans are being laid to carry on their activities as in previous years.

The representatives of the following colleges were present, and gave brief talks on how the war had affected the conduct of their affairs, and what plans were being laid for future meetings:

Armour Institute of Technology.......Mr. A. H. Anderson
State University of Iowa....................Mr. Sheatsley
State University of Kentucky......Prof. F. Paul Anderson
Massachusetts Institute of Technology......Mr. A. Saunders
New York University.....................Mr. H. G. Tyler
Polytechnic Institute of Brooklyn.........Mr. Wm. Sumner
Rensselaer Polytechnic Institute............Mr. R. P. Kolb
Stevens Institute of Technology.............Mr. McDermot
University of Washington....................Mr. McCoy
Worcester Polytechnic Institute............Mr. R. C. Lewis
Yale University..........................Mr. R. Wier, Jr.

While some of the colleges have been affected less seriously than others, none have escaped without feeling some strain of the present war conditions. Massachusetts Institute of Technology reported a loss of 50 per cent of its members and a number of the other colleges reported losses from 30 per cent to 50 per cent. With the provision just made by the Government to enlist all engineering students in the Engineer Reserve, and to

exempt them from the national draft, many more men will now probably stay in the institutions and complete their courses.

On account of the loss of professors in the various colleges a great many courses have been eliminated from the college curricula entirely and outdoor drills substituted. While the kind of training varies in the different colleges, nearly every college devotes part of the time to military training. Reports from a few of the colleges in this connection follow:

At Columbia University a complete submarine has been installed in the laboratory and the students are instructed in the testing of motors, engines, etc. In Cambridge are the aviation school and the only naval school of its kind in the country. At Ohio State University there is an aviation school. At Stevens Institute of Technology military drills are required two days a week; Stevens has received an assignment of guns and the students receive instructions in the manual of arms. While it has been a regular requirement at the University of Washington since 1909 that strict military training is required for two years, this training has now been made more severe and students receive instructions under the supervision of U. S. Army officers and have three drill parades a week. Yale University has thirty horses which are utilized in the artillery training the students are receiving.

F. R. Hutton, *Chairman*,
Committee on Student Branches.

Student Branch Meetings

(Some of the Student Branch Reports are unavoidably held over on account of lack of space, but will be published in the February issue.)

ARMOUR INSTITUTE OF TECHNOLOGY

November 27. One of the main objects of the Branch this season is to have short talks given by three or four members of the Society, on some technical subject. At the last meeting K. A. Taylor spoke on the construction, assembling and testing of different types of Fairbanks-Morse Gas Engines. Mr. Rehfelt discussed the modern dispensing machine, such as the type used in the automatic restaurant. Mr. Wutheimer spoke on the design, remodeling, process of construction, and routing through the shops of different types of valves as used on gasoline motors, as made by the American Car & Foundry Company.

The officers of the Branch for the coming year are as follows: President, D. A. Taylor; vice-president, J. A. Keeth; secretary, V. A. Kerr; treasurer, H. Anderson.

The Armour Institute of Technology has discontinued athletics this year, although it strongly advises its students to make use of the gymnasium to keep themselves fit for Government service, and has made it compulsory that the freshmen and sophomores take military training one afternoon a week. The training is left optional to the junior and senior classes, but a large majority of both upper classes are drilling.

Under the instruction of Professor Libby and Professor Pebbles, a class of marine engineers is now meeting four times a week.

V. A. Kerr,
Branch Secretary.

UNIVERSITY OF CINCINNATI

October 19. The spirit and ardor shown at the first meeting of the season gave every indication that the Branch would be very active this year. An entertainment and membership committee, along with a new publicity man, were appointed. An orchestra and several good speakers was the program offered for the evening. Among other visitors several of the alumni of the Engineering College, along with a few professors, were present. J. B. Stanwood, Mem.Am.Soc.M.E., gave a very interesting talk on The Power to Visualize Objects of Study. He suggested that engineering problems be solved, as far as possible, by means of a rational reasoning process rather than by the use of handbook rules and formulæ. Mr. Stanwood solved several problems dealing with the valve motion of the simple slide-valve engine to illustrate his remarks. Professors Jenkins and Joerger also addressed the students and strongly advocated Mr. Stanwood's ideas.

At the second meeting of the Branch on November 23, Wm. A. Greaves, of the Greaves-Klusman Tool Company, Cincinnati, spoke of his engineering experiences. The talk presented many interesting problems such as the repairing of very large anchors, the underlying principle of the building of the Mississippi Jetties, and Captain Eads's ship railway. The speaker concluded his talk by urging the students to do everything in life with a determination to win.

It was decided at this meeting to make an inspection trip to the new plant of the Union Gas & Electric Company, now under construction. At the present time the construction company is placing the condensers and the boilers. This plant is to be one of the largest of its kind in that part of the country. Up to the present time the students have been studying the foundation as a part of their steam-power-plant course in steam engineering.

C. L. Koehler,
Branch Secretary.

LEHIGH UNIVERSITY

November 12. The first meeting of the Branch for the season was given over entirely to a business session and the electing of the officers for the present year, which resulted in the following: President, W. R. Penman; secretary, N. Dmytrow; treasurer, R. M. Stettler.

P. B. de Schweinitz,
Honorary Chairman.

UNIVERSITY OF MAINE

November 23. The first meeting of the Branch for the season was given over to a short business session, and the electing of the new officers for the present year, which resulted in the election of I. L. Newman, president; I. S. Hanson, vice-president; D. F. Theriault, secretary and treasurer; A. F. Barnard, R. L. Googins, K. B. Noyes, as the Executive Committee, and Prof. W. J. Sweetser, Mem.Am.Soc.M.E., Honorary Chairman.

D. F. Theriault,
Branch Secretary.

MICHIGAN AGRICULTURAL COLLEGE

November 1. The first meeting of the Branch for the season was given over entirely to the electing of the new officers for the present year, and the discussion of campaigns for membership. The results of the election were as follows: President, H. T. Froelich; vice-president, W. G. Retzlaff; secretary, H. M. Sass; treasurer, F. O. Stang.

H. M. Sass,
Branch Secretary.

PENNSYLVANIA STATE COLLEGE

November 16. The first meeting of the Branch for the season began by a short business session, after which the meeting was turned over to the Program Committee. Prof. R. B. Fehr, Mem.Am.Soc.M.E., gave an illustrated talk on the romantic development of the steam engine, beginning with the earliest forms of which there is any record and tracing its development to the present day. Dean R. L. Sackett gave a short talk to the students with reference to the activities of the Branch. There followed a few selections by the Mandolin Club, after which refreshments were served. Prof. E. A. Fessenden, Mem.Am.Soc.M.E., Professor Resides, and Prof. A. F. Wood, Mem.Am.Soc.M.E., then gave short talks, completing the program of a very successful evening.

H. W. Parthesun,
Branch Secretary.

THROOP COLLEGE OF TECHNOLOGY

November 8. Dr. Ira N. Hollis, Pres.Am.Soc.M.E., was present as speaker and guest of honor at the opening meeting of the Branch this year. Dr. Hollis addressed the students on the War, Conservation, The Part of Engineering in the War, and told his philosophy of life. Everyone present was much impressed by

this stirring address and the true simplicity of this really great man.

Because of the enlistment of so many of its students the Branch has had some difficulty in organizing this year. Plans have been made to coöperate with the Student Branch of the American Institute of Electrical Engineers, and to have joint meetings once a month. The outlook for a successful year is very good so far.

Retla Alter,
Branch Secretary.

UNIVERSITY OF WASHINGTON

November 16. K. B. Sallee was elected corresponding secretary, and the following Committees appointed: Program committee, Prof. J. H. Macintire, *chairman*, Buel B. Blake, and Earl Elvidge; election committee, Valentine Hoffman, *chairman*, Lester R. McLeed, and Leroy Burque. Jasper F. Keuhnert was elected freshman representative, and Arthur W. Stewart sophomore representative. Plans were completed for the coming smoker which it was decided to hold on November 22, at 8 p. m.

K. B. Sallee,
Branch Secretary.

WASHINGTON UNIVERSITY

November 7. The first meeting of the season resulted in the following elections: Chairman, Ernest E. Bissett; vice-president, Francis Packer; secretary, Fairman B. Lee; treasurer, Corwin P. Rummel. Plans for future meetings and a smoker were discussed, after which Professor Macintire gave a short talk on the aims and ideas of the Society. Representatives from the freshman and sophomore classes were appointed to get all underclassmen interested.

Fairman B. Lee,
Branch Secretary.

UNIVERSITY OF WISCONSIN

October 18. The season opened with a well attended business meeting and was followed by a talk given by Professor Corp, Mem. Am.Soc.M.E., on the purpose of the Society and the benefits derived by the members.

At the November 11 meeting of the Branch, Mr. Stocker gave an illustrated lecture on his work and experiences in China. He gave a very good description of the life, customs, habits and methods of the Chinese. A business session followed at which the names of the men applying for membership were read for the second time, and the date of initiation was set for Thursday night, November 15.

The December 6 meeting consisted of an interesting and complete talk on Gas Turbines by Glenn Warren. Mr. Warren has spent a great deal of time studying gas turbines, and was therefore well qualified to speak on this subject.

H. K. Shieks,
Branch Secretary.

WORCESTER POLYTECHNIC INSTITUTE

November 16. The November meeting of the Student Branch was made especially interesting by a discourse on Employment Relations Work, by E. H. Fish, Employment Manager of the Norton Co. The speaker emphasized the attempts made by employer experts to reëstablish the old cordial relations between the employed and the employer. He also told how the up-to-date employment manager coöperated with the welfare work among the employees, even assisting in the employees' home in times of great stress of sickness. In closing he called attention to the present lack of skilled workmen and showed how the Norton Companies established their records of employees as related to the working ability, ambitions, health, etc., of the individual as a means of putting the right man in his proper place.

On December 7, the Branch held a joint meeting with the American Institution of Electrical Engineers, in the Electrical Building. The meeting was opened by Benjamin Luther, chairman of the A.I.E.E. Branch, who introduced Mr. Geo. M. Eaton, W.P.I., '96, now head of the Railway Division of the Westinghouse Electric & Manufacturing Co. Mr. Eaton gave an illustrated lecture on The Other Half of Engineering, and showed how a new machine or apparatus is seldom in its best form as first designed and tested. By displaying a variety of designs the speaker showed how new goods are often defective, as first constructed, and how these inevitable defects are corrected. The talk was both instructive and unique, inasmuch as it dealt with the difficulties of engineering rather than with the successes. Mr. Eaton showed the students that an engineer's job sometimes is that of pulling batters out of a hole and is not always easy.

H. P. Fairfield,
Branch Secretary.

KANSAS STATE AGRICULTURAL COLLEGE

November 22. James I. Brady, senior in mechanical engineering, gave a paper entitled Ordnance Work. He dwelt upon the organization of the Ordnance Department and the importance of the work at the present time, laying emphasis on the part technically trained men might perform in this field of work. The second number on the program was a review of the September issue of The Journal, presented by Mr. Harry Bell, Junior in Mechanical Engineering. Mr. Bell laid special emphasis on the article of "Modern Locomotive Practice."

At the December 6 meeting of the Branch Seibert Fairman presented a paper entitled Aviation Training. The subject matter was gathered from current magazines and from reports of students of this school who are at present training as aviators. This subject proved very interesting and of much importance because of the fact that a large per cent of the students are entering the aviation service of the Government. Mr. Gordon Hamilton, junior in mechanical engineering, presented a review of the November issue of The Journal. Mr. Hamilton in his review spoke on the two articles of Accident Prevention, and Labor Turnover Records and the Labor Problems.

I. O. Mall,
Branch Secretary.

College Reunions

The College Reunions were held on Friday night of the Annual Meeting as in previous years, and if the war lessened the number somewhat, nevertheless the reunions that were held were very thoroughly enjoyed.

The Cornell reunion had as its guests Mr. Lawrence Sperry, Prof. D. S. Kimball and Mr. Robert Lee. Mr. Sperry gave an interesting talk of his "flying" experiences; Professor Kimball spoke on the wartime conditions at the University and Mr. Lee illustrated his talk on the gyroscope with lantern slides and models. Mr. C. F. Hirschfeld and Mr. W. W. Macon acted as toastmasters at the dinner.

The Massachusetts Institute of Technology had forty A.S.M.E. members at its reunion at the Technology Club. After an informal dinner Mr. James P. Munroe, '82, gave a talk on Washington in War Times.

Purdue held its annual reunion at the Phi Gamma Delta Club, and over thirty members were present, including as guests Dr. W. F. M. Goss, Prof. C. A. Waldo, Dean C. H. Benjamin and Mr. Angus Sinclair, all of whom gave very interesting talks. Dean Benjamin spoke on what the University and graduates are doing for their country at the present time, while Dr. Goss brought home forcibly the necessity of conserving the number of men training for the engineering profession. Congratulations were telegraphed the University on its patriotic help and services at this time.

Stevens Institute of Technology gave a supper dance at the Hotel Astor, omitting their usual theater party in view of the seriousness of the times. The dance was most successful and voted by all one of the most enjoyable dances ever given by Stevens.

The University of Kentucky N. Y. Club held an informal smoker at Keen's Chop House, having as their guests the out-of-town alumni who were in the city attending the Annual Meeting, as well as several other engineers that Kentucky would be proud to claim as hers. Professor Anderson, dean of the mechanical and electrical colleges of the University, and President Wendt of the Buffalo Forge Co. gave very interesting impromptu talks. The attendance was somewhat reduced owing to the fact that so many Kentucky men are in the national service.

Worcester Polytechnic Institute held its reunion in the Society rooms. Following a buffet supper remarks were made by three Past-Presidents of the Society, Dr. Ambrose Swasey, Dr. John A. Brashear and Dr. Ira N. Hollis, President of the Institute. The other guests who addressed the meeting were Prof. M. E. Cooley, of the University of Michigan, and Prof. Chas. M. Allen, of Worcester, who gave an interesting account of the present activities of the Institute.

ROLL OF HONOR

THE SOCIETY'S SERVICE FLAG unfurled at the Annual Meeting bore the number 433 in stars, which was the total number of members in the Service of which the Society had notification on December 4, 1917. This new list of names received since the publication of the previous list brings the total to nearly 600.

ADAMS, PORTER H., Office of Naval Intelligence, United States Navy.
ADAMSON, KEITH F., Captain, Inf. U. S. R., U. S. Expeditionary Forces.
ALISON, E. E., Major, Production Section, Gun Division, Ordnance Department, U. S. R.
AUSTIN, RICHARD S., Aviation Student, Division 5, Foreign Detachment, American Expeditionary Forces.

BACON, HOWARD E., Company C, 318 Field Signal Battalion, Camp Jackson, Columbia, S. C.
BAIRD, JAMES T., JR., Captain, Ordnance Department, United States Reserve.
BALDWIN, BERT L., Major, Engineer Officers' Reserve Corps.
BASSETT, CHARLES K., Lieutenant, Ordnance Department, United States Reserve.
BEEBE, LAWRENCE L., Captain, Engineer Officers' Reserve Corps.
BEHR, F. J., Major, Coast Artillery Corps, United States Army.
BENEDICT, BYRON W., First Lieutenant, Ordnance Section, Oficers Reserve Corps, United States Army.
BENHAM, W. L., Major, Quartermaster Officers' Reserve Corps, Camp Funston, Ft. Riley, Kan.
BENSON, H. S., First Lieutenant, Ordnance Department, Inspection Section, U. S. R.
BILLINGS, A. W. K., Lieut.-Commander, care of Commander U. S. Naval Aviation Forces, Paris, France.
BIRDSEYE, GARNER K., First Class Private, Aviation Section, Signal Corps, United States Army.
BOWES, LAWRENCE C., 332nd Field Artillery, U. S. A.
BOYD, FRANK F., Lieutenant, United States Naval Reserve Force.
BRADFORD, J. S., Captain, 103rd Engineers, Company B, Camp Hancock, Augusta, Ga.
BRADY, GEORGE S., Captain, American Ordnance Base Depot in France.
BREADY, WILLIAM M., JR., First Lieutenant, 108th Engineers, Company E, 33rd Division, Camp Logan, Texas.
BREWSTER, HENRY B., Captain, 303rd Regiment of Engineers, Camp Dix, N. J.
BROWN, EDWARD W., Lieutenant, United States Naval Reserve Force.
BUCKLEY, JOHN H., Captain, Equipment Engineer, Small Arms Division, Frankford Arsenal.
BYLLESBY, H. M., Major, U. S. R., Signal Corps Headquarters.

CAHILL, EDWARD H., First Lieutenant, Field Artillery Section, Carriage Division, Ordnance Department.
CAMPBELL, JEREMIAH, Major of Engineers, United States Reserve Corps, American Expeditionary Force, France.
CARPENTER, CHARLES A., First Lieutenant, Ordnance Section, Officers' Reserve Corps, United States Army.
CHAPIN, WARREN W., Captain, Engineers, United States Reserve.
CHRISTIE, A. G., Private, Reserve Officers' Training Corps, Johns Hopkins University.
CHURCH, ELIHU C., Captain, Engineer Officers' Reserve Corps, Adjutant 117th Engineer Regiment, 42nd Division.
CLARK, JOHN W., Second Lieutenant, Engineer Officers' Reserve Corps, United States Army.
CLAUSSEN, HOWARD P., Ensign, United States Naval Reserve Force, Class 5 (Naval Reserve Flying Corps).
CLEMONS, ROBERT S., Major, Commanding 506th Engineering Service Bureau, Camp Lee, Va.
CLUCAS, GEORGE W., Private, Company G, First Reg. 122 Reserve Militia.
COHEN, ABRAHAM SAUL, First Lieutenant, Ordnance Reserve Corps, United States Army.
COLE, C. S., Captain, Ordnance Reserves.
CONANT, WILLIAM S., Captain, Ordnance Officers' Reserve Corps.
CONROY, RAYMOND, Second Lieutenant, Coast Artillery Corps, United States Army.
COOK, WILLIAM P., JR., First Lieutenant, Ordnance Officers' Reserve Corps.
CYPHERS, JAMES F., First Lieutenant, Ordnance Officers' Reserve Corps.

DAILEY, FRED A., Captain, Engineer Officers' Reserve Corps.
DELEMOS, FREDERICK P., Second Lieutenant, Infantry Officers' Reserve Corps.
DE VISSER, JOHN H., Captain, Officers' Reserve Corps, Ordnance Department, Supply Division.
DEXTER, HARRIS E., Lieutenant, 30th Engineers (Gas and Flame).
DICKERSON, H. S., Captain, United States Reserve.
DIEMER, HUGO, Major, Ordnance Officers' Reserve Corps.
DIETRICH, FRED E., Machinist's Mate, Second Class, Naval Coast Defense Reserve.
DRESSLER, L. RICHARD, First Lieutenant, Ordnance Department, Carriage Division, Officers' Reserve Corps.
DREW, WILLIAM N., Second Lieutenant, 323rd Field Artillery.
DUNCAN, J. C., Captain, Quartermaster Corps, U. S. R.

EATON, P. B., Second Lieutenant of Engineers, United States Coast Guard.
EDE, ALBERT B., Second Lieutenant, Coast Artillery Corps, U. S. A., American Expeditionary Forces.
EDMONDSON, RALPH S., First Lieutenant, 27th Engineers, Engineers' Reserve Corps.
ESTABROOK, M., Captain, Ordnance Department, United States Army.
EVANS, GEORGE A., Lieutenant (Junior Grade), United States Naval Reserve Force.
EVANS, LYNN B., Ensign, United States Naval Reserve Force.
FABENS, ANDREW L., First Lieutenant, Ordnance Reserve Corps.

FERNSTROM, F. S., United States Naval Reserve Force.
FESSENDEN, C. H., Captain, Ordnance Reserve Corps, Ordnance Department, Frankford Arsenal, Philadelphia, Pa.
FIELD, FREDERICK C., Captain, Ordnance Officers' Reserve Corps, Small Arms Division, Ordnance Department.
FISH, M. R., Private, Mass. State Guard, Company H., 19th Regiment.
FISHER, R. R., First Lieutenant, 106th Engineers, 31st Division, Camp Wheeler, Macon, Ga.
FISHLEIGH, WALTER T., Major, Sanitary Corps, N. A., Surgeon General's Office, Washington, D. C.
FORDYCE, JOHN R., Major Engineers, U. S. R.
FORFAR, DONALD M., First Lieutenant Engineers, U. S. R. Engineer Officers' Reserve Corps.
FOWLER, WALLACE S., First Lieutenant, Ordnance Officers' Reserve Corps, Production Section, Carriage Division.
FOSTER, ERNEST H., Ensign, United States Naval Reserve, Class No. 4.
FRANCE, JOHN E., First Lieutenant, Engineer Officers' Reserve Corps, 5th Engineer Corps, Company F.
FRANKET, WILLIAM F., Second Lieutenant, Ordnance Officers' Reserve Corps.
FRANKLIN, BENJAMIN A., Major, Ordnance Department.
FREDERICK, ALVAH B., Second Lieutenant, Ordnance Officers' Reserve Corps.
FREEMAN, B. W., First Lieutenant, Ordnance Department.
FRIEDMAN, FERDINAND J., First Lieutenant, Supply Division, Ordnance Department, U. S. R.
FRITZ, A. L. G., Cadet, Squadron B, Signal Corps, Aviation Section, Officers' Reserve Corps, United States Army, Wright Field, Dayton, Ohio.

GIBBS, PAUL H., First Lieutenant, Ordnance Department, Inspection Section, Gun Division, U. S. R.
GILSON, JOSEPH L., Corporal, Company F, 302nd Engineers, United States Army.
GITHENS, THOMAS F., First Lieutenant, Ordnance U. S. R., Trench Motor Design.
GLEASON, GILBERT H., Trooper, First Troop (Cavalry) Mass. State Guard.
GRAY, H. LIGGETT, Chief Machinist's Mate, U. S. Naval Reserve.
GREENE, AUGUSTINE E., Major, Ordnance Officers' Reserve Corps.
GREENLEAF, GEORGE E., Major, Ordnance Bureau, United States Army.
GREF, W. H., Lieutenant, Torresdale Station, Philadelphia, Pa.
GUEST, W. E., Captain, Ordnance Officers' Reserve Corps.

HANSEN, F. D., First Lieutenant, Reserve Corps, Ordnance Department.
HARKNESS, V. F., Lieutenant (Junior Grade), United States Naval Reserve Force.
HENRY, VERNOR S., First Lieutenant, Ordnance Department, United States Reserve.
HERRICKS, E. A., Captain, Ordnance Officers' Reserve Corps.
HOBBS, GEORGE W., First Lieutenant, Ordnance Section, Officers' Reserve Corps.
HOFFMAN, JOHN ERNEST, Second Lieutenant, Engineer Officers' Reserve Corps, American Expeditionary Forces.
HORTON, ELIAS Q., Ensign, U. S. Naval Reserve Force, on board U. S. S. South Carolina.
HOWARTH, JACOB M., First Lieutenant, Officers' Reserve Corps, Intelligence Officer, 342nd Inf. Headquarters, Camp Grant, Ill.
HUBBELL, ARTHUR C., First Lieutenant, Purchase Section Small Arms Division, Ordnance Department.
HUNICKE, C. CAMPBELL, Sub-Inspector of Ordnance, Ordnance Department, United States Navy.
HUNT, H. B., Major, Ordnance Department, Gun Division.
HUNTER, CHARLES F., Captain, Ordnance Reserve Corps.

Jackson, John P., Major, Engineer Officers' Reserve Corps.

Kaemmerling, Gustav H., Second Lieutenant, U. S. M. C., First Aviation Squadron.
Kehl, R. J., First Lieutenant, Division of American Ordnance Base Depot in France.
Kellogg, Charles D., First Lieutenant, Ordnance Department, Small Arms Division.
Knowlton, F. K., Captain, Ordnance Reserve Corps, United States Army.
Lambelet, Carl H., First Lieutenant, Ordnance Department, United States Reserve.

Lamoree, J. K., First Lieutenant, Engineers, U. S. R., Officers' Reserve Corps, Engineer Section.
Lancaster, William C., Captain, Engineer Officers' Reserve Corps.
Langville, H. B., Lieutenant (Junior Grade), Naval Coast Defense Reserve, U. S. Naval Reserve Force.
Leonard, Elton Ibbotson, Canadian Expeditionary Force in France.
Leisen, Theodore A., Major, Quartermaster Corps, Utilities Department, 85th Div., U. S. Army.
Lewis, Kenneth B., Private, Company H, 19th Infantry, Mass. State Guard.
Lightowler, George R., First Lieutenant, Ordnance Reserve Corps, Watertown Arsenal.
Luehrmann, Hugh, Second Lieutenant, Signal Reserve Corps, U. S. School for Military Aeronautics, Cornell University, Ithaca, N. Y.
Lyon, Percy S., Captain, Coast Artillery Reserve Corps, Ft. Monroe, Va.
Lyster, Thomas L. B., Major, U. S. A., Air Service, American Expeditionary Forces, France.
Lytle, Charles W., Private, Aviation Section, Enlisted Reserve Corps.

McGrew, J. A., Major, Quartermaster Reserve Corps, Cantonment Constructing Department.
McKissick, Ellison S., First Lieutenant, Company F, 306th Engineers, U. S. R.
Marshall, Harold F., First Lieutenant, Aviation Section, Signal Officers' Reserve Corps, United States Army.
Metcalf, George R., First Lieutenant, Ordnance Officers' Reserve Corps, Fort Hancock, N. J.
Miltenberger, George K., First Lieutenant Engineers, United States Reserve, Company D, 314th Engineers, 89th Division, Camp Funston, Kan.
Mixter, George W., Major, Signal Corps, Equipment Division.
Monaghan, James F., Captain, Ordnance Officers' Reserve Corps, United States Army.
Morgan, John D., First Lieutenant, Engineer Officers' Reserve Corps.
Morris, Thomas B., First Lieutenant, Engineers, United States Reserve.
Murrie, John L., Lieutenant, United States Naval Reserve Force.

Neidig, W. N., First Lieutenant, Signal Corps, United States Reserve, Construction Division, Aviation Section.
Newcomb, Benjamin R., First Lieutenant, Ordnance Reserve Corps, United States Army.
Newcomb, Franklin L., First Lieutenant, Company C, 24th Regiment of Engineers, Engineers Reserve Corps.
Nielsen, Lawrence H., Naval Reserve Flying Corps.

Oberlin, E. G., Lieutenant Commander, United States Navy.
Obrison, Thomas E., First Lieutenant Engineers, U. S. R., 2nd Company, 2nd Engineers Officers' Training Camp, Fort Leavenworth, Kan.

Pancoast, Fred L., Captain, Ordnance Department, United States Reserve.
Parr, Harry L., Lieutenant, United States Naval Reserve Force.
Penney, Rupert L., Captain, Ordnance Officers' Reserve Corps.
Perry, E. D., First Lieutenant, Equipment Division, Purchasing Section, Ordnance Corps.
Peters, H., Signal Corps, U. S. A., Inspection and Specifications Section.
Pope, Clarence James, First Lieutenant, Ordnance Department, U. S. R., Motor Section.
Pope, Frederick, Captain, 30th Engineers, Gas and Flame Division.

Reimer, A. A., Major, 305th Engineers, 80th Division.
Reitz, Walter R., First Lieutenant, Ordnance Department, U. S. A.
Rhame, Frank P., First Lieutenant, Ordnance Department, United States Reserve, Inspection Section.
Ripley, William H., First Lieutenant, Ordnance Department, United States Reserve.
Rittenour, Frederick H., Captain, Engineer Officers' Reserve Corps.
Rockwell, Sherburne B., Chief Petty Officer, U. S. Navy, on board U. S. S. Noma.
Roesen, Robert H., Sergeant, Company D, 302nd Engineers, National Army.
Rose, C. E., Captain, Engineer Officers' Reserve Corps.
Ross, Cleland Coldwell, First Lieutenant, Ordnance Reserve Corps, Fort Hancock, N. J.

Sampter, Herbert C., Aviation Section, Signal Corps, Enlisted Reserve, U. S. A.
Samson, Charles L., First Lieutenant, Engineer Officers' Reserve Corps.
Savage, L. L., Lieutenant, 309th Engineer Regiment, U. S. A.
Schmidt, Edward C., Major, Ordnance Reserve Corps, Carriage Division, Inspection Section.
Schwenker, Robert F., Second Lieutenant, Field Artillery, Officers' Reserve Corps, U. S. A.
Sedgwick, H. A., Prov. Lieutenant Commander, United States Naval Reserve Force.
Seed, Charles R., Ensign, United States Naval Reserve Force, U. S. S. Waukiva.
Segalowitz, Oscar, First Sergeant, Company D, 302nd Engineers.
Shea, Thomas F., First Class Private, Aviation Section S C.
Sheedy, M. M., Captain Engineers U. S. R., Company C, 21st Regiment Engineers (Light Railway).
Simmons, Harry M., Second Lieutenant, 6th Division Engineers, Field Train, U. S. A.
Smith, Robert W., Second Lieutenant, Engineer Officers' Reserve Corps, 106th Engineers.
Snavely, A. Bowman, Second Lieutenant, Coast Artillery, Officers Reserve Corps, Fort Dupont, Del.
Spaulding, H. C., Captain, U. S. R., Purchase Section, Gun Division, Ordnance Department.
Spencer, C. G., First Lieutenant, Aviation Section, Signal Officers' Reserve Corps.
Spencer, F. G., Captain, Ordnance Department, U. S. R.
Stem, Clifford H., Second Lieutenant, Engineers, U. S. R.
Stewart, Harry M., Sergeant Motor Truck 375, Motor Supply Train 409, Quartermasters' Corps, U. S. A.
Sticksel, C. P., First Lieutenant, Engineer Reserve Corps.
Stringham, Joseph S., Captain, Ordnance Department, Rock Island, Arsenal, Ill.
Swain, Philip W., Second Lieutenant, Field Artillery Reserve Corps, B Battery, 303rd Field Artillery.
Swetting, J. Rodney, Second Lieutenant, Engineer Officers' Reserve Corps.

Talbot, John Alden, Second Lieutenant, Field Artillery, United States Reserve.
Tangeman, W. W., Lieutenant, United States Army.
Terry, M. V., Captain, Engineer Officers' Reserve Corps.
Thomas, Felix, First Lieutenant, Motor Equipment Section, Ordnance Department, Carriage Division, U. S. R.
Thomas, Winthrop G., Corporal, Depot Company H, Signal Corps, United States Army.
Thompson, Paul W., First Lieutenant, Ordnance Department, Gun Division.
Tompkins, Harold D., Lieutenant, Company C, 104th Field Signal Battalion, Camp McClellan, Ala.
Turner, Channing, First Lieutenant, Field Artillery, Officers' Reserve Corps.
Tuska, Gustave R., Major, Engineer Officers' Reserve Corps.

Van Denburgh, O. A., Jr., Private, Enlisted Ordnance Corps, National Army.
Vinnedge, Earle W., Second Lieutenant, Engineers U. S. R., American Expeditionary Forces.

Wahl, James H., Lieutenant (Junior Grade), United States Naval Reserve Force.
Walker, L. E., First Lieutenant, Ordnance Department, Production Section, Carriage Division, U. S. R.
Wall, George L., Major, Ordnance Reserve Corps.
Walsh, Walter V., Aviation Section, Signal Corps, U. S. Army.
Waters, Everett O., Second Lieutenant, Ordnance Section, Officers' Reserve Corps.
Wells, A. E., Major, 121st Infantry, U. S. A.
Whyte, Jessel S., Captain, Company F, 310th Engineers, United States Army.
Williams, H. E., Captain, Field Artillery, Officers' Reserve Corps.
Williams, Harold J., First Lieutenant, Ordnance Department, United States Reserve, Carriage Division, Field Artillery Section.
Williams, Samuel S., Aviation Section, Signal Reserve Corps.
Woodcock, William E., Second Lieutenant, Engineers, United States Reserve.
Woodward, Hiram W., Second Lieutenant, 106th Engineers, U. S. R.
Woolson, Clifford G., Captain, Company A, 104th Engineers, S. E. Department, 29th Division, United States Army.
Wright, Stanley, Second Lieutenant, 314th Engineers, Camp Funston, Kan.

Young, John P., Fifth Company, Coast Artillery Corps, U. S. A., Fort Hancock, N. J.

NECROLOGY

E. W. GRIEVES

E. W. Grieves was born in Delaware in 1843 and attended the public schools in that state. He spent a four years' apprenticeship at woodworking, and then served several years as a patternmaker on ship and car work and as a designer and constructor of cars.

He became the chief draftsman and assistant superintendent of the shops of the Harlan & Hollingsworth Co. Later he was associated with the Baltimore and Ohio Railroad as master car builder. At the time of his death he held the position of mechanical expert with the Galena Signal Oil Co., Franklin, Pa.

Mr. Grieves became a member of the Society in 1891. He died in February 1917.

E. W. GRIEVES

CHARLES E. NEWTON

Charles E. Newton was born in Hartford, Conn., in 1858. He was educated in the public schools of that city, leaving high school to enter the employ of the Jewell Belting Co. in Hartford as office boy, where his ability speedily won him promotion. He became salesman for the company and was on the road for a number of years, where he had more than usual success.

In 1892 Mr. Newton was elected secretary of the company, and later became assistant manager. His responsibilities increased with time, and in August 1917 he became president of the company.

Mr. Newton became an Associate of the Society in 1895. He died on November 15, 1917.

HENRY RUTGERS FORD

Henry R. Ford was born on January 30, 1871, in Lawrenceville, Pa. He was educated in Binghamton, N. Y., attending both the grammar and high schools of that city. Later he took the engineering course at Pratt Institute, Brooklyn.

After serving his apprenticeship as electric wireman and as machinist, he obtained a position with the Edison Electric Illuminating Co., New York City, as wireman. In 1893 he was employed by the F. P. Little Company, Buffalo, N. Y., in the capacity of wireman and machinist, later becoming foreman and superintendent. In 1898 Mr. Ford became associated with the firm of McCarthy Bros. & Ford, giving special attention to designing, general engineering and contract work. Throughout Buffalo and its vicinity he designed and installed many steam- and gas-power and lighting plants.

He became a member of the Society in 1914. He died on October 31, 1917.

JOSEPH REID

Joseph Reid was born on November 11, 1843, in Maybole, Ayrshire, Scotland, where he attended the public schools until his eleventh year. He then was apprenticed by his father to learn the joiners' trade, at which he worked for four years. Later he became a machinist in the railroad shops of the Glasgow and Southwestern Railroad Co., Kilmarnock, Scotland.

In 1863 Mr. Reid located in Montreal, Canada, where he worked for a short time as machinist, after which he followed his trade in the United States, and was for some years connected with the

JOSEPH REID

HENRY R. FORD

Baldwin Locomotive Works in Philadelphia. In 1876 he entered the service of the Atlantic and Great Western Railroad Co., now the Erie Railroad, at Meadville, Pa.

In the following year Mr. Reid went to Oil City, where he worked with W. J. Innis & Co. and also with the firm of Malcomson & Patterson. When the latter firm failed in business, he bought their shop and started a small business of his own. In addition to general jobbing work, he made a specialty of refinery supplies. The opening of the Lima, Ohio, oil fields found the refiners unable to take care of the grade of oil produced in that field. The oil, how-

ever, could be used as fuel, and after careful experiment Mr. Reid designed, patented and manufactured a line of oil burners which were very successful and to handle which in 1885 he formed the Reid Burner Co.

As the result of extensive experiment, Mr. Reid brought out in 1894 what is believed to have been the first practical natural-gas engine, and by 1899 had made many improvements in it. The small repair shop became a large factory and the Joseph Reid Gas Engine Co. was organized with Mr. Reid as president. Mr. Reid assisted also in organizing the Frick-Reid Supply Co., a large oil concern in the West, and was vice-president and director of this company. He was also president of the Reid Land & Development Co., which operates fruit ranches in the West.

Mr. Reid became a member of the Society in 1904. He died on October 23, 1917.

ROWLAND SPENCER BROTHERHOOD

Rowland S. Brotherhood was born in September 1875 in Charleston, S. C. He was educated at the Patric Military Institute, Anderson, S. C.

His apprenticeship was spent with the Betts Machine Co., Wilmington, Del., where he gained his experience in machine-tool designing. In 1902 he accepted a position with the Bethlehem Steel Tool Co., South Bethlehm, Pa., in hydraulic-press and machine-tool designing and on general mill work in charge of the manufacturing drawing office. In 1903 he resigned from this position to become associated with the Portland Iron & Steel Co., South Portland, Me., in general engineering and construction work during the erection of the plant. In 1904 he became connected with the Standard Horse Shoe Co., South Watertown, Mass., as a designer of horse-shoe bending and swedging machines. Later in the same year he took charge of the Brotherhood Railway Supply Co., and the following year accepted a position with the Cambria Steel Co., Johnstown, Pa., in the drafting department on boiler, engine, marine and locomotive work and designing special machinery.

In 1907 Mr. Brotherhood became connected with the Remington Arms-Union Metallic Cartridge Co., Bridgeport, Conn. His position was in the equipment department, where he designed automatic machinery and was assistant to the chief equipment engineer. After five years he resigned to accept a position with the International Silver Co., Bridgeport, superintending the changing of the entire plant over from steam to electric drive, the installation of a new electric-lighting system and the erection of a new building. From April 1913 until the time of his death Mr. Brotherhood's work dealt with the general mechanical, electrical and efficiency engineering of the company.

Mr. Brotherhood became a member of the Society in 1916. He was the secretary of the Meriden branch of the Connecticut Section. He died on October 13, 1917.

CANDIDATES FOR MEMBERSHIP

TO BE VOTED ON AFTER FEBRUARY 10

A TOTAL of 157 new applications for membership in the Society are published in the first list of the new year. This makes 1766 new applications since January 1, 1917. The total membership of the Society is now upward of 8500.

Below is the list of candidates who have filed applications since the date of the last issue of The Journal. These are classified according to the grades for which their ages qualify them, and not with regard to professional qualifications, i.e., the ages of those under the first heading place them under either Member, Associate or Associate-Member, those in the next class under Associate or Associate-Member, those in the third class under Associate-Member or Junior, and those in the fourth under Junior grade only. Applications for change of grading are also posted.

The Membership Committee, and in turn the Council, urge the members to scrutinize this list with care and advise the Secretary promptly of any objections to the candidates posted. All correspondence in this regard is strictly confidential. Unless objection is made to any of the candidates by February 10, and providing satisfactory replies have been received from the required number of references, they will be balloted upon by the Council. Those elected will be notified about March 15.

NOTE. The Council desires to impress upon applicants for membership that under the present national conditions the procedure of election of members may be slower than under normal conditions.

NEW APPLICATIONS

FOR CONSIDERATION AS MEMBER, ASSOCIATE OR ASSOCIATE-MEMBER

California

ELLINGWOOD, E. L., Consulting Mechanical Engineer, National Bank Building, Los Angeles

HALLORAN, Ralph A., Gas Engineer, Standard Oil Co. of California Whittier

RINGE, William H., Pacific Coast Manager, Shepard Electric Crane & Hoist Co., of Montour Falls, N. Y., San Francisco

WHATLEY, Arthur C., Mechanical Engineer, Interstate Commerce Commission, San Francisco

Connecticut

BAYRER, L. Garfield, Production Superintendent, Billings & Spencer Co., Hartford

DEE, William V., Secretary, G. Drouve Co., Bridgeport

GLEDHILL, Ernest, Foreman Department Metals, The Remington Arms U. M. C. Co., Inc., Bridgeport

STANLEY, John C., President and General Manager, American & Bristol Manufacturing Co., Bridgeport

District of Columbia

GROVE, William G., Aeronautical Engineer, Balloon Section, Air Division, Signal Corps, U. S. Army, Washington

Florida

AHERN, J. F., Manager, Fairbanks-Morse & Co., Jacksonville

Idaho

GOUGH, Achilles C., Professor Industrial Arts and Engineering, Idaho Technical Institute, Pocatello

Illinois

BUTCHER, Ira A., General Superintendent, A. W. Stoolman, Champaign

DUDLEY, Edward F., Mechanical Engineer and Designer, Miehle Printing Press & Manufacturing Co., Chicago

GRIFFIN, Lorne A., Vice-President, American Steam Conveyor Corporation, Chicago

LEVY, Lehman, Mechanical Engineer, Wilson & Co., Chicago

LIBBY, Edwin S., Assistant Professor Experimental Engineering, Armour Institute of Technology, Chicago

WOODMAN, Andrew W., President, The Joliet Bridge & Iron Co., Chicago

Indiana

KJELDGAARD, Niels C. S., Engineer, Burnoil Engine Co., South Bend

MAYO, Edward H., Consulting Engineer, Fletcher Trust Building, Indianapolis

Iowa

HENNESSY, William J., Inspector of Engines and Boilers, Emergency Fleet Corporation, U. S. Shipping Board, Burlington

Kansas

PHELPS, Barton P., Engineer Shop Extensions, Santa Fé Railway System, Topeka

Maryland

DANA, William J., Instructor in Mechanical Engineering, Johns Hopkins University, Baltimore

WILKINSON, Turner A., Sales Manager, Erie City Iron Works, Baltimore

Massachusetts

BRADY, John J., Sales Agent, Boston Office, Heine Safety Boiler Co., Boston

DANA, Clarence A., Chief Draftsman, Lowell Division, Saco-Lowell Shops, Lowell

DERBYSHIRE, FREDERICK W., Manufacturer of Watch Tools, F. W. Derbyshire, Waltham
INGHAM, IRVING L., Chief Inspector, Gilbert & Barker Manufacturing Co., West Springfield
POLLOCK, ROBERT T., President, Robert T. Pollock Co., Boston

Michigan

CLUNE, JOSEPH P., Manager, Soda Ash Department, Solvay Process Co., Detroit
COLE, ROY E., Chief Engineer, Liberty Motor Car Co., Detroit
FIGEE, J. HENDRIK, Engineer, Steere Engineering Co., Detroit
HAZLEY, JOSEPH H., Sales Engineer, Wilmarth & Morman Co., Grand Rapids
WERNICKE, OTTO H. L., President, Wernicke Hatcher Pump Co., Grand Rapids

Minnesota

ROWLEY, FRANK B., Assistant Professor Experimental Engineering, University of Minnesota, Minneapolis

Missouri

DUFFY, RALPH E., Engineer, Public Service Commission of Missouri, Jefferson City
HEDRICK, EARLE R., Professor of Mathematics, The University of Missouri, Columbia
HOFF, JOHN A., Consulting Engineer, Anheuser-Busch Brewing Association, St. Louis

Nebraska

MITCHELL, WILLIAM A., Assistant Chief Engineer, The Great Western Sugar Co., Scottsbluff
SEATON, LAURENCE F., Professor of Mechanical Engineering, University of Nebraska, Lincoln

Nevada

MUNROE, HAROLD S., General Superintendent, Consolidated Coppermines Co., Kimberly

New Jersey

BEAVERS, GEORGE, JR., Works Manager, American Standard Metal Products Corporation, Paulsboro
COEY, STEWART C., Works Superintendent, The Celluloid Co., Newark
PALM, ROBERT, Chief Engineer, Chrome Steel Works, Chrome

New York

ABRAMS, JACK, Jack Abrams & Bro., Inc., Plumbing & Heating Contractors, New York
BETHELL, JAMES G., Patent Attorney, New York
BRIGHTMAN, HENRY M., General Manager, Interests of J. H. Flagler, New York
DAVIS, FRANCIS G., Master Mechanic, American Brass Co., Buffalo
DOWD, ALBERT A., Consulting Engineer, Russo-Baltic Car Works New York
DUNLAP, JOHN R., Editor and Publisher, *Industrial Management*, New York
ESHELMAN, CLARENCE M., Service Engineer, Cameron Machine Co., Brooklyn
FARNHAM, BION B., Superintendent Farnham Mfg. Co., Buffalo
FASTING, SVERRE, Contracting Engineer, Shepard Electric Crane & Hoist Co., Montour Falls
FRASER, JOHN, Consulting Engineer, New York
FULLER, FREDERICK M., Assistant Chief Engineer, Ice Machine Division, De La Vergne Machine Co., New York
GIRTANNER, ALEXANDER, Vice-President, American Steam Conveyor Corporation, New York
GRADY, JAMES J., President and Treasurer, Freeman & Grady, Inc., New York
GUNDLACH, CARL E., Chief Engineer, George Schautz Engineering Co., Inc., Buffalo
LEUDEMANN, JOHN, Chief Engineer and Superintendent, International Exhibit Building, New York
LIPETZ, ALPHONS I., Chief, Locomotive Department, Russian Mission of Ways of Communication, New York
McMILLAN, CHARLES E., Consulting and Inspection, Brazil Railway, New York
MEAGHER, FRANCIS J., Sales Engineer, W. F. Davis Machine Tool Co., New York
MOSCHETTI, RICHARD L., Mechanical Draftsman, Public Works Department, Navy Yard, New York
OHNSTRAND, ENOCH, Chief Engineer of Construction, Library Bureau, Ilion
PLAIN, MORSE D., Power Engineer, Syracuse Lighting Co., Syracuse
ROBBINS, GERALD G., Chief Draftsman, Shepard Electric Crane & Hoist Co., Montour Falls
SCHWEIGERT, WILLIAM F., Traveler, Niagara Machine & Tool Works, Buffalo
SEAMAN, FRANK W., Chief Engineer, Edward R. Ladew Co., Glen Cove
SELDEN, WILLIAM H., Chief Estimator, American Car & Foundry Co., New York

Ohio

BJOERN-CALLESEN, WILLIAM, Chief Draftsman, Development Department, Firestone Tire & Rubber Co., Akron
DAVISON, CHARLES M., Assistant Engineer, The Edwards Manufacturing Co., Cincinnati
DYKSTRA, JOHN E., Superintendent, Foos Gas Engine Co., Springfield
EVANS, FREDERICK H., Dean, College of Industrial Science of Toledo University, Toledo
UNVERFERTH, CLARENCE B. D., Chief Draftsman and Surveyor, County Surveyor's Office, New Court House, Dayton

Oklahoma

LANEY, LEON K., with Jordan, Laney & Nickel, Bartlesville
PETERSON, FRANKLIN P., Petroleum (Gas) Engineer, Frank P. Peterson & Co., Tulsa

Pennsylvania

De LAPOTTERIE, Harry, Works Manager, Townsend Co., Vice-President Metal Patents Co., New Brighton
GUCKER, FRANK T., Secretary and Treasurer, The John T. Dyer Quarry Co., Philadelphia
JONES, ALFRED, Superintendent, Armstrong Cork Co., Linoleum Department, Lancaster
LEECH, EDWARD, Construction Engineer, Barrett Co., Frankford
McKENNA, ROY C., President, Vanadium-Alloys Steel Co., Latrobe
WASILKOWSKI, FELIX J., Mechanical Engineer, David Lupton Sons Co., Philadelphia
WERTHEIM, FERD E., Production Engineer, Bonney Vise & Tool Works, Inc., Allentown

Rhode Island

GUILLEMETTE, JOSEPH D., Assistant Engineer, Warren B. Lewis, Providence

Tennessee

BEUTNER, VICTOR, Consulting Engineer, Knoxville

Wisconsin

JOHNS, EDWARD F., Assistant Engineer, Bayley Manufacturing Co., Milwaukee

Canada

DENTON, LOUIS L., Light, Heat & Power Engineer, Canadian Explosives, Ltd., Montreal
McCOY, LLOYD, Engineer on Special Work, Canadian Car & Foundry Co., Montreal
WARK, THOMAS A., General Superintendent, St. Maurice Paper Co., Cap Madeleine, P. Q.

Philippine Islands

SUZARA, AUGUSTUS, Boiler Inspector, Bureau of Customs, Philippine Government, Manila

Russia

JANOUSHEVSKY, PAUL, Chief Engineer Motive Power, Vladicaucase Railway, Petrograd

FOR CONSIDERATION AS ASSOCIATE OR ASSOCIATE-MEMBER

California

FAKKEMA, R., Draftsman, Holt Manufacturing Co., Stockton

Connecticut

STUART, CHARLES J., Mechanical Engineer, Footwear Division, U. S. Rubber Co., Naugatuck

Massachusetts

COYLE, WILLIAM T., Secretary and Mechanical Engineer, Deane Machine Co., Fitchburg

New Jersey

COUCH, FREDERICK F., Assistant Professor Mechanical Engineering, Rutgers College, New Brunswick

New York

BUTLER, RICHARD E., Engineer, The Babcock & Wilcox Co., New York

North Carolina

HEISKANEN, JALMAR E., Mechanical Engineer, The Champion Fibre Co., Canton

Virginia

LANCE, CLARENCE C., Shop Engineer, Seaboard Air Line Railway Co., Portsmouth

Dominican Republic

TRUEBA-SUAREZ, BENIGNO, Contracting Engineer, Erecting Sugar Factory, Central Las Pajas, Macoriz Sugar Co., San Pedor de Macoriz

FOR CONSIDERATION AS ASSOCIATE-MEMBER OR JUNIOR

California

KNAUER, HENRY S., Assistant Engineer of Tests and Chief Draftsman, Southern Pacific Co., Los Angeles

Connecticut

HERRICK, EDSON P., Cost Accountant, Colt's Patent Fire Arms Mfg. Co., Hartford
MacBEAN, ROBERT A., Industrial Engineering Staff, Winchester Repeating Arms Co., New Haven

District of Columbia

YOUNG, ROSS H., Squad Chief, Mechanical Designer, Stone & Webster Co., Washington

Illinois

MEYER, LESLIE C., Mechanical Engineer W. A. Jones Foundry & Machine Co., Chicago

Iowa

WILDER, MORRIS B., Industrial Engineer, Sioux City Gas & Electric Co., Sioux City

Massachusetts

GABELER, William H., Assistant Superintendent, Barrett Co., Everett

HORTON, William G., Turbine Tester, General Electric Co., Lynn

KING, Harry H., Mechanical Engineer, Scovell, Wellington & Co., Boston

New Jersey

GREGG, Louis D., Vice-President, The Gregg Co., Ltd., Hackensack

New York

BEVIN, Victor D., Shop Superintendent, United Filters Corp., Brooklyn

EVERITT, Commercial Engineering Department, New York Telephone Co., New York

JAMISON, George S., Engineer, Underwriters' Bureau of the Middle & Southern States, New York

Pennsylvania

TADDIKEN, Ulrich A., Engineer, Condenser Department, Westinghouse Electric & Manufacturing Co., Pittsburgh

ZIMMERMAN, James J., Inspector and Expeditor, Engineering Equipment, Mechanical Engineering Dept., Cambria Steel Co., Johnstown

Texas

MURPHY, Eugene A., Instructor Technical Courses, U. S. Signal Corps, Ground Officers Training School, San Antonio

FOR CONSIDERATION AS JUNIOR

Alabama

MILLER, Lewis H., Mechanical Engineer, The Tennessee Coal Iron & R. R. Co., Birmingham

MULLER, Jacob F., Jr., Assistant Secretary, Assistant Treasurer, United Gas & Electric Engineering Corporation, Birmingham

California

KARSTENSEN, Alvin M., Tool, Die and Machine Designer, Bethlehem Shipbuilding Corporation, San Francisco

Colorado

HARRISON, Horace L., Draftsman, Dorr Co., Denver

LUNDQUIST, Joseph M., Assistant Chief Engineer, River Smelting & Refining Co., Florence

Connecticut

JONES, Vincent L., Assistant Engineer, New York, New Haven & Hartford R. R. Co., Cos Cob

TAFT, Edgar W., Statistical Engineer, Winchester Repeating Arms Co., New Haven

WARNER, Ralph M., 1st Lieutenant Ord. Department, U. S. R., Union Metallic Cartridge Co., Bridgeport

Delaware

HOMEWOOD, George M., Junior Mechanical Engineer, E. I. du Pont de Nemours & Co., Wilmington

District of Columbia

McCREA, Charles L., Ensign, U. S. N. R. F., Bureau of Ordnance, Navy Department, Washington

SANDMANN, William F., Aeronautical Mechanical Engineer, Signal Service at Large, Washington

Illinois

KAHN, I. F., Assistant, Turbine Department, General Electric Co., Chicago

REED, Melbourne O., Junior Engineer, Cooley & Marvin Co., Chicago

Indiana

CROOK, William R., Chief Designer & Superintendent of Factory Building, Aerothrust Engine Co., La Porte

Kansas

ROBERT, Jules H., Instructor, Department of Applied Mechanics and Machine Design, Kansas State Agricultural College, Manhattan

Maine

CHADBOURNE, John L., with Portable Steam Saw Mill, North Berwick

New Jersey

ANTOSCH, Walter, Engineer, Standard Aero Corporation, Elizabeth

BARRY, John L., Jr., Engineer, Standard Aero Corporation, Elizabeth

COLDWELL, Clarence B., Sales Engineer, Voorhees Rubber Manufacturing Co., Jersey City

SMITH, Harry R., Testing Engineer, Hyatt Roller Bearing Co., Newark

THIERINGER, Herman, Production Department, Babcock & Wilcox Co., Bayonne

New York

BROWNELL, Frederick J., Mechanical Designer, Western Electric Co., New York

BUCHHAGEN, Walter H., Experimental Engineer, J. P. Devine Co., Buffalo

EPPS, Frank A., Chief Mechanical Engineer, Foamite Fire Extinguisher Co., New York

HEIDE, George F., Field Engineer, Construction Div., Interboro Rapid Transit Co., New York

HOLDEN, Edward A., Assistant Engineer and Draftsman, The Engineer Co., New York

LANDT, James L., Assistant to Mechanical Engineer, Semet-Solvay Co., Syracuse

LAUTZ, Edward G., Mechanical Engineer, Assistant to the President, Niagara Machine & Tools Works, Buffalo

LOCKE, Charles A., Head of Mechanical and Electrical Detailing, E. F. Terry Manufacturing Co., New York

MERRILL, S. Clifford, 2nd Lieutenant, Ordnance Reserve Corps, U. S. R., c/o National Envelope Co., New York

PARKER, Karr, Chief Engineer, McCarthy Bros. & Ford, Buffalo

PRIDDY, Benjamin E., Assistant Service Manager, Cameron Machine Co., Brooklyn

SILBER, Alfred A., Draftsman, Perin & Marshall, New York

WEISS, Paul A. H., Assistant Engineer, Central Hudson Gas & Electric Co., Poughkeepsie

Ohio

PARKER, George C., Assistant Chief Draftsman, Cincinnati Ball Crank Co., Cincinnati

SINNIGE, Carl E., Engineer, Plant Engrg. Dept., The Lodge & Shipley Machine Tool Co., Cincinnati

Pennsylvania

BLUM, Mayer I., Mechanical Draftsman, Stone & Webster Engineering Corporation, Philadelphia

JENSEN, James A., Mechanical Engineer, Quaker City Iron Works, Philadelphia

SHUTT, James M., Designing Draftsman, Arthur Brock, Jr., Philadelphia

Rhode Island

OWEN, Richard L., Draftsman, Brown & Sharpe Manufacturing Co., Providence

South Carolina

SLOAN, Pearson H., Mill Engineer, J. E. Sarrine Co., Greenville

Virginia

THEE, Walter C., 2nd Lieutenant, Coast Artillery Corps, U. S. A., Fortress Monroe

China

HARKNESS, Harold W., Professor, Shantung Christian University, Shantung

Japan

NEDDERMANN, Theodore J., Mechanical Engineer, Messrs. Sale & Frazar, Tokyo

APPLICATIONS FOR CHANGE OF GRADING

PROMOTION FROM ASSOCIATE

Wyoming

GRATIOT, James T., Manager, Coliseum Garage Co., Casper

PROMOTION FROM ASSOCIATE-MEMBER

Alabama

ROUSSEAU, Edwin H., Chief Engineer, Engineering Department, Birmingham Machine & Foundry Co., Birmingham

Massachusetts

STALEY, Allen C., Research Engineer, Stanley Motor Carriage Co., Newton

Ohio

HILMER, Otto E., Engineer, Walter G. Franz, Construction Engineer., Cincinnati

PROMOTION FROM JUNIOR

New York

KENT, Herbert S., Chief Draftsman, West India Management & Consultation Co., New York

OATMAN, Paul B., Mechanical Engineer, Modern Tool Co., New York

TYLER, Hazen G., Assistant Professor of Mechanical Engineering, New York University, New York

Ohio

EINIG, Alvin B., Machine Tool Salesman, Motch & Merryweather Machinery Co., Cleveland

SANDERSON, O. W., Director of Labor, The B. F. Goodrich Co., Akron

Pennsylvania

YODER, Jacob H., Supervisor of Apprentices, Penn. R. R., Lines East of Pittsburgh, Altoona

SUMMARY

New applications	157
Applications for change of grading:	
Promotion from Associate	1
Promotion from Associate-Member	3
Promotion from Junior	6
Total	167

EMPLOYMENT BULLETIN

THE SECRETARY considers it a special obligation and pleasant duty to make the office of the Society the medium for assisting members to secure positions, by putting them in touch with special opportunities for which their training and experience qualify them, and for helping anyone desiring engineering services. The Society acts only as a clearing house in these matters.

In forwarding applications, stamps should be enclosed for transmittal to advertisers; applications of non members should be accompanied by a letter of reference or introduction from a member, such reference letter to be filed with the Society.

GOVERNMENT REQUESTS

The Society has been asked to make suggestions of men for the following positions with the Government. Non-members possessing the necessary qualifications may avail themselves of these notices by enclosing with their reply a personal introduction to the Secretary.

STAFF OF FIFTY MEN for the equipment division of Signal Corps, in connection with contracts for motors and airplanes, to handle detail work of passing on material and labor costs and quantity of both material and labor entering into work. Must have good general education and sound judgment, technical, manufacturing and accounting experience, with personal qualities which will command confidence and respect; must be capable of taking general charge of work and acting as chief of Section when latter is absent. Approximately three men will be stationed at each factory who will report to Finance Department in Washington. Best man of each group will be commissioned and given charge of special work at each point. 2475(a).

TRAVELING LABOR INVESTIGATOR, analyst of labor costs and conditions to improve and unify labor problem among contractors. May be commissioned. 2475(b).

TRAVELING MATERIAL INVESTIGATOR, to help in reducing waste of material and capable of readily locating and pointing out excessive costs. May be commissioned. 2475(c).

SPECIAL TOOL AND FIXTURE INVESTIGATOR, to travel between plants and assist in saving expense by unification of tool, jig and fixture work, capable of assisting contractors to find outside capacity where necessary due to lack of capacity in their own plants, and capable of passing upon cost of work, for Finance Department. Will probably be commissioned. 2475(d).

THREE ASSISTANTS in main office at Washington, who will be commissioned and assume charge of intelligent compilation of reports sent in by field force. 2475(e).

It is desired to have all of the men recruited for this work above the conscription age, to insure the permanence of the organization.

DRAFTSMEN on heating and plumbing, to go to France. 2476.

1. LABORATORY INVESTIGATION and testing of airplane instruments. 2477.

2. MECHANICIAN on same. 2477.

3 RESEARCH ENGINEER in physics. 2477

DRAFTSMEN DETAILERS on ordnance. 2507.

HIGH GRADE MECHANICAL ENGINEER experienced in freight handling and conveying work, design and building local ports for munitions. Major's Commission. In U. S. 2527

CIVIL ENGINEER, designer of buildings and docks. Major's Commission. In U. S. 2528.

EXPERIENCED CONSTRUCTION MEN, power houses and coaling facilities. Major's Commission. In U. S. 2529.

POWER HOUSE DESIGN AND CONSTRUCTION MEN. Captain's commission Later appointment of one man in charge of completed ports. In U. S. 2530.

STATISTICAL ENGINEER AND ACCOUNTANT; as chief statistical and estimator for construction work in U. S. 2531.

POSITIONS AVAILABLE

PHYSICISTS, ENGINEERS, DESIGNERS AND DRAFTSMEN for work of research, development, and design related to problems of telephonic, telegraphic and radio communication which are matters of public importance, required by the Western Electric Company, Inc. Both temporary and permanent positions open. Apply by letter, not in person unless so specifically requested, to F. B. Jewett, Chief Engineer, 463 West Street, New York City. 2178-AA.

TECHNICAL GRADUATE having three or four years' practical experience in efficient operation of boilers and stokers wanted for position of traveling engineer. Exceptional opportunity for man with initiative and ability to become expert combustion and steam engineer. Work requires extensive traveling in connection with investigation of power plants throughout country. 2340-AA.

YOUNG ENGINEER to take up safety work in connection with plant in New England and to take general charge of building inspection. 2438 (a) AA.

CHIEF CHEMIST in connection with investigation work involved in manufacture of product. 2438 (b)-AA.

MECHANICAL SUPERINTENDENT. Must be competent to handle and direct construction, installation and maintenance of buildings, machinery and equipment, also power-plant operation. Jurisdiction will cover several plants. Only high-calibered men need apply. Outline fully past experience, age, salary, credentials. 2440-AA.

OPERATING ENGINEER for industrial plant. Must be technical graduate, have had practical operating experience in power plants and be capable of handling power proposition involving approximately 5000 boiler h.p. State age, experience in detail and salary expected. Location vicinity of Chicago. 2445-AA.

MECHANICAL ENGINEERS for permanent positions with established firm of consulting engineers. Young men, not liable to early army-draft call preferred, but age not necessarily deciding factor. No special technical experience necessary, but must have good technical education upon which to build. Good opportunity for men now in other lines, who wish to enter consulting field. Reply in own handwriting, stating education, experience, age, weight, height, nationality, and salary expected at start. Location New York City. 2446-AA.

ENGINEER AND DRAFTSMAN familiar with power-plant work and general piping. Good future for young man interested in general steam engineering in large manufacturing plant. Stage age, experience and salary expected. Location Philadelphia. 2448-AA.

EXECUTIVE POSITION in purchasing department of firm manufacturing tires and sundries. Location New England. 2457-AA.

EXPERIENCED DESIGNER on small machinery and tool work, with small and growing concern building machinery for canning industry. Location Maryland. 2458-AA.

YOUNG MECHANICAL ENGINEER who has not yet passed beyond the point of doing installation work of light machinery, and who may wish to develop in salesmanship. Location New York. 2461-AA.

PRODUCTION ENGINEER with practical experience in manufacturing line. Prefer man familiar with brass-foundry practice. as well as small parts for automobile manufacture. Location New Jersey. 2463-AA.

YOUNG ENGINEER for testing. State experience, references, and salary wanted. Location Pennsylvania. 2467-AA.

YOUNG GRADUATE in mechanical or electrical engineering for drafting and estimating work in connection with blast furnaces and mines. Location East Tennessee. 2468-AA.

ENGINEER WORKS MANAGER, experienced man in shop principles and management, good executive and capable handler of men. Location West Virginia. 2470 (a)-AA.

SUPERINTENDENT assistant to above, practical shop man. 2470 (b)-AA.

ASSISTANT MECHANICAL ENGINEER, to pass on mechanical features of design, as strength of bases, shafts, sizes of bearings for particular duty and similar questions. Location New Jersey. 2471-AA.

ENGINEER, experienced in steam-power-station design, operation and efficiency. Location New York City. 2472-AA.

ENGINEER, experienced in power-station construction, must be familiar with modern steam-power-station construction and operation. Location Ohio. 2473-AA.

GAS ENGINEER, experienced in small municipal gas plants, on construction, operation, and efficiency. Must be familiar with standard practice and system ordinarily in use. Location New York and Ohio, part time in each place. 2474-AA.

COLLEGE GRADUATES, ENGINEERS. Men out at least a year for general shop-engineering work with growing concern. Work leads to industrial management. State full particulars. 2478-AA.

MECHANICAL ENGINEER, technical graduate, one who has had experience in stoker business preferred and experienced in answering technical correspondence. Good opportunity for right man. Location Chicago. 2479-AA.

YOUNG A-1 TIME-STUDY MEN, connected directly with general manager's office, large rubber plant; only high-grade men with strong sense of proportion and natural ability need apply. Salary commensurate with achievement. Location Ohio. 2480-AA.

CHIEF DRAFTSMAN, qualified to handle position in connection with aeroplane designing, working under chief engineer. Location Cleveland. 2482 (a)-AA.

A-1 TOOL AND FIXTURE DESIGNERS. Location Cleveland. 2482 (b)-AA.

DRAFTSMEN to lay out and arrange equipment to get both efficient utilization of floor space and economical plant operation, have sufficient electrical knowledge to make drawings of electric light and power systems required by electricians. Only reliable, experienced, persons wanted. Excellent opportunity for advancement with possibility of being placed in charge of entire drafting room. Plant manufactures nitric, sulphuric and muriatic acids, barium products, aniline dyes, dry colors, printing and lithographic inks and supplies, paints and varnishes. Salary to start $1200. Location Ohio. 2487-AA.

CHIEF ENGINEER versed in refrigeration and producer-gas engines. Salary $2400 to $3000 a year. Location 50 miles from Baltimore. 2488 (a)-AA.

EXPERIENCED DESIGNER familiar with automatic machinery, adding machines, etc., must be capable of developing complete design from freehand sketches. Permanent position open with concern at present doing important government work. Salary to start $40 to $50. Location New York City. 2491-AA.

SWITCHBOARD OPERATORS who have had experience in large stations, preferably young men with good education who can quality for responsible positions in this line of work. Location Ohio. 2492 (b)-AA.

ENGINEERING EDITOR to take responsible charge of monthly periodical in automotive-engineering field. Should have broad engineering training. Man with experience on high-class technical periodical preferred. State salary, education and experience, and enclose samples (which will be returned) of technical articles written or prepared for publication. Location New York City. 2493-AA.

GRADUATE ENGINEER capable of learning part of business for large industrial company, with view to taking charge of department. Previous experience unnecessary, but ability and energy essential. Location New Jersey. 2495-AA.

ASSISTANT MANAGER for engineering department of Brooklyn concern. Man best fitted for position would be one having experience along general metal-manufacturing lines, especially machine-shop and sheet-metal-stamping work. American citizen only considered. Duties are to have active charge of making up plans and estimates for new work. 2496-AA.

SUPERINTENDENT for road-making-machinery plant, consisting of machine and erecting shops, boiler and forge shops, foundry and wood working shop. Want man who has made good in similar position, of real executive ability, organizer and one who can handle men with the necessary push to drive job along. Salary to start $2500. Location New York State. 2497-AA.

STEEL SALESMAN not subject to military draft wanted by old-established steel house for permanent position. Give experience and full details in first letter. Location New York City. 2499-AA.

PRACTICAL MAN to take charge of laboratory. Should possess qualifications of engineer of tests as well as being practical man to handle foundry problems. Location Illinois. 2500-AA.

DRAFTSMEN familiar with designing and detailing machinery for economical production of farming machinery, automobiles, and pumps. Experience on cotton-gin and oil-mill machinery desirable but not essential. Must have some knowledge of shop and foundry practice. Salary depends on man. Location Georgia. 2503-AA.

ASSISTANT SUPERINTENDENT for shop making hydraulic forgings for 6, 8 and 9½-in. howitzer shells. Must be hustler and have practical experience along mechanical lines and ability to handle men. Need not be experienced forge man. Compensation dependent upon ability. Location Middle West. 2509-AA.

MAN for boiler-room-efficiency work, where principal duties will be to make flue gas analyses, get coal and ash samples, inspect equipment, and observe all boiler-room operations, with view to making improvements Previous experience not required. Salary $90 to $100, with good opportunity for energetic man. Location Ohio. 2510-AA.

SALES ENGINEER OR MACHINERY SALESMAN with good technical training, able to develop sales end of business in American machinery in France, with headquarters in Paris. Knowledge of French preferred, but not necessary. Man of 30 to 45 preferred. Must have actual sales experience, preferably in following lines: machine tools, power-plant and electric equipment, including oil engines, road-making machinery, and mining machinery. Location New York City. 2511-AA.

MANUFACTURER of engineering specialties, large eastern firm, long established, desires young man not under 30, with technical education, good personality, and initiative. Knowledge of heating, ventilation, and power-plant engineering and installation practice essential. Excellent opportunity provided for development and promotion for right man. In letter give full particulars and experience and salary expected. Location New Jersey. 2512-AA.

HIGH-CLASS ENGINEER, with engineering, as well as executive ability, to take charge of engineering department. Man capable of looking after generation of power, particularly, but who will also have charge of plant maintenance, construction of new building, and, in general, supervision of machine departments. Location Ohio. 2513-AA.

EXPERIENCED MAN to take full charge of production problems of Connecticut concern; young man who has qualifications essential to handling problems of production with success. 2515-AA.

ASSISTANT SUPERINTENDENT for factory manufacturing fire-extinguisher equipment. Organization employing both men and women. Man slightly over draft age with several years' practical experience. Technical training preferred. Headquarters New York. Salary depends on man. 2516-AA.

INSPECTOR for factory manufacturing small brass parts. Man over draft age, capable of taking charge of department. Salary to start $30. Location New York City. 2519-AA.

DRAFTSMAN for work on wide range of designing machinery for roofing manufacture, conveying, foundations and plant layout. Location New Jersey. 2504-AA.

DRAFTSMAN, mechanical and electrical experience, and familiar with conveying machinery or designing of similar type of machinery. Location New York City. 2518-AA.

MEN AVAILABLE

MECHANICAL ENGINEER or SUPERINTENDENT. American with 14 years' practical and theoretical experience. Specialist in steam, air, gas, oil and water-engineering specialties. Machines, tools, fixtures and shop equipment, shop maintenance, efficiency, engineering testing and production engineer. Executive who can go into shop and do things. Successfully held positions involving above. At present employed. Salary $3000. A-1.

CONSTRUCTION SUPERINTENDENT. American, age 30. Technical-school graduate. In charge of large plant construction for last eight years, responsible for labor, ordering of materials, quality and progress of work. Desires responsible position with growing manufacturing company. A-2.

EXECUTIVE MECHANICAL ENGINEER, master mechanic, construction superintendent or chief draftsman. Member, technical graduate, married, aged 39, with several years' high-grade commercial experience and sixteen years' varied engineering experience in design construction and operation of manufacturing properties. Broad experience on material handling and power-transmission machinery, shop layouts, equipment and operation, with considerable experience in their construction. Can design, supervise, install, organize and produce in field of ordinary metal manufacturing, comprising pattern, foundry, forge, structural and machine-shop departments. Broad technical knowledge, energetic and industrious, executive and administrative ability. Available immediately. About $4000. Correspondence solicited. A-3.

PURCHASING ENGINEER OR EXECUTIVE. Graduate mechanical engineer, 30, married, clean cut, aggressive, and with capacity for work. Has moved up to position of purchasing engineer and general-office executive with young company doing million-dollar business. Wishes change in position, Michigan preferred. A-4.

ORDNANCE ENGINEER. Member with broad experience in design, construction and testing of machine, automatic, semi-automatic and rapid-fire guns, mounts, and ammunition of all kinds. A-5.

MECHANICAL ENGINEER, Columbia graduate, 1912, desires position as assistant to executive or consulting engineer. Broad general engineering experience, including industrial-plant layouts, machine design, inspection, construction, etc. Salary $1800. A-6.

MECHANICAL ENGINEER OR ASSISTANT TO EXECUTIVE. Member, 39, Cornell graduate, with advanced engineering degrees. Fifteen years' experience in estimating, designing, construction, development of processes, operations and office work, also considerable knowledge of munitions. Would like to change position and secure permanency if possible with some firm now engaged in war work. A-7.

CHIEF DRAFTSMAN OR ASSOCIATE CHIEF ENGINEER. Associate member, 28. Employed as chief draftsman of tube company. Desires change offering larger possibilities with future. Experienced in mechanical and structural engineering, also efficiency engineer, designing, estimating and erection. Complete tube plants, rod, wire, billet, skelp, rail and steel mills. Acid and zinc plants,

by product coke-oven plant. Steel mill buildings and bridge design. Best references, desires permanent position. Salary to start $200. A-8.

SUPERINTENDENT. Member, graduate, mechanical, 1904, large western university engineering school. Fifteen years' practical experience along mechanical lines, machine-shop practice, pattern making, foundry practical and efficient production methods. Thoroughly familiar with Taylor system of organization and bonus or piece-rate system of labor rates. Would invest. Location Chicago. A-9.

EXECUTIVE, assistant to executive or mechanical engineer. Cornell graduate, 36, 12 years' experience in positions covering chief executive, office management and works manager, operation, construction and experimental work. Experienced in combustion, steam and gas power, gas manufacture. At present employed. A-10.

MECHANICAL ENGINEER, technical graduate, desires position as assistant engineer or chief draftsman of machine company. At present employed as designer, estimator, and testing engineer. Experience includes testing, machine and structural design, office engineering, machine-shop and steel-foundry practice. Location Middle of Far West preferred. A-11.

CONSTRUCTION ENGINEER OR WORKS ENGINEER, member, technical graduate, 36. Fourteen years' experience, in charge of engineering department and assistant to construction engineer. Is thoroughly experienced in designing of blooming, billet, rod and strip mills, merchant mills, etc., also complete wire-mill plants. At present employed. A-12.

FRANCE, sales, investigational or executive services offered by American graduate, M.E., 37, formerly resident in France and speaking the language fluently, at present earning about $4000; but seeking position with better future prospects. Machine and erecting-shop, drafting and designing-room, as well as executive and sales experience in both building and mechanical fields. French and American references. A-13.

MECHANICAL ENGINEER, 33, 11 years' estimating, designing and shop experience on boilers, superheaters, stokers and oil burners; also with heating, ventilating and air conditioning, desires position as chief draftsman or assistant to chief engineer or manager of progressive concern, where conditions allow development of ability. Location New York or Brooklyn preferred. A-14.

MECHANICAL ENGINEER with 15 years' experience in the design of power plants, industrial plants, heating, ventilation, etc. Has had charge of men and shown executive ability. At present holds responsible position but has very little work to do. Willing to consider responsible and permanent position only. A-15.

ASSISTANT TO SUPERINTENDENT OR PLANT ENGINEER. Cornell graduate, American, 35, with 13 years' experience in engineering department of both manufacturing and metallurgical plants, desires position with prospects of permanency and advancement. A-16.

MECHANICAL ENGINEER, member, 39, American, 22 years' experience on automatic machinery, automatic press tools and deep drawing-press work, 12 years' experience in Connecticut brass shops. Shall soon finish seven year contract with present employers. Can design, supervise, organize or install new work as mentioned above. A-17.

MECHANICAL ENGINEER, associate member, 15 years' experience in consulting, designing, machine-shop, laboratory work, superintending coistruction and with general high-grade mechanical engineering experience desires position where economical developing ability of patents and research work is required. Prefer Middle West, South West or West. A-18.

DIESEL ENGINE EXPERT desires to communicate with some concern, having the capital and willing to go into development of Diesel-engine business. Advertiser, now employed, has had broad engineering experience and knowledge of how to obtain real efficiency. Communications to be confidential. A-19.

ENGINEER AND SUPERINTENDENT. Successful in manufacture of high-explosive shells and tools for machining, nosing and finishing shells. Will consider any proposition along these lines for patriotic and personal reasons. A-20.

HEATING AND VENTILATING ENGINEER, M.E. graduate, American, 36, married. Seven years' experience in heating and ventilating engineering, both design and construction, experience in refrigeration and other lines of engineering. Sober, energetic and ambitious. Has reached limit of advancement with present employers. Prefers position in charge of work as assistant to chief engineer. Salary $3000 to $3500. Available February 1, 1918. A-21.

CHIEF ENGINEER OR MECHANICAL SUPERINTENDENT under 40, with technical education and sixteen years' experience in design, construction, and equipment of industrial buildings and power plants, now with large corporation, desires connection where organization and executive ability combined with engineering experience will command fair salary. A-22.

MECHANICAL ENGINEER, Columbia graduate, 1902. Has served in railroad-motive-power department for number of years. Desires position as mechanical engineer or engineer of tests on railroad or in a line of business related to railroading. At present employed. Salary expected, $3000. A-23.

YOUNG MECHANICAL ENGINEER desires position as assistant general superintendent, production manager or superintendent of equipment of large plant or general manager of small plant. Has successfully held above positions and also worked in machine shop and drafting room. Capable executive, thoroughly practical, aggressive and of generous build. Has specialized on production work, having full charge of designing and building equipment to produce wide range of articles of wire, sheet metal, wood, paper, etc., also designed and installed equipment for processing, assembling, conveying and labor saving. Understands cost accounting, estimating, rate setting, time study and routing; 28 years old, with family. Exempt under federal draft. At present employed. Salary $3500 to $4000. Any location, prefer concern one of whose lines, at least, is of vital importance to Government at this time. A-24.

MANUFACTURING OR MECHANICAL EXECUTIVE. Age 44, at present holding position as superintendent. Desires to locate in Bridgeport, Conn. Experienced in machine shop practice, and in manufacture of hardware, guns and ammunition. A-25.

TECHNICAL GRADUATE in mechanical engineering, 33, married, experience in factory planning and construction, design of special equipment, power-plant installation and maintenance, as well as organization and management, desires to make connection in executive capacity with progressive industrial enterprise. Location immaterial. Complete record with references available. Minimum salary considered $3600. A-26.

MANUFACTURING EXECUTIVE, 33, married. Thorough mechanical and modern management experience in manufacturing of small machines and sheet-metal goods. Fifteen years' experience from apprentice, through tool-making, designing, foremanship, to position of management engineer with leading company for past 4 years. Practical, progressive, originating, and clean cut. Interested only in permanent position with greater opportunites with reliable company located in good home town. A-27.

EXECUTIVE OR ASSISTANT SUPERINTENDENT. Technical education, American, 36. Practical mechanic, familiar with design of special machinery, tools, jigs, fixtures, etc., for manufacturing duplicate parts on interchangeable system. Twelve years in drafting room, including chief draftsman; six years' shop experience, one as foreman. Salary $2000. Location preferred, Eastern States. A-28.

CHIEF ENGINEER OR MASTER MECHANIC, with thorough technical and practical experience, covering construction, operation and upkeep of steel plant, specialty metallurgical work, heating and melting furnaces. A-29.

SAFETY ENGINEER, six years' thorough technical and practical experience in this capacity, with large steel works in Pennsylvania. A-30.

METALLURGIST AND TESTING ENGINEER. Graduate mechanical engineer, 33, married, wishes to connect with reliable concern, whose product requires careful and thorough testing nid heat-treating of steels. Interested only in permanent position with good prospects. Seven years' experience in steel research work and heat-treating, successful in handling men. At present employed. A-31.

WORKS MANAGER OR GENERAL SUPERINTENDENT, desires connection with large plant, any product from automobiles to clocks; broad-gage, fully-trained executive; 36; experienced in plant layout, best shop practice, management control methods, systems and man training; successful in all jobs through production, design and control divisions; man whose vision is equal to possibilities of business and accustomed to make plans become facts. A-32.

YOUNG MAN of proven ability, 9 years' practical experience in consulting engineering, contracting, sales engineering and technical editorial field. Specialist in mechanical and electrical equipments for power plants and buildings. Maintenance supervision, investigation, design and layout. A-33.

SUPERINTENDENT, MECHANICAL ENGINEER, or MECHANICAL DRAFTSMAN. Experienced in plant layout detail work, small machine design, rolling-mill machinery, installation of machinery and high-tension electric service, motors, generators, transformers, etc. Executive ability, can handle men. Machine shop practice and well experienced in furnace construction, annealing and melting type. Consider any position of technical nature. Graduate of Manual Training School and University in Mechanical Engineering, eight-year course. A-34.

ENGINEERING SURVEY

A Review of Engineering Progress and Attainment in Mechanical Engineering and Related Fields, Including a Digest of Current Technical Periodicals and Selected Titles of Engineering Articles

War Service Boards

THE mobilization of the industries of the United States for war purposes—The War Service Conference—was brought about by the Chamber of Commerce of the United States at a meeting of the business men from all over the country held in Washington today. Addresses were made by W. S. Gifford, director of the Council of National Defense; Daniel Willard, chairman of the War Industries Board; Harry A. Garfield, Fuel Administrator; Geo. N. Peek, industrial representative of the War Industries Board, and others.

"It is not going to be any light task," Mr. Gifford said, "to completely organize industry in this country, but we think we are going to do it effectively, so that we may go ahead and have these new war-service committees of the Chamber tell the Government what can and what should be done. It is obvious that some industries are going to be more essential than others, but it would be foolhardy to think that the time will not come when the so-called less essential industries may not be needed."

Mr. Gifford spoke of the question of possible Government recognition of the War Service Committee.

"This is a Democratic formation of committees by the industries and not by the Government," he said.

A. C. Bedford, president of the Standard Oil Company, who has been chairman of the Council of National Defense Committee on Oil and Petroleum Products, told the committeemen of some of the difficulties his committee had experienced in endeavoring to aid in organizing the war.

"Nevertheless," he said, "we have not failed to supply any order which has been given to us either by our own or any foreign government."

Mr. Willard discussed the industrial end of the war. After saying that legislation by Congress will be necessary before the country can have a plan of one centralized control of purchasing, such as the British Ministry of Munitions, Mr. Willard said that because a ministry of munitions had been established in England, it does not follow that such a plan would be successful here. (*Journal of Commerce and Commercial Bulletin*, December 13, 1917, p. 3)

4500-Ton Concrete Ship for U. S.

Working in conjunction with the Bureau of Standards, the United States Shipping Board has decided to start the construction of a concrete ship. A representative of the bureau returned today from San Francisco and reported favorably on a concrete vessel of 4500 tons which had been built there. The experiment by the Shipping Board will probably be begun shortly in one of the Southern yards, most likely in Georgia.

Announcement was also made by the board today that a Boston concern would build a concrete vessel of 3500 tons at its own expense, which would be turned over to the Shipping Board. If satisfactory, this firm will be awarded a contract for twenty more ships of the same size and type. This vessel will be constructed in a yard nearby that where the Shipping Board will try its experiment.

Hope is held out that the concrete ships which will soon be laid down will prove practicable, as the material involved is not required for any other section of the war program, and could be obtained without difficulty. Only a small amount of steel is needed for concrete ships, which have another advantage in that they can be speedily constructed. The time for completing a concrete hull is estimated at sixty days at the most. The vessels are expected to be capable of a speed of ten knots or greater.

Secretary Redfield today requested the Shipping Board to coöperate so far as possible with the Bureau of Standards. An inspector will probably be appointed for the Pacific Coast, and also for the South, with this idea in view. The Shipping Board may make an appropriation specifically for this work. (*Journal of Commerce and Commercial Bulletin*, December 13, 1917, p. 5)

Naval Vessels in Commission

At the beginning of the fiscal year 1917, the monthly expenditures for all naval purposes were about \$8,000,000; they are now about \$60,000,000. On January 1, 1917, there were 300 naval vessels of all kinds in commission; today there are many more than a thousand. These typical figures sufficiently indicate the task the navy has had to accomplish to date in the way of expansion.

There was embarrassment in the early days of the war by reason of the patriotic and eager response of the young men of the country to the navy's efforts in recruiting. These were so successful that it was difficult with the then facilities to take care of the flood of volunteers. There were also various threats of epidemics of the diseases that appear when unseasoned men are suddenly assembled in large numbers. These, however, were stamped out, and facilities either completed or to be ready before winter are now adequate for the needs of the present navy personnel. If required, these can be enlarged even more rapidly after the experience now had. (*The Official Bulletin*, December 11, 1917, p. 10)

Concrete Craft May Operate on Canals

The *Barge Canal Bulletin* for November, which makes a rather belated appearance, contains a hint that concrete craft may be seen on the canals during the coming summer. A review of the situation reads in part:

"During the intervening winter, if sufficient energy is exerted, the new craft for this traffic may be built and the old boats be made more suitable, but there must be no delay in beginning. It may happen, also, that the season will witness an innovation in the kind of boat. Many studies in boat building have been made recently by various engineers and naval architects, and the vessel constructed of reinforced concrete has not been overlooked. This type has the advantage of quick construction, and of being composed of materials which can be obtained easily and without interfering greatly with ordinary war supplies." (*Journal of Commerce and Commercial Bulletin*, December 15, 1917, p. 16)

Change in Airplane Program

Recent rumors that the Liberty airplane engine had proved a failure are emphatically denied in official quarters in Washington. Unofficially, *The Iron Age* learns, however, that a decision has been reached to limit the use of the Liberty motor to scout duty and the time-tried French motors will be used on the battle airplanes used by the United States Government. In various ways the airplane plans of France and the United States appear to have been consolidated. " The French-American airplane program " is a phrase that is now frequently used in Washington.

The decision to use the Liberty motor for scout duty only is believed to have followed the criticism of French airplane experts that the United States in putting all its faith in the one motor was placing its eggs in one basket, and that if, under actual fighting conditions, the Liberty motor did not measure fully up to expectations, there would be nothing to fall back upon. The motors which the French and English have used most successfully in battle are the Renault, Gnome, Hispano-Suiza and the Rolls-Royce. It is now apparent that this Government will build a certain number of each of these motors in the United States. Contracts have recently been placed with American manufacturers for Renault and Hispano-Suiza motors and other contracts are pending. In addition, this Government will provide additional equipment for the French automobile plants which are making airplane engines and will also supply several thousand mechanics, who are now being recruited. The original program was to build only 5000 Liberty motors in France, but latest information is to be the effect that the United States will assist the French in building a large number of French and English engines as well.

An important step in the airplane program was the taking over by the Aircraft Production Board of the plant and equipment of the General Vehicle Co., Long Island City, N. Y., at a price said to have been fixed at $2,500,000. The General Vehicle Co. has been figuring for some time on a large contract for the manufacture of Gnome motors and had issued a list of about 900 machine tools to be purchased. The plant will probably be used by the Aircraft Production Board for experiments in airplane engine construction. (*The Iron Age*, vol. 100, no. 22, November 29, 1917, p. 1331)

National Advisory Committee for Aeronautics

The last annual report of the Executive Committee of the National Advisory Committee for Aeronautics gives many interesting data on the activities of the Committee during the fiscal year 1916-1917. Naturally, some of the activities can be mentioned in only a summary manner, but the report, nevertheless, first shows that a large volume of important work has been performed.

In March 1917 the committee arranged, in conjunction with the National Research Council for representation on the Foreign Committee sent abroad by the National Research Council, to obtain detailed information on scientific matters of importance in connection with the war. Dr. Joseph S. Ames was appointed as such representative.

In October 1916 the committee took under consideration the question of the selection of a suitable site for its proposed experimental laboratory. In this study the committee acted in coöperation with a board of officers of the U. S. Army which had been appointed to inspect sites for the experimental station and proving ground of the War Department.

At the suggestion of the War Department requesting recommendation by the Advisory Committee in the matter, this committee inspected several proposed sites, and after making inquiries as to the general health conditions and the problems of accessibility to Washington and the larger industrial centers of the East, protection from enemy naval attack, climatic conditions, and cost of the site, it made recommendation to the War Department for the purchase of a site about four miles north of Hampton, Va., which recommendation was accepted by the War Department, and the site was purchased.

On this field the War Department has allotted to the committee a space suited to the erection of the committee's proposed research laboratories. The committee has designed the first building of the group contemplated, and the design has been approved by the architects for the War Department. Contract has been entered into with the J. G. White Engineering Corporation, New York City, for the erection of the laboratory at an estimated cost of $80,900. The laboratory building is now in the course of construction. At this laboratory the committee will carry on, in wide variety, research and investigation relating to aeronautic science, and including a study of planes in free flight. The committee has also under preparation plans for the first aerodynamic laboratory to be installed at Langley Field intended for the development of high wind speeds. The work on this laboratory will be begun as plans are ready.

The committee has coöperated with the Aircraft Production Board in connection with a wide variety of problems relating to the design, specifications, and tests of aircraft. The committee has now in hand (November 1917) a most important investigation on the use of steel for airplane construction, and is supervising the development of a design for construction in steel, to be later subject to a program of tests intended to show the possibilities of such type of construction.

In connection with the subject of the materials for airplane construction, the committee has given its attention chiefly to the investigation of strut forms for airplanes, the strength of spruce spars, and the development of cotton airplane fabrics as a substitute for Irish linen.

In the field of power-plant design and construction for aircraft, the committee has coöperated with the Bureau of Standards in the design, construction, equipment and operation of a large vacuum-chamber, engine-testing laboratory which is intended to reproduce the conditions of aeronautic engines operating at high altitudes. This equipment has been installed with special reference to the development and improvement of the Liberty engine and important investigations bearing on this problem are now being carried forward. The committee has also carried on a number of researches on the subject of radiator design and proportions, carburetor design and adjustment, ignition apparatus, and is continuing its study of the problem of an airplane engine muffler.

At the request of the War Department, the committee loaned one of the members of its technical staff for the supervision of tests on the first Liberty engines at Detroit, Pike's Peak, and elsewhere, to determine their mechanical and thermal efficiency and the power delivery of the engines at various altitudes.

The committee has undertaken important investigations relating to the development of various instruments used in the navigation of aircraft and in testing aircraft in free flight. In particular there has been developed an improved form of geographic position indicator which will be of special value in connection with certain free-flight tests under consideration.

Regarding the subject of aircraft communications, the committee has coöperated in the development of a generator for wireless sending from airplanes and intended to satisfy the requirements of the army and navy. Means for receiving wireless signals in an airplane have also been investigated, and it has been established that a very efficient receiving set employing the sound method is practicable; investigations are still being carried on regarding means for detecting hostile airplanes before they are visible or before they can be heard by the unaided ear.

On March 8, 1917, the committee took under consideration the development of methods for mapping from airplanes which should be rapid, economical and sufficiently accurate for aviation purposes. Allotments were made for developing a new type of airplane mapping camera, and gratifying progress has been made in the development of such an instrument. Before regular navigation of the air can be undertaken, it will be necessary to supply maps and to establish and suitably mark aerial routes and suitable landing places for the aviator. In certain sections of the country and through the generous coöperation of patriotic citizens interested in this work, gratifying progress has been made in these directions, notably between Dayton, Ohio, and Rantoul, Ill.

Soon after the declaration of hostilities with Germany, the Chief Signal Officer called to the attention of the committee the large amount of material which was coming before the War Department, comprising inventions and suggestions relating to aeronautics in warfare, and asked assistance in examining and disposing of such material. Accordingly, this committee, through an appropriate sub-committee appointed for the purpose, has acted as a board of inventions for the Government in matters relating to aeronautics, and since the outbreak of hostilities between the United States and Germany it has weekly examined hundreds of suggestions and inventions pertaining to this subject, and referred to it by the War and Navy Departments, in addition to the suggestions and inventions which come direct to the committee. This work has required a large amount of time and careful study, and has called for considerable increase in the technical and clerical staff of the committee in order to care for the very large amount of examinations, study, and correspondence with inventors regarding these matters. Several suggestions of value have been received and brought promptly to the attention of the particular Government office that was most directly interested.

During the year the committee has given further attention to the subject of the definition and standardization of technical terms used in aeronautics, and has prepared a further edition of its bulletin on the subject (Technical Report No. 15).

On recommendation of the Advisory Committee, in December 1916, the War, Treasury, Interior and Commerce Departments adopted the metric system of weights and measures for all drawings and calculations on aeronautical matters, for use with the accompanying English equivalents.

The committee has made progress during the year in the study and investigation of the following problems:

Stability as determined by mathematical investigation
Air speed meters
Wind sections
Aeronautical-engine design
Radiator design
Air-propeller design and efficiency
Forms of airplane
Radiotelegraphy
Non-corrosive materials
Flat and cambered surfaces
Terminal connections
Characteristics of constructive materials
Standardization of specifications for materials.

First Machine-Made Liberty Engine

The first machine-made Liberty airplane engine was completed on Thanksgiving Day and a substantial number will be delivered this month. Production of Liberty airplane engines on a quantity basis has actually begun, while at the same time aviators are being graduated in large numbers from training schools here to immediately travel to the fighting lines in Europe. It may be authoritatively stated that the United States is within sight of realization of the great air-fleet project mapped out since the date this country entered the war.

Figures cannot be published for obvious reasons, but it became known in Washington, following the return of members of the Aircraft Board from an inspection trip through the country, that these members are certain that another 60 days will witness men and machines being turned out at a rate insuring success to the original plans. Numerous tests have been made for power, gasoline consumption and for breakdown, and these have proven the engines to be even more powerful and efficient than was originally claimed for them. (*Automotive Industries*, vol. 37, no. 24, December 13, 1917, p. 1064).

Exchange of Technical Information with the Allies

There has been a particularly frank and free interchange of naval and technical information between the countries with which we are allied and ourselves which has been of great value in view of actual war experiences abroad. Not only as to broad policies, but also with respect to details of construction and tactics we are in close touch. The "partnership of democratic nations" has thus already proved its efficacy in the conduct of naval war.

While the details of what have been done, and how we have done it, must wait until it is permissible to spread them upon public record, this summary may be given to our people: In the navy we have prepared for and have met the duties of the present; we are preparing for and are confident we will be able to meet any call for greater duties, for more exacting responsibilities. The best way to secure enduring peace is to prepare unceasingly, night and day, for the winning of the war. (From the annual report of the Secretary of the Navy, see *The Official Bulletin*, December 11, 1917, p. 11)

Burn More Wood, Save Coal, Fuel Administration Urges

The Fuel Administration issues the following:

"The United States Fuel Administration, in coöperation with the Department of Agriculture, has inaugurated an intensive campaign for the substitution of wood for coal. The action is taken as a means of conserving the coal supply.

"In this connection it is announced that the Department of Agriculture will provide the services of expert foresters, who will supervise cutting of wood so that no damage may be done to growing timber, and that the largest use may be obtained of the supply of wood.

"One cord of hardwood is equal to a ton of coal, according

to the experts of the Fuel Administration. The Department of Agriculture and the Fuel Administration have statistics showing that there is a vast quantity of dead wood in many sections of the country, and that the supply in many communities is sufficient for domestic purposes. This wood, in many instances, is destroyed as waste." (*Official Bulletin*, November 30, 1917, p. 5)

Enlistment of Students in the Technical Schools

The Provost Marshal General has sent the following telegram to the governors of all states:

"Section 151, Selective Service Regulations is amended by the addition of sub-paragraph D as follows:

"Under such regulations as the Chief of Engineers may prescribe, a proportion of the students, as named by the school faculty, pursuing an engineering course in one of the approved technical engineering schools listed in the War Department, may enlist in the Enlisted Reserve Corps of the Engineer Department, and thereafter, upon presentation by the registrant to his local board of a certificate of enlistment, such certificate shall be filed with the questionnaire, and the registrant shall be placed in Class 5 on the ground that he is in the military service of the United States." (*Official Bulletin*, December 11, 1917, p. 4)

U. S. BUREAU OF STANDARDS

In the investigation of building stones of the United States now being conducted at the Bureau of Standards, the tests of sandstones have been completed and work begun on the Indiana limestones with a view to grading as to quality and use. The special experimental freezing apparatus for testing the stone has been installed and is now ready to put into operation.

Stresses on Floors. Investigation is being made of working stresses and loads on floors built under the regulations of the Baltimore Code as compared with floors built under Government regulations. Preparations have been completed for the testing of three floors for the Bureau of Yards and Docks, Navy Department. These tests are to be made on concrete floors in warehouses located at New London, Conn., Charleston, S. C., and Hampton Roads, Va. It is anticipated that these tests will be made within the next few weeks. The results will afford an excellent opportunity for the investigation of flat-slab floor design, as the floors in question are designed by three different systems to carry the same live load.

Cement Testing. The amount of cement testing done by the Bureau of Standards has increased 800 per cent during the past month over the corresponding period twelve months ago.

Steel Wheels for Motor Trucks. A number of truck wheels were tested for the War Department, covering different makes of wheels. The wheels were submitted in pairs, each including a front and a rear wheel. The testing was done in a large 3,200,000-lb. Emery testing machine.

Test of Stop Watches. The Bureau has carried out tests on 1200 stop watches to determine their accuracy with a view to acceptance on contracts. Runs of 30 sec., 1 min., and 5 min. were made on each watch and a tolerance of 0.4 sec. was allowed. Only 10 per cent of the watches failed to pass the test, some for defective mechanism and the majority for exceeding the tolerance.

Investigation on Cloth Tapes. A comparative test of sample cloth tapes was made to determine which would be most suitable for use in rough measurements such as the measurement of hulls of vessels of the Steamboat Inspection Service. This test included determination of the errors of the tapes; the change in length with tension; the recovery of length after tension had been applied; the effect of moisture on the tapes in their original condition when new, and the effect upon these factors of wear upon the tape. To ascertain the latter, the tapes were run by means of a motor and idler pulley over a series of obstructions covered with sandpaper that removed part of the coating in a manner similar to what would take place in use. One of the tapes was a so-called metallic tape having several threads of metal tinsel running lengthwise of the tape. The other was a linen tape without such threads. The latter tape showed greater changes in the first part of the test and its surface was worn off more in the latter part of the test, resulting in greater exposure to the efforts of moisture and consequent shrinkage of the tape.

Instruments and Methods. A new profile device is being constructed from two discarded theodolites and a "last-word indicator," and will give errors in profiles without computation, thus making a great saving in time. Another important feature is the method of adjusting profiles, which separates the adjustments necessary for proper alignment to two definite motions.

Short-Weight Mine Scales. Note may be made of the successful conclusion of cases against mining companies in Maryland, inaugurated by the Grand Jury of Allegheny County, as a result of disclosures made by the Bureau after a test of nine scales in this region. One company was fined $900 and costs. Sentence was withheld in another case until the conclusion of negotiations between the miners and the company regarding the payment of back wages which have accumulated as a result of short weighing of coal mined.

Infra-Red Spectroscopy. During November the work on infra-red photography was continued. Data were collected which will enable the absorption lines in the solar spectrum to be classified as solar or terrestrial. The latter are due to the selective absorption of the earth's atmosphere. The spectra of iron and cobalt have been extended well beyond 10,000 Angstrom units or 1 μ, and the nickel spectrum has been photographed to 9700 A. The measurements of iron and cobalt spectra have been collected and the data are ready for publication. A preliminary report on the solar work has been sent to press and will shortly be available. An important development of this work is its application to military photography.

Engineering Research. A large number of engineering problems are being investigated by the Bureau, among which some typical examples may be cited: design of airplane thrust and torque dynamometer, investigation of aluminum struts, magneto couplings, arc-welded sheets for lifeboat construction, design of instrument for measuring tension in airplane cables, machine-tool investigation, investigation of structural columns, and many other problems of military importance where the subjects are of confidential character.

NEWS OF OTHER SOCIETIES

Society of Naval Architects and Marine Engineers

LOYAL support of the Government in the present crisis was pledged by the Society of Naval Architects and Marine Engineers at its annual meeting held in New York, November 15 and 16, and at the same time in a petition to the President of the United States an earnest plea was made for the appointment of a representative builder of merchant vessels as a member of the Council of National Defense, where other important industries engaged in war work are now represented.

Throughout the meetings, and at the annual banquet which followed and was addressed by the Secretary of the Navy, the general manager of the United States Shipping Board Emergency Fleet Corporation and representative shipbuilders, the difficulties which shipbuilders are now facing, arising from the shortage of labor, labor troubles and the urgent need of increased production, were constantly referred to. Two of the papers presented at the technical meetings dealt with various phases of the labor problem. The first described the service department which has recently been established at the Fore River shipyard, and which has proved so successful that the underlying principles on which it is based are now being extended to all shipyards of the country through the Industrial Service Department of the Emergency Fleet Corporation. The other paper, by Naval Constructor T. G. Roberts, U. S. N., analyzed the principles of industrial management, especially as applied to the organization of a shipyard. Still another phase of the labor question as applied to the manning of the emergency fleet was discussed in a paper on the Progress of Marine Engineering and the Education of Marine Engineers.

The effect of the war on ship design and construction was reflected in at least three papers. The first described the method of building fabricated ships, as developed by the Chester Shipbuilding Company, Ltd., and the Merchant Shipbuilding Corporation. The second gave the results of tests at the Government experimental tank in Washington on models of cargo ships with lines of simple form, where the ordinary ship sections are replaced by straight-line sections with rounded bilges. The results of these experiments led the author, Naval Constructor William McIntee, U. S. N., to the conclusion that cargo vessels can be built on simplified lines which will give practically as good results from the resistance standpoint as those built on the present conventional lines. If propulsive efficiency is also taken into account, it is believed that the simplified form will have, at least in certain cases, advantages over the present type. The third paper, by Robert W. Morrell, hull superintendent of the Standard Oil Company of New Jersey, outlined recent developments in tank-steamer construction, showing that the total tonnage of American tankers now in service represents about 20 per cent of the total American steel-vessel tonnage, exclusive of that on the Great Lakes, as against 10 per cent at the beginning of 1915. Previous to 1915, the average size of the modern tanker was 5200 tons, while at present it has increased to 9100 tons. Along with the increased size has come the development of the shelter-deck type of vessel, and a growing tendency to adopt a straight sheer line amidships. Special constructional features which have recently been developed are the adoption of the rolled tee-bar section for oiltight work and the use of the multiple punch. In closing, Mr. Morrell points out that as all of the tank vessels now under construction are for 1917-1918 delivery, and as the Shipping Board has failed to provide for any tank-steamer construction in its shipbuilding program, the building of tank ships will soon be at a standstill in this country, in spite of the fact that the transportation of oil is one of the greatest necessities in the war.

The submarine question was taken up in two papers, one by Naval Constructor E. S. Land, U. S. N., which discussed the relative advantages and disadvantages of single- and double-hull types of submarines, and the other by Marley F. Hay, which outlined the influence of the war on submarine policy and advocated a new type of submarine, designated as a contra-submarine, especially designed for offensive warfare against submarines.

Several papers dealt with various auxiliaries on board ship, one by Dr. K. Suyehiro of Japan, describing an ingenious device for comparing the rotation of shafts; another by H. L. Hibbard, reviewing the applications of electricity to various auxiliaries on shipboard, and a third by Elmer A. Sperry, giving the results of the application of gyro stabilizers on board ship for the prevention of rolling. Valuable data were also given by W. W. Smith in a paper on Wind and Fouling Resistance on the Naval Collier *Neptune,* as determined both by model experiments in the Washington wind tunnel and from the service performance of the vessel, and by Messrs. A. G. Mattsson and Thomas Durkin, in a paper giving power and economy tests of one of the most efficient ore carriers on the Great Lakes.

H. H. Brown.

National Machine Tool Builders' Association

The Annual Meeting of the National Machine Tool Builders' Association was held at the Hotel Astor in New York on October 30-31.

The Machine Tool Builders' Association, composed, as it is, of the owners and the executive heads of machine-tool-building concerns, generally devotes its time more to the commercial than to the engineering side of the business. The session was marked by a very keen interest in present conditions. President J. B. Doan set the keynote in calling attention to the very important part that the machine-tool builders now play in the necessities of the Government. Followed, as this was, by a talk by Mr. Henry Japp, C. B. E., Deputy Director General in U. S. for British Minister of Munitions, the members and guests were still more impressed with the obligations resting upon them in the present crisis.

In an executive session, Mr. George E. Merryweather talked in a very intimate manner, and impressed by citation of actually existing conditions the necessity incumbent upon the machine-tool builder to urge forward work in this industry.

While there is no doubt but that the membership in all cases have been feeling the responsibility that is upon them at this time, yet this meeting impressed upon them more than ever that the greatest possible efforts that they could make would be needed to help improve conditions. Guns and ammunition are needed, and in large quantity, but before they can be produced to the extent that they should be, machine tools of nearly all types are wanted to produce them, and, as one speaker expressed it, while there might be a change in conditions later, today the machine-tool industry is the one that the manufacturers of all types are looking to to get out their production.

It is inspiring and helpful to participate in such a meeting

as this was—to see the response of men to the call when the necessities are visualized to them relative to their own businesses, and they respond with the purpose of doing not their "bit," but their whole.

The keynote of service that President Hollis struck at the time of installation into office last year, permeates not only the general engineering branches, but every branch of the service with which engineers and their co-workers have to do, and the complete printed report of this meeting, when it appears, will be well worth careful reading by all.

At the business meeting, J. B. Doan, of the American Tool Works Co., Cincinnati, was elected president.

W. A. VIALL.

Catalogue Studies

Through the courtesy of Mr. George Francis Whipple, the United Engineering Society Library has received a complete set of the Catalogue Studies compiled by him, together with a bookcase for the fifty-five volumes comprising the set at present.

This work represents an attempt on the part of some one hundred and fifty manufacturers of technical merchandise to make their catalogues more useful for reference purposes than such publications usually are. The machine catalogue of today is an expensive and valuable book, useful not only as a price list of the manufacturer's products, but also frequently as a manual of current practice, and for its tables of various constants, formulae, etc. Many catalogues are distinctly valuable as textbooks for educational purposes. Nowhere else are the latest approved methods so promptly available in print.

This material has, unfortunately, not been easily accessible in the past. This is partly due to the form in which it is published, partly to the difficulty of separating the useful material from that of little relevance, and partly to the lack of any key or index to that portion which is worth while.

To remove these difficulties has been the object of Mr. Whipple and the firms represented in this collection. The valuable catalogues issued by these firms have been selected and assembled in fifty-four binders of convenient sizes. An additional binder contains blueprints, charts, etc.

This Month's Abstracts

In the section Air Engineering a practical method is recommended for measuring air delivered by a turbo-blower; also the drop of pressure in compressed-air hose is discussed on the basis of tests carried out at the University of California.

An article on the hardening of aluminum bronze is indirectly abstracted from a German publication. It may be mentioned, in this connection, that with the exception of a few publications, mainly those concerned with aeronautics, marine engineering and internal-combustion engineering, there is at present no prohibition on the part of the German Government of the export of engineering publications. It has been stated, however, that the classes above referred to, as well as some of the medical and surgical periodicals, are not allowed to leave the country.

In the section Firing and Fuels is reproduced a chart prepared by Walter N. Polakov, Mem.Am.Soc.M.E., with which to make various records for coal.

Another article abstracted from *Power* deals with the control of smoking chimneys and describes a system of electric signaling by which an outside observer can call the attention of the firing squads to the fact that their stack is smoking. The subject of the flow in channels with large expansion ratio is abstracted in the section Hydraulics. The classification of this article is, however, somewhat uncertain, as it deals both with the flow of air and the flow of water.

In the section Machine Shop will be found brief answers given by various machine-tool builders showing their attitude toward motor drive. It is significant that the majority clearly recognize the value of motor drive, and that not a single company expresses its disapproval of this system.

A discussion of inspection of screw gages for munitions of war has been abstracted from a pamphlet published by H. J. Bingham-Powell, of the British Ministry of Munitions in the United States. We understand that this pamphlet is to be reprinted in part or in full in an early issue of the *American Machinist*.

In the same section attention is called to a brief list of specifications for munitions prepared by the Library of the Engineering Societies. While not claiming to be comprehensive, this list, it is believed, will prove of interest.

The refrigerator cars of the Baltimore & Ohio Railroad, described and illustrated in the section Railroad Engineering, are of interest in that the system of insulation is materially different from the usual practice. The bulkheads of the ice chambers are also made in a novel way.

In the same section, Railroad Engineering, an editorial has been abstracted from the *Railway Review* concerning standardization vs. improvement. The entrance of the United States into the war suddenly necessitating the production of vast quantities of direct and indirect war material largely in shops not designed to handle the particular class of material required, led the various boards to the adoption of a rather intensive system of standardization. This, in its turn, prompted an effort to extend standardization to fields where it was but sparingly known before. As shown by the editorial abstracted and by the account of the meeting of the Aeronautical Society of America, also in this issue, this tendency is beginning to meet opposition from various quarters. It may be of interest in this connection to recall that Sir David Henderson, formerly in charge of aircraft production in Great Britain, has also publicly cautioned this country against excessive standardization.

In the section Steam Engineering are two articles—one on nozzle characteristics and the other on purifying circulating water for surface condensers—which were indirectly abstracted from German publications.

Cleaning condenser tubes in place with hydrochloric acid, as practiced in South Africa, is described and illustrated. It appears that this method gives good results, but is rather expensive unless the acid can be secured at very low cost.

In the same section J. C. Hobbs, Mem.Am.Soc.M.E., describes a gas-fired boiler installation (from a paper before the Engineers' Society of Western Pennsylvania). This installation is of interest in many respects as several constructional difficulties had to be overcome. Among other things, it describes a horizontal-type baffle in the boilers, and a special gas burner permitting an absolute control of the relative quantities of gas and air.

Heat transfer from air to pipes forms the subject of an extensive discussion by Charles H. Herter before the American Society of Refrigerating Engineers. One of the conclusions arrived at by the writer is that, within certain limits of velocity of flow, the coefficient of heat transfer from air to pipe varies approximately as the two-thirds power of the velocity instead of as the square root of the velocity as has frequently been stated.

Friction of slime pulp in pipes is discussed by E. J. Laschinger in a paper before the South African Institution of Engineers and is abstracted in the section Varia.

REVIEW OF ENGINEERING PERIODICALS

For Articles on Subjects Relating to the War, see Aeronautics, Firing and Fuel, Munitions, Railroad Engineering, Varia.

Aeronautics

INTERNATIONAL AIRCRAFT STANDARDS. The following standards were recently adopted by the International Aircraft Standards Board:

Specification for Soft Solder. The specification determines the composition of the solder and, among other things, demands that it be made from new tin and commercially pure new lead.

Babbitt Metal for Bronze-Backed Bearings. The specification determines the composition of the material and the methods for taking a sample for analysis and of manufacture. No scrap is permitted to be used other than that produced in the manufacturers' own plants, and which is of the same composition as the material specified.

Seamless Brass Tubes. The specification determines the composition of the material, method of manufacture, physical properties and tests. It is stated that this tubing is resistant to the corrosive action of salt water, salt air and gases. As regards tests, the following are specified: flattening test, expanding test, and hydrostatic pressure test, in the latter case with a tensile stress of 7000 lb. per sq. in. in the tube, but in no case shall a test pressure of more than 1000 lb. per sq. in. be required. A table of tolerances of outside diameters and wall thicknesses is also given. Among other things, it is stated that when no length is specified, the tubes may be shipped in stack length of 10 ft. to 14 ft. When ordered in definite lengths, no length shall be less than that specified.

Phosphor-Bronze Castings for Bearings.

Cold-Rolled or Drawn Carbon-Steel Bars. A table is given showing the physical properties indicated by a tensile test; namely, minimum tensile strength, minimum yield point, minimum elongation in 2 in. or proportion gage length, and minimum reduction of area for bars under 0.75 in. diameter of width across the flats from 0.75 to 1.50 in. and over 1.50 in. The composition is indicated with maximum phosphorus 0.045 and maximum sulphur 0.050, except for electric- or crucible-furnace steel, where the maximum allowable percentage of phosphorus and sulphur may, at the option of the purchaser, be limited to 0.034 per cent.

ANVÄNDANDET AF LOGARITMISKA POLARKURVOR, VID BERÄKNING AF FLYGMASKINER, Henry Kjellson, *Teknisk Tidskrift*, Mekanik, 47 Arg., Häft 10, October 10, 1917, pp. 85-87, 3 figs. Application of logarithmic polar curves to calculations of heavier-than-air flying machines.

THE SOPWITH TRIPLANE. *Automotive Industries*, vol. 37, no. 24, December 13, 1917, p. 1044.

THE 160 HP. BENZ AND MERCEDES AIRCRAFT ENGINES COMPARED. *Aviation*, vol. 3, no. 9, December 1, 1917, pp. 610-615, 31 figs., 8 tables. Comparative data are given as to the general detailed dimensions, friction losses in engines, gas velocities, inertia forces, valve details, power curves, crankshaft dimensions, etc. Various parts of the two engines are illustrated side by side so as to show the respective constructions.

AIRSCREW ANALYSIS, A. F. Zahm. *Aviation*, vol. 3, no. 9, December 1, 1917, pp. 601-608, 15 figs. Aerodynamic analysis of the operation of an airscrew, followed by a stress analysis. Among other things, the writer shows a propeller computer which is a kind of slide rule by which the thrust efficiency and various intensive properties of a propeller blade can be quickly derived.

SOME NOTES OF THE AIRSCREW AND THE PROBLEM OF OPTIMUM DIAMETER, E. P. King. *Aeronautics*, vol. 13, no. 210 (new series), October 24, 1917, pp. 308-314, 6 figs. Discussion of a method of determining the best diameter for a propeller, such method to be employed in a particular case where restrictions as to engine power, speed and revolutions are completely defined. The writer attempts to reconcile the Newtonian method with the blade method and expresses the belief that there is no real discrepancy between the two methods, except in quantities utilized.

FRENCH AND BRITISH STATIONARY AERO ENGINES. *Flight*, no. 462 (no. 44, vol. 9), Nov. 1, 1917, pp. 1137-1139, 16 figs.

BIPLAN ALLEMAND BI-MOTEUR TRIPLACE FRIEDRICHSHAFEN, 450 HP., TYPE G H. *L'Aérophile*, 25 Annee, nos. 19-20, October 1-15, 1917. Description of a twin-engined three-passenger German biplane carrying 450 hp. in engines.

METAL IN AEROPLANE CONSTRUCTION, A. Pomilio. *Aerial Age Weekly*, vol. 6, no. 9, November 12, 1917, p. 378.

ECONOMY OF TIGHT AIR HOSE CONNECTIONS, Glenn B. Harris. *American Machinist*, vol. 47, no. 23, December 6, 1917, pp. 985-986. Points out the frequent occurrence of costly leaks in air lines and hose, and recommends a number of remedies to prevent the costly waste of power.

Air Engineering

MEASURING AIR DELIVERED BY A TURBO-BLOWER, Thomas G. Estep, Jr. In the measurement of air delivered by a turbo-blower to blast furnaces a new problem has been presented to engineers. It is very essential that the volume of air delivered to the furnace be known at all times, and it is even desirable that a continuous record of this quantity be obtained so that a comparative study of the furnace operation can be made.

The blower itself does not give any means of determining this quantity. On the other hand, as it produces a steady flow, any of the approved methods of measuring gases can be used, the only question being to select the most accurate and simple method. A pitot tube in the intake pipe suggests itself as a simple means of measurement, but before such an installation will give reasonably accurate results certain factors must be taken into consideration, such as the uniformity of the internal diameter of the intake pipe, the possibility of eddy currents in the pipe due to the presence of ring seams, and finally the possibility of the intake pipe being so short that the flow does not become uniform before being measured.

The writer recommends as the best solution a combination of a standard orifice and a pitot tube. The standard orifice may be placed in the end of the intake pipe directly under the

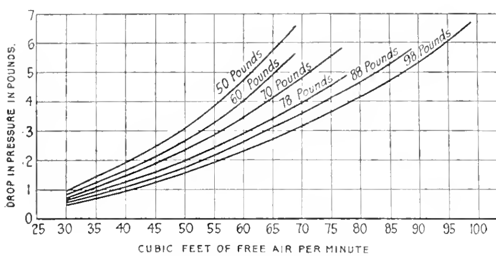


FIG. 1 DROP IN PRESSURE IN WOVEN HOSE AGAINST AIR DELIVERED AT DIFFERENT PRESSURES

hood, and the pitot tube used to measure the velocity of the air leaving the orifice.

With this arrangement practically no changes are required in the intake pipe. The hood may have to be raised a little in order to install a screen and give a free inlet to the orifice. Some tests made at the laboratories of the Carnegie Institute of Technology showed that if the hood was at least one-quarter the diameter of the pipe away from the orifice it would have no influence on the flow.

With the orifice at the end of the pipe the velocity of approach is zero, which facilitates the construction of the chart of the recording mechanism. Further, with this location of the orifice, static-pressure determinations are not necessary, and the pitot tube in reality becomes a simple impact tube, with just one connection to the recording device.

The length of the intake pipe has no influence on the measurements. If the orifice diameter bears the proper relation to the pipe diameter, the loss in pressure in negligible. Carnot many years ago proposed an equation for this loss, as follows:

$$\text{Lost head} = \frac{(V - V_1)^2}{2g}$$

where V_1 = velocity of fluid in pipe, ft. per sec.
V_2 = velocity of fluid in orifice, ft. per sec.
g = acceleration due to gravity, ft. per sec.

and the lost head is in feet of the fluid being measured. Tests made at the Carnegie Institute of Technology showed that this equation will give fairly close results. When the velocities are low the calculated loss is too high, and when the velocities are high the equation gives results too low. Over the range of velocities used in the tests, the variation of the actual and calculated loss did not exceed 7 per cent. If an orifice diameter of about six-tenths of the pipe diameter is used, and the lost head reduced to actual additional horsepower required to drive the turbo-blower, it is found that it amounts to less than one half of one per cent. (*The Blast Furnace and Steel Plant*, vol. 5, no. 12, December 1917, pp. 558-559, 1 fig., *pe*)

DROP OF PRESSURE IN COMPRESSED-AIR HOSE, Walter S. Weeks. Data of tests made last year under the writer's direction in the Mining College of the University of California to determine the drop in pressure that compressed air undergoes in passing through a 50-ft. length of commercial air-drill hose.

The tests were made on ¾- and 1-in. hose, and the results are presented in the form of charts, of which the one for the ¾-in. hose is reproduced in Fig. 1. Approximate tests were also made on the drop through the fittings alone, but this proved to be quite negligible.

The writer also makes some practical suggestions. It is necessary to have the hole in the hose of the specified size. The hose with the most "give" has the least drop in pressure, because when it is under pressure the diameter of the hose is slightly increased. Wire-wound hose is very rigid, and in addition often corrugated by the tight winding. These corrugations increase friction and constrict the opening. (*Western Engineering*, vol. 8, no. 11, November 1917, pp. 434-435, 3 figs., *e*)

Attention is called in this connection to the article, Economy of Tight Air-Hose Connections, Glenn B. Harris, *American Machinist*, vol. 47, no. 23, December 6, 1917, pp. 985-986.

Cooling

MECHANICAL WATER COOLING ON THE "HEENAN" PRINCIPLE. *Indian and Eastern Engineer*, New Series, vol. 41, no. 13, September 1917, pp. 85-86, 2 figs. Description of the "Heenan" cooler applied particularly for cooling jacket water of stationary gas engines. The cooler consists of cylinders built up of galvanized sheeting wound into the form of a spiral with the air space to each convolution. It will be described more fully in an early issue of THE JOURNAL.

Engineering Materials

HARDENING OF ALUMINUM BRONZE. According to an article in the *Giesserei Zeitung* for June 1, aluminum bronzes can be improved by thermal treatment. When they contain less than 7 per cent copper, the thermal treatment will not affect the properties much. Higher-grade bronzes can be hardened, however, and by the further addition of iron, silicon and other elements the mechanical properties of the alloys can be much varied. Thus, e.g., bronzes can be prepared having a Brinell hardness of 100 without being brittle. An aluminum bronze resembling in its mechanical properties a 0.35 carbon Swedish steel was given hardness values ranging from 100 to 260 by various thermal treatments; such bronzes of great hardness will answer as bearing metals even for high speeds. The following figures are given as to the properties of a 10 per cent aluminum bronze containing some titanium, the percentage of which is not quoted:

	Bronze as Cast.	Quenched Bronze.	After Thermal Treatment at Different Temperatures
Limit of elasticity....	9.6	19.8	27.7 to 19.2 kg. per sq. cm.
Tensile strength......	51.8	73.6	67.7 to 64 kg. per sq. cm.
Elongation	19.5	1.0	5.5 to 1.4 per cent
Contraction of area...	33.7	0.8	9 to 18.5 per cent
Brinell hardness......	100	262	158 to 140

(*The Journal of Industrial and Engineering Chemistry*, vol. 9, no. 12. December 1917, pp. 1144, *p*)

TESTS OF CORK FOR FRICTION CLUTCHES AND OTHER SIMILAR PURPOSES, G. G. Becknell and C. N. Weurich. *American Machinist*, vol. 47, no. 23, December 6, 1917, p. 972. Data on cork tests obtained in the laboratory of the University of Pittsburgh, including a summary of coefficients of friction. Also data with charred cork to determine the value of cork in dry-clutch work where intense heat is likely to be developed.

HYDRATED LIME AND ITS QUALIFICATIONS AS A STRUCTURAL MATERIAL, Bela Nagy. *Proceedings of The Engineers' Society of Western Pennsylvania*, vol. 33, no. 7, October 1917, pp. 457-473, 7 figs.

RECHERCHES SUR LA DILATION THERMIQUE ET SUR LA VITESSE DE DISSOLUTION DES ACIERS AU CARBONE, Joh. Driesen. *Revue de Métallurgie*, 14e Année, no. 5, September-October 1917, pp. 683-706, 14 figs., 8 tables. Investigation of thermal expansion and velocity of solution of carbon steels.

RUSTPROOFING IRON AND STEEL, Joseph W. Wunsch. *Machinery*, vol. 24, no. 4, December 1917, pp. 309-311, 3 figs.

THE MICROSTRUCTURE OF COMMERCIALLY PURE IRON, W. J. Brooke and F. F. Hunting. *Engineering*, vol. 104, no. 2707, November 16, 1917, pp. 532-534, 14 figs.

SUR LES PROPRIÉTÉS RÉFRACTAIRES DE LA MAGNÉSIE, H. Le-Chatelier and B. Bogitch. *Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences*, tome 165, no. 16, October 15, 1917, pp. 488-491, 1 fig., 2 tables. Discusses the refractory properties of magnesia.

PROPERTIES OF VARIOUS WOODS, compiled by A. Pomilio. *Aerial Age Weekly*, vol. 6, no. 9, November 12, 1917, p. 379.

Evaporators

TEST OF SCHUTTE AND KOERTING EVAPORATOR, M. C. Stuart. *Journal of the American Society of Naval Engineers*, vol. 29, no. 4, November 1917, pp. 725-738, 4 figs., 1 plate. An abstract of this paper will appear in an early issue of THE JOURNAL.

Firing and Fuel

CHART WITH WHICH TO MAKE VARIOUS RECORDS FOR COAL. Walter N. Polakov, Mem.Am.Soc.M.E. With the present scarcity of coal, the old slipshod manner of handling coal records should not be tolerated. By using the chart Fig. 2, the following information can be gained at a glance: (1) Quantity of coal on hand (bin or yard); (2) daily coal deliveries; (3) when unloading started and finished; (4) daily balance on hand; (5) heat value, ash and volatile contents of each delivery; (6) daily coal consumption; (7) coal consumption per kilowatt-hour; (8) cumulative consumption of coal to date; (9) on what day any certain coal was used; (10) the demurrage, if any.

The construction of the chart requires two main scales, namely, time (days of the month) and quantity (pounds of coal). The coal-consumed curve is started from zero on the first of the month, as shown, and grows gradually as coal is used from the overhead bin or yard each day. The vertical distance by which the curve rises from day to day gives the daily consumption, and the ordinate at the end of the line indicates the total coal used.

The amount of coal delivered is shown to the left of the coal-consumed curve, the grade being lettered opposite the line representing the quantity. The vertical bars representing the deliveries are divided to represent what portion of the total is in the overhead bin, what is in the yard pile, and how much is ready for unloading from the barges or cars. As the contents of each barge or car are consumed, the length of the bar representing the amount of its contents is projected on the coal-consumed curve, indicating in this manner the duration of the period during which its load was utilized.

Whenever a new delivery is made, a new bar indicating the amount is started on the day when the barge or car arrived at

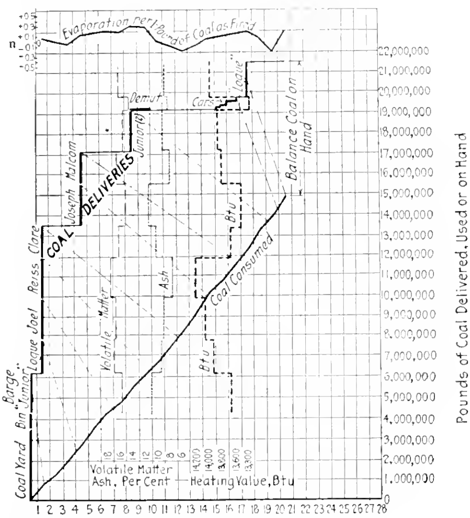


FIG. 2 METHOD OF RECORDING DATA REGARDING COAL SUPPLY, CONSUMPTION, ETC.

the dock or siding, while the horizontal line after each new delivery thus represents the time elapsed as periods between deliveries. The heavy part of the horizontal line represents the length of time during which the demurrage charges were accumulating.

The analysis of coal for each delivery may be shown as complete as desired, being indicated horizontally opposite each delivery. In the case illustrated, only the heating value, ash and volatile percentage are shown. In the upper part of the chart is a reference curve showing the evaporation per pound of coal. Any other relation, such as boiler efficiency or pounds of coal per kilowatt-hour, which may be of use can also be placed here.

To facilitate using these charts they can be plotted daily on cross-section tracing cloth, and blueprints can be sent from time to time (generally weekly) to the managers and purchasing agents. (*Electrical World*, vol. 70, no. 19, November 10, 1917, pp. 911-912, *p*)

Controlling Smoking Chimneys. Description of a method of electric signaling to indicate to the firemen the fact that the stack taking care of their set of boilers is smoking. The system described has been installed at the Duquesne Light Company's Brunots Island Power Station on an island in the Ohio River.

The station is served by 50 boilers having a total of 32,460 boiler hp., nominal rating. These boilers are served by 18 chimneys.

The system was designed mainly as an aid in preventing smoke. In each boiler room above the firing aisle is a red incandescent lamp enclosed in an opal globe so as to increase the glow of the lamp. Outside there is an observation house so situated that the observer has a view of all chimneys. In front of the observer is a switchboard through which he can control any of the red lamps.

The operation of the system is essentially as follows:

The operator observes that, say, No. 3 stack is making smoke corresponding to No. 2 chart. The switch of No. 3 circuit is thrown, which lights the lamp in front of the fireman who is operating the boilers served by No. 3 stack, and also brings the No. 3 recording pen of the time recorder into action. Both the combustion engineer and the water tender are available to asssist him, if needed. When the smoke has been reduced to correspond to No. 1 chart, the switch is opened, thus cutting out the lights and the pen of the time recorder.

The adoption of this system eliminated erroneous entries which might easily occur if the log system only were used. The charts are changed daily and filed for future reference. (*Power*, vol. 46, no. 22, November 27, 1917, pp. 718-720, 4 figs., *g*)

Methods for More Efficiently Utilizing Our Fuel Resources. *General Electric Review*, vol. 20, no. 12, December 1917, pp. 924-939, 12 figs. Parts 7 and 8.

Double Pass Recuperative Furnaces. *Iron Trade Review*, vol. 61, no. 24, December 13, 1917, pp. 1277-1278, 2 figs. Special brick used in the construction of this type of furnace heats the incoming gas continuously and eliminates the reversing valves required in other heating systems.

Heating

Calculations and Analysis of a Compound Gravity Low-Pressure Hot Water System, A. J. Wells. *Journal of the American Society of Heating and Ventilating Engineers*, vol. 24, no. 1, October 1917, pp. 1-22, 11 figs., 2 tables, 5 charts.

Hoisting

History of Wire Hoisting Ropes, with Notes on Factors of Safety. *Engineering and Mining Journal*, vol. 104, no. 19, November 10, 1917, pp. 832-835.

Hydraulics

Reversal of Water Wheel to Absorb Energy During Test. In the cross-cut hydroelectric plant built for the U. S. Reclamation Service on the Salt River Reclamation Project in Arizona, it was agreed that the high voltage and low amperage made it inadvisable to employ the usual water-rheostat method for absorbing the load in carrying out efficiency tests. It was therefore decided to connect the generator of the wheel under test with the generator of another unit in such way that the latter would be run as a motor. In this way the load would be taken up by the jets from the nozzles retarding the reverse rotation of the buckets.

This was done with hand regulation. One penstock was used for supplying water to the unit under test, and another for supplying water to the exciters and providing the load in the braking unit. With water admitted through the nozzles of the unit operated as a synchronous motor, electric energy was absorbed in direct relation to the hydraulic energy developed by water passing through its nozzles.

The stresses imposed on the buckets were directly opposite to those for which the unit was designed. Nevertheless, the motor unit was operated in this condition almost continuously for two days. While the Kingsbury bearing on the motor unit was designed for rotation in one direction only, it showed no undue distress throughout the entire run. (*Engineering News-Record*, vol. 79, no. 22, November 29, 1917, p. 1023, *t*)

Flow in Channels with Large Expansion Ratio, R. Kröner. (*Zeits. Vereines Deutsch. Ing.* 61, pp. 605-609, July 21, and pp. 630-633, July 28, 1917). This research comprises a detailed investigation of flow in close channels, following the work commenced by Andres and Hochschild. The complexity of the phenomena necessitates three-dimensional investigation of the flow. Special importance is attached to measurement and representation of losses; and the distribution of velocity and pressure is investigated. Air is used as the fluid medium in order to reduce the use of the large pipes required for close examination of stream lines, etc. The velocities of the flow are so low that the compressibility of air does not enter into the case. The Prandtl tube is used to measure the "velocity height" $\gamma w^2/2g$; where γ = specific gravity of air and w = velocity of flow. Double and treble search tubes are used in conjunction with manometers to determine the plane and direction of flow; the readings of the Prandtl tube and of a right-angled "book tube" (indicating the "energy" $e = p + \gamma w^2/2g$, where p = static pressure) are corrected according to the obliquity of stream flow. The experimental pipe used was 4 m. long and 250 mm. square. It was connected in the suction line of an electrically driven fan with suitable provision made to eliminate extraneous influence on the stream flow. The construction and arrangement of the measuring devices are illustrated in the original. A novel feature is a semi-automatic pen recorder which gives more accurate results than point-by-point readings, and also saves time and labor. A pivoted beam with two pressure bells of gasometer type insures, in conjunction with a relay system, that the driving motor runs at constant speed.

Insertion pieces of five different designs were used to reduce the canal section to a rectangular slot from 67.2 to 68.3 mm. wide in the several cases and with the full height of the channel. The constricting "nozzle" was of the same form in each case, and was 260 mm. long axially. In case A the constricting nozzle was used alone so that the channel increased abruptly in the ratio 1:3.62. In the other four cases fat sheets were used to provide rectangular expansion cones, the half expansion angles and the expansion ratios being: (I) 45 deg.; 1:3.7. (II) 22 deg. 34 min.; 1:3.64. (III) 12 deg.; 1:3.67. (IV) 5 deg. 53 min.; 1:3.69. The "nozzles" were symmetrical about a vertical plane through the axis of the channel, and were composed of zinc plates over wooden frames. Coördinates adopted were x positive in the direction of flow and reckoned from the narrowest section as zero; y and z from the right-hand upper corner of the main canal as viewed in the direction of flow, y positive to the left and z positive downward. Losses were reckoned from the narrowest section. Over 1000 curves were prepared during the main series of the tests. Considerable difficulty was experienced in some cases in restoring the exact conditions of flow which it

was desired to check or investigate; often a sudden change from one type of flow to another occurred without any particular reason being evident. Evaluation of test data and correction for certain errors are discussed in a portion of the original which cannot usefully be abstracted. Velocity, pressure, and loss of power are reduced to dimensionless quantities to permit of comparison between one channel and another, and lines of equal velocity are traced for those sections which show the velocity as a function of z to be very variable. The measurements show flow to be very asymmetric in cases A and I to III inclusive, also that different forms of flow are in the same channel. In case IV the flow jumps continually from one state to another. Pressure loss in case A showed a small departure from the square law; and the departure was comparatively large in case IV. Curves in the original show the more or less unstable alternative conditions of flow in some places. In no case has the power loss curve the cubic form which would correspond to a quadratic law of resistance; the curves are not harmonic among themselves, the losses being dependent on the extent of the back-flow zone.

The paper concludes with a comparison of the mechanical similarity between flow in air and water, based on channel IV. More definite conclusions and a discussion of the application of the results may be given in the detailed report of the research, which is to form a separate publication. (*Science Abstracts,* vol. 20, no. 238, section B, October 31, 1917, p. 362)

Les Coups de bélier dans les conduites forcées, C. Camichel and D. Eydoux. *Revue Générale des Sciences pures et appliquées,* 28e Annee, nos. 20, 21, October 31 and November 13, 1917, pp. 565-574, 610-615, 18 figs. Description of the theory and determination of magnitudes of water hammer in conduits under pressure.

Pulsations in Pipe Lines, as Shown by Some Recent Tests, H. C. Vensano. *Proceedings of the American Society of Civil Engineers,* vol. 43, no. 8, October 1917, pp. 1593-1643, 31 figs. Data of a highly interesting series of experiments and measurements of water hammer in long pipe lines made under actual operating conditions. They show what can be expected, particularly, in the way of wave effects, and demonstrate that pulsations, whether due to gate opening or closing, can by no means be neglected in design, even for lines which are controlled by slowly moving gates.

Internal-Combustion Engineering

A Petrol Engine Ring Valve, a Comparison with Other Types, A. E. Hammond. *Flight,* no. 463 (no. 45, vol. 9), November 8, 1917, pp. 1170-1172, 10 figs. Description of the Howard slide valve as applied to an aircraft engine. The valve consists of broad, flat split rings covering annular slots cut through the walls of the working cylinder on opposite sides, and made to move with the cylinder in parts at each end of its travel, its mid-position shutting both parts gastight. The ring being split allows full force of compression and explosion to hold it gastight against the cylinder wall.

Diesel Engine Revolution-Speed and Efficiency, T. Orchard Lisle. *Motorship,* vol. 2, no. 12, p. 9.

Lubrication

Lubricant Testing, Lieut. Commander J. G. Meyers. *Journal of the American Society of Naval Engineers,* vol. 29, no. 4, November 1917, pp. 698-712, 4 figs.

Machine Design

Expansion Bends. *Mechanical World,* vol. 62, no. 1609, November 2, 1917, pp. 245-246, 5 figs.

Machine Shop

Attitude of Machine-Tool Builders to Motor Drive, C. E. Clewell. In order to gage the recent tendencies in machine-tool design which have been brought about at least partly by the growing use of motor drive, a number of typical questions were addressed to representative machine-tool builders. The article here abstracted represents a digest of the answers obtained. Besides the general expression of opinion, the various manufacturers indicated also the approximate percentage of output supplied for individual motor drive, group electric drive and straight-line shaft drive, and recent changes in machine tools adapting them specifically to motor drive.

From these data it appears that a very large percentage of machines of the majority of machine-tool manufacturers are supplied for electric drive.

The following represents in a general manner the expression of the attitude of the different companies toward motor drive:

1 *Lodge & Shipley.* In general, group drive is preferred to individual drive, except in cases where a few machines are run on overtime or at night, and for the reversing control of planers and where crane operation is facilitated by the elimination of overhead shafting.

2 *Ingersoll Milling Machine Company.* Individual motor drive is preferred.

3 *Jones & Lamson.* The tendency is strongly toward motor-driven machinery, motors being used practically always on heavy machinery, and, where conditions permit, also on lighter lathes, drill presses and the like.

4 *Cincinnati Bickford Tool Company.* Not much choice is expressed between a speed box and a variable-speed motor for standard tools. For special schemes of mounting, the motor drive is preferable.

5 *International Machine Tool Company.* Individual motor drive is preferred to any other method of drive.

6 *Bridgeford Machine Tool Works.* Individual motor drive is preferred for machine tools requiring 20 hp. or more, group drive for machines which require not more than 5 hp. or 6 hp. All machines that are made by this company and have gear heads are heavy-duty, requiring 10 hp. to 15 hp. In 95 per cent of the cases involving these machines motor drive is specified. Very few geared-head machines are belt-driven.

7 *Cincinnati Planer Company.* Wherever possible, electrically driven tools are favored.

8 *Bausch Machine Tool Company.* Favorable to motor-driven machinery.

9 *Foster Machine Company.* About 80 per cent of the machine tools in this company's plants are individually motor-driven.

10 *American Tool Works Company.* The preference of this company for motor-driven or belt-driven machine tools is influenced entirely by the conditions under which these tools are to be operated. Both types of machines are handled and each has a legitimate field of operation. (*Electrical World,* vol. 70, no. 29, November 24, 1917, pp. 994-997, 10 figs., *g*)

Casting Bearings in Sand and Metal Moulds, R. R. Clarke. *The Metal Industry,* vol. 15, no. 12, December 1917, pp. 516-517.

Repairing German Vandalism by Electric Welding,

Commander E. P. Jessop. *Journal of the American Society of Naval Engineers*, vol. 29, no. 4, November 1917, pp. 663-672, 7 figs., 3 tables. Description of some electrical-welding repair jobs done on the interned German ships taken over since the war by the United States authorities.

Power Required for Driving Reamers. *Machinery*, vol. 24, no. 4, December 1917, p. 337. Data of tests made at the Worcester Polytechnic Institute to ascertain the effect of reamer design on the power required for driving reamers of different types. It was found that the main element affecting power is the keenness of the cutting edges.

Unification des Filetages. *Bulletin de la Société d'Encouragement pour l'Industrie Nationale*, tome 128, no. 4, Juillet-Aout 1917, p. 84. Brief note on screw-thread standardization in France.

Extracts from a Paper on Screw Thread Measurements, read by the late Mr. Arthur Brooker. *The Post Office Electrical Engineers' Journal*, vol. 10, part 3, October 1917, pp. 153-170, 3 figs.

Emploi des Outils en Acier Moulé Rapide, M. Grenet. *Revue de Métallurgie*, 14e Annee, no. 4, July-August 1917, pp. 547-550. Brief description of the use of high-speed-steel cast tools. An abstract will appear in an early issne.

Tapping Machines and Attachments, Franklin D. Jones. *Machinery*, vol. 24, no. 4, December 1917, pp. 319-328, 27 figs.

A Study of Velocity Diagrams for Shapers and Slotters, A. Lewis Jenkins. *American Machinist*, vol. 47, no. 17, October 25, 1917, pp. 709-711, 10 figs.

Mechanics

The Whirling of Shafts, H. A. Webb. *Engineering*, vol. 104, no. 2705, November 2, 1917, pp. 455-456. (To be continued.)

Worm Gearing, Francis J. Bostock. *Engineering*, vol. 104, no. 2705, November 2, 1917, pp. 479-480, 6 figs. Paper read before the Manchester Association of Engineers on October 27, 1917. An abstract will appear in an early issue.

Analysis of Crankshaft Stresses, Otto M. Burkhardt. *Automotive Industries*, vol. 37, no. 21, November 22, 1917, pp 925-927, 6 figs.

Combined Twisting and Bending Moments, Victor M. Summa. *Machinery*, vol. 24, no. 4, December 1917, pp. 307-308. The writer shows by examples how the so-called Rankine formulae may be applied to the determination of the combined twisting and bending movements.

The Whirling of Shafts, H. A. Webb. *Engineering*, vol. 104, no. 2707, November 16, 1917, pp. 513-515, figs. 8-11. (Concluded.)

Measuring and Testing

An Impact-Endurance Testing Machine, D. J. McAdam, Jr. *Journal of the American Society of Naval Engineers*, vol. 29, no. 24, November 1917, pp. 663-672, 7 figs., 3 tables.

Dilatomètre Différentiel Enregistreur, Description et Premières Applications, M. Pierre Chevenard. *Revue de Métallurgie*, 14e Annee, no. 5, September-October 1917, pp. 611-640, 23 figs. Description and method of application of a new type of self-registering differential dilatometer.

Munitions

The Inspection of Screw Gages for Munitions of War, H. J. Bingham-Powell. Attention in the inspection of gages has until recently been principally given only to correctness of the ruling diameters of the thread. The matter of pitch was largely disregarded, mainly because of the lack of an instrument which could measnre it from thread to thread in a rapid and exact manner independent of the personal equation of the operator.

Within the last two years, however, the question of pitch became prominent because of the accuracy required in the screw gages used on munition work.

A number of devices exist to measure the pitch based on the idea of measuring over a given number of threads. There are also a few machines to measure the pitch from thread to thread, but they have the defect that the accuracy of the operation depends on the care taken by the user. In England the pitch-measuring machine invented by Vidal is claimed to have overcome these troubles. Instead of the V-point is used a ball so arranged that it can bear evenly in the thread without the inclination of the spindle to which it is fixed. This ball is split with a lamina of mica interposed as insulation between the two portions. Electric circuits are made between the halves of the ball and the screw, and will only close when the ball is touching the slope of the thread on both sides. The spindle with the ball is connected to a longitudinal carrier of a triangular-truss form, with the spring arranged to press it toward the screw and so keep the ball in continually light contact with the thread. The adjustment given by the spring is so delicate that the carrier can be blown away from the contact by the breath. Since the ball and the screw must be quite clean and free from grease in order that the electric circuit may be established, the operator knows at all times that he has obtained a true contact on the thread without an intervening film of oil.

The writer was impressed by the fact that in all the existing designs the devices for insuring that the V-points or ball-pointed spindles resting in the screw bore equally on both sides of the thread depended on visual inspection, electric contact or reflection from a mirror on to a scale. The writer believes that a more convenient way to design the bearing on the thread is to arrange that this is fundamentally so without having to rely on electrical, optical or other devices to prove it. If a suitably sized ball is dropped into a screw, this ball must naturally assume an equal bearing on both slopes. If it were possible to have such a ball placed between guides so that its center was always over the axis of the screw and then to arrange a microscope moved by a micrometer head or similar measuring system and read down on it a point on the ball or else to an engraved line on the flat surface on a hemisphere instead of the complete ball, the solution would be complete.

However, there is no satisfactory way of knowing that the ball is in proper position. But if for the simple ball or half ball is substituted a ball-ended spindle that freely bears vertically or nearly vertically into the screw and is suitably guided along the axis from thread to thread, its movement being measured by a micrometer head, a satisfactory basis for designing the machine is found, and this is the principle adopted by the writer.

The paper describes and illustrates the machine in detail.

From this the writer proceeds to a discussion of measurement of the full effective core diameters of the Whitworth thread and of the full and effective diameters of the United States standard threads of plug screw gages and ring screw gages.

The writer recommends the following equipment for checking screw gages:

1 A pitch-measuring machine to read from thread to thread, to at least 1/10,000 of an inch
2 An appliance to take casts of ring screw gages, so arranged that the cast may be accurately set up in the pitch machine, or projection apparatus
3 A screw-measuring machine to check the governing diameters of a plug screw gage with accuracy to 1/10,000 of an inch. An equipment of " best " diameter and " maximum " diameter wires, and triangular pieces for the same
4 Thread micrometers, checked for accuracy, to use in conjunction with the screw-measuring machine
5 Ordinary micrometers, to measure full diameters, with Johansson blocks to keep them accurate
6 Complete sets of check plugs for the several diameters, pitch and form of thread of ring screw gages.

Finally, the equipment wonld be complete with a " projection " apparatus for observing the angle between the slopes of the thread and the form of the thread.

Possessing an inspection laboratory with these instruments, a gage maker is in a position to produce the very accurate screw gages employed in munitions work, and to meet all the requirements of the inspection departments of the several governments. (Pamphlet, N. Y., 1917)

SOME SPECIFICATIONS FOR MUNITIONS. The following list of specifications has been prepared by the Library of the Engineering Societies:

1896.—Specification for Steel for Gun-Barrels.—U. S. Government Specification, 1896. (Washington, D. C., Annual Report of the Chief of Ordnance, pp. 69-72.) Requirements are an elastic limit of 60,000 lb., tensile strength not under 100,000 lb., and an elongation of 15-20 per cent. The chemical limits were not to exceed: C, 0.50; Mn, 0.60; Si, 0.16; S, 0.034; P, 0.045. Analyses and tests are given of a large number of submitted samples, but none was quite up to the standard.

1897.—Armor-Piercing Projectiles (8-, 10- and 12-in. shot for the U. S. Government), 1897. (*The Engineer*, London, vol. 84, pp. 504-505.) Dimensioned sketches and specifications.

1907.—Qualities Necessary for Gun Steel, Carriage Steel, Spring Steel, Shield Steel (excluding armor-plate steel) and Shell Steel, 1907. (*Times Engrg. Suppl.*, May 22, p. 162). Specifications and tests of various steels in current use are given.

1913.—Bulleus, D. K., The Manufacture of Armor Plate, 1913. (*The Iron Age,* vol. 92, p. 953-954.) Details of the Harvey and Krupp processes. An American method described. Chemical composition and prices compared. Specifications for protective plates.

1915.—Specifications for High-Explosive Shells. Abstract of the Official British, French and Russian Government Specifications for high-explosive shells and fuses. New York, 1915. The Industrial Press, publishers of *Machinery,* 44 pp. (Pamphlet, p. 623.45 M. 185.) Gives details regarding Russian 3-in. H.-E. shell; Russian high-explosive percussion fuse; British H.-E. shells; British high-explosive shell fuse; French 75-mm. H.-E. shell.

1916.—French Specifications for Shell Steel. 1916. (*The Iron Age,* August 31, vol. 98, pp. 450-451.) Details regarding the specifications of the French government for shell steel. The bars are to be rolled or forged steel of the best quality, made either by the acid or basic open-hearth process, or electric-furnace processes, free from seams, floors, piping and porosity. The conditions of annealing are described, as well as those of temper drawing after quenching, and the mechanical requirements are also given. Twenty-eight per cent top discard and 4 per cent from the foot is stipulated, and the percentage chemical composition is specified as follows:

	Minimum	Maximum
C	0.30	...
Si	0.15	0.25
Mn	0.50	0.80
P	0.03	0.08
S	...	0.05

THE MANUFACTURE OF THE LEWIS MACHINE GUN, *American Machinist,* vol. 47, no. 23, December 6, 1917, pp. 969-971, 11 figs. (To be continued.)

SPECIAL AUTOMATIC RIFLE-BARREL MACHINE, E. H. Ingram. *American Machinist,* vol. 47, no. 21, November 22, 1917, pp. 905-908, 3 figs.

WEAR IN BIG GUNS, Major T. G. Tulloch. *Arms and Explosives*, vol. 25, no. 302, November 1, 1917, pp. 143-146.

AMMUNITION PROBLEMS IN WAR TIME, A. L. Humphrey. *Official Proceedings of the Railway Club of Pittsburgh,* vol. 16, no. 8, September 28, 1917, pp. 298-318, 12 figs.

EFFECT OF AIR CONDITIONING UPON MUNITIONS MANUFACTURE, J. Irvine Lyle. *Journal of the American Society of Heating and Ventilating Engineers*, vol. 24, no. 1, October 1917, pp. 45-53, 8 figs.

Power Generation

NEW 92,500-HORSEPOWER HYDROELECTRIC PLANT FOR SPAIN. *Electrical Review*, vol. 71, no. 20, November 17, 1917, p. 837.

CEDEGOLO STATION OF THE ADAMELLO POWER DEVELOPMENT IN ITALY, C. A. Tupper. *Electrical Review*, vol. 71, no. 20, November 17, 1917, pp. 838-839, 2 figs.

A COMPARISON OF THE WORKING COSTS OF THE PRINCIPAL PRIME MOVERS, Oswald Wans. *The Journal of the Institution of Mechanical Engineers*, November 1917, no. 7, pp. 531-555, 8 figs.

Pumps

CHARACTERISTICS AND SPECIFIC SPEEDS OF CENTRIFUGAL PUMPS, F. G. Hechler. *Journal of the American Society of Naval Engineers*, vol. 29, no. 4, November 1917, pp. 673-697, 10 figs.

ONE-HUNDRED-AND-TEN-MILLION GALLON PUMP FOR ST. LOUIS, H. F. Gauss. *Power,* vol. 46, no. 23, December 4, 1917, pp. 752-755, 4 figs. Describes a turbine-driven, 13-stage centrifugal pump having a maximum capacity of 110,000,000 gal. against a head of 65 ft. Under normal conditions, a pump efficiency of 81 per cent is expected, and a duty exceeding 114,500,000 ft.-lb. per million B.t.u.

MERCURY VAPOR PUMPS FOR OPERATING AGAINST HIGH PRESSURES, Chas. A. Kraus. *The Journal of the American Chemical Society,* vol. 39, no. 10, October 1917, pp. 2183-2186.

THE PARALLEL JET HIGH VACUUM PUMP, William W. Crawford. *The Physical Review*, vol. 10, Second Series, no. 5, November 1917, pp. 557-563, 3 figs.

Railroad Engineering

REFRIGERATOR CARS FOR THE BALTIMORE & OHIO. The Baltimore & Ohio has recently constructed in its own shops some

refrigerator cars that contain interesting features of design.

Contrary to the customary practice, the insulation throughout the car is applied without any air space between the different layers. This was done because it has been found that it is difficult to maintain tight a car with the layers of insulation separated, due to the constant waving of the car. Further, by applying the various layers of insulation directly upon each other, the construction of the car is made less complicated and the insulation is better supported.

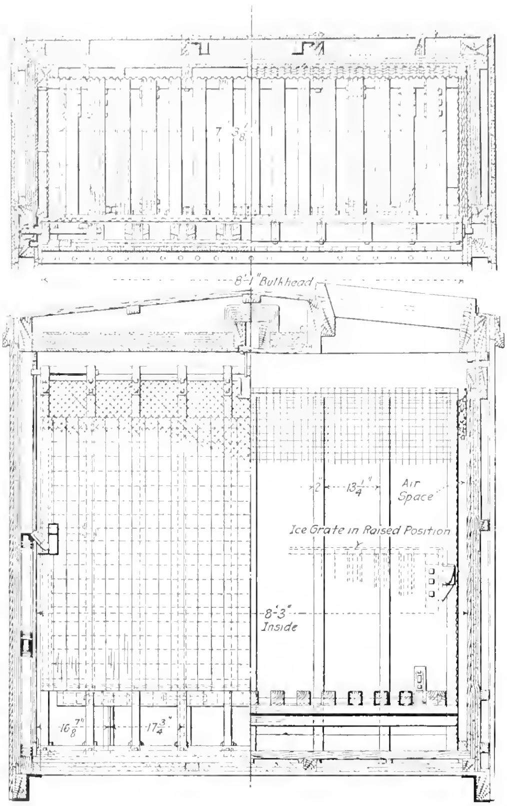


FIG. 3 SECTIONS THROUGH ICE BUNKERS SHOWING INSULATED BULKHEAD

It was the belief of the designers that better refrigeration is obtained if the air in the car has a direct and positive circulation. To secure this, the bulkhead of the ice chamber was made solid, with ample openings at the top and bottom, and the load held above the floor on racks. To obtain greater effectiveness from the ice, a wire netting is provided to hold it, which permits a free circulation of air around it. With the ice thus held away from the sides and end of the car less heat is absorbed through the car walls. The bulkhead is insulated (see Fig. 3) so that it will not transmit heat to the ice, but instead will guide the cold air down to the bottom of the car for circulation. The insulated bulkhead also prevents, to a large extent, the condensation of moisture on the car side of the bulkhead, which is liable to spoil the material placed against it.

The actual method of applying the insulation is shown in Fig. 4. The insulation passes around the corners of the car in continuous strips to better provide a tight insulated joint. At the top the outside layer of insulation is lapped up into the ceiling insulation around the side plate. The insulation of the ceiling is heavier than that on the sides, as it has been found that the absorption of heat is greater on the top of the car than on the sides. Since the weight of the ceiling with the insulation is too great for it to be firmly held by nails, $\frac{3}{4}$-in. to 3-in. support strips are placed at every third carline and are bolted at the carlines by $\frac{3}{8}$-in. bolts countersunk into the carlines.

Special care has been taken to properly insulate the walls surrounding the icebox, and the ice-hatch door is constructed with great care. The ice bunkers have a capacity of 15,000 lb. of ice. (*Railway Age Gazette*, vol. 63, no. 22, November 30, 1917, pp. 981-984, 6 figs., *d*)

STANDARDIZATION VERSUS IMPROVEMENT. "Standardization is a good thing within certain limits, but standards are not an end in themselves. They are only an aid to be applied with discretion." This is the statement made in an editorial article in the *Railway Review*. The writer proceeds somewhat as follows:

The standardization cult may easily become a mere drag on improvement, and in some cases the refuge of mental laziness and torpidity. The standards of today will be the deadwood of tomorrow, unless controlled by brains.

With particular reference to railroad engineering, in some things the advantages of standards are very perceptible. Freight cars travel all over the railroad system and need maintenance repairs wherever they happen to be. The advantage of standardizing parts that must work together, like couplers, and of dimensions and locations, so that interchange-

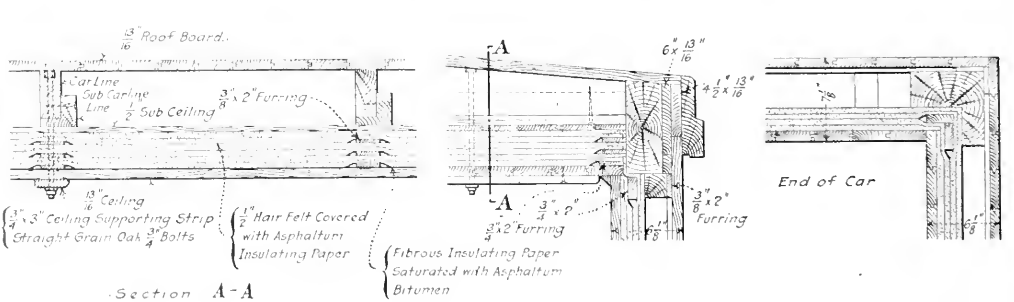


FIG. 4 METHOD OF APPLYING INSULATION TO BALTIMORE & OHIO REFRIGERATOR CARS

ability may be insured, are self-evident, but the freight car of today is not a perfect vehicle, and is in the process of evolution. This evolution can easily conform itself to such standards as will not hinder the way of improvement, but engineering improvement will not cease either by agreement or legislative mandate.

In the case of locomotives there is less real field for standardization as they stay on their own roads. They must operate with different fuels and different waters over varying grades and curves, and are subject to numerous conditions which stationary power plants do not have to contend with.

The best results are to be obtained by designing the machine for the service conditions it is to meet, so that excessive standardization, if applied to locomotives, would militate against ultimate efficiency. (*Railway Review*, vol. 61, no. 19, November 10, 1917, pp. 581-583, *g*)

Locomotives of the 2-10-2 Type for the Wabash. *Railway Age Gazette*, vol. 63, no. 23, December 7, 1917, pp. 1025-1028, 7 figs.

The 4-4-0 Type Locomotive in Great Britain. *The Railway Gazette*, vol. 27, no. 20, November 16, 1917, pp, 536-540, 5 figs.

A Study of Friction Draft Gear Capacity, Louis E. Endsley. *Railway Age Gazette*, vol. 63, no. 20, November 16, 1917, pp. 893-896, 3 figs., 2 tables.

The Ability of Refrigerator Cars to Carry Perishable Products, Dr. M. E. Pennington. *The Railroad Herald*, vol. 21, no. 12, November 1917, pp. 276-278, 1 chart.

Transverse Fissures in Rails, James E. Howard. *Railway Review*, vol. 61, no. 21, November 24, 1917, pp. 644-647. An abstract of this article will appear in an early issue of The Journal.

Refrigerator Cars for the Baltimore & Ohio. *Railway Age Gazette*, vol. 63, no. 22, November 30, 1917, pp. 981-984, 7 figs.

Methods of Loading, Bracing and Stowing L. C. L. Freight, Atchison, Topeka & Santa Fe Railway, Charles E. Parks. *Railway Review*, vol. 61, no. 19, November 10, 1917, pp. 576-579, 12 figs.

Refrigeration

The Specific and Latent Heats of Liquid Ammonia, reviewed by H. C. Dickinson. *Refrigerating World*, vol. 52, no. 11, November 1917, pp. 21-26, 9 figs., 4 tables. A summary of the work done at the Bureau of Standards, with a view to determining the physical constants of liquid ammonia.

A Five-Hundred-Ton High-Speed Booster Ammonia Compressor, F. L. Fairbanks. *A. S. R. E. Journal*, vol. 4, no. 3, November 1917, pp. 298-307.

Steam Engineering

Nozzle Characteristics, G. Flügel. (*Zeits. Vereines Deutsch. Ing.* 61, pp. 650-655, Aug. 4, 1917). Notwithstanding many theoretical and experimental investigations into the question of the expansion of elastic media flowing through nozzles, there still remains a series of technically important phenomena which require explanation. In the present paper the nozzle effect is examined for the case of a medium conforming to given conditions and with unrestricted exit. By nozzle characteristics the author means curves which exhibit the relationship between the reaction force of velocity coefficient at constant initial pressure before the nozzle, and either the final pressure after expansion of the adiabatic exit velocity.

The average velocity first receives attention, and here the existence of the mean active velocity and its relationship to the actual mean velocity and to the square of the mean velocity, is made clear. Nozzles suitably enlarged are next dealt with, the calculation of the respective velocity coefficient being given. It is shown that the curve of velocity coefficient becomes steeper within the critical zone for increasing exit velocity. The author shows how the most favorable form of nozzle may be evolved when the conditions of flow are known. For nozzles of normal cross-section but with too small enlargement, the velocity coefficients may be calculated with perfect accuracy, and with a good approximation for nozzles of oblique cross-section when certain simplifications are made. The striking result is obtained that after decrease of back pressure, the velocity coefficient still grows and reaches its maximum value for high pressures, the worse the nozzle. A limiting inferior pressure is shown for nozzles with oblique section, from which the expansion conforms to other laws as in the intermediate zone. Finally, with nozzles of too great enlargement experiments are quoted showing the improbability of the so-called direct gas impact and an indirect confirmation of this consideration is indicated. The author opines that a better solution may be sought from analogy with incompressible liquids flowing through an enlarged canal. Under this assumption a suitable approximation for the velocity coefficients is given which corresponds better with reality. (*Science Abstracts*, vol. 20, no. 238, section A, October 31, 1917, pp. 451-2)

Purifying Circulating Water for Surface Condensers, W. Seyffert. (*Ver. d. Elektrizitätswerke*, Mitt. no. 191, April 1917. *Elektrot. u. Maschinenbau*, 35. p. 376, Aug. 5, 1917). Mechanical and chemical impurities in circulating water form more or less rapidly a hard crust in the condenser tubes. The rate of heat transfer is then reduced; so also are the quantity and velocity of water flow. Thus vacuum is lowered and the efficiency of the main engine decreases. Removal of deposits either mechanically or by acid involves interruption of service. It is better and cheaper to eliminate mechanical impurities in settling ponds, and to undertake such chemical purification as may be necessary. The Martin (Berlin) patent clarifier is more convenient than a series of settling ponds. Water enters the funnel-shaped bottom of a vertical container. Any sludge, etc., settles in the funnel-shaped bottom and clear water is siphoned away from the top. Starting is facilitated by connection to a vacuum line; subsequently, with the inlet, outlet and sludge pipe open, the apparatus is entirely automatic. A clarifier with drum diameter of 5 m., capable of dealing with 70 cu. m. of water per hour, occupies 25 to 30 sq. m., including attendance space. Grease, oil, and gas rise to the top and are removed periodically through a special outlet. Tests at the Waldenburg central station showed 83.8 per cent "purification efficiency" for such a clarifier; chemical purification was also necessary in this case. From 11 to 14 kg. of circulating water was lost per kw.-hr. by evaporation in the cooling towers (air temperature — 4.5 deg. to + 11 deg. cent.; circulating-water inlet 24 deg. to 39 deg., outlet 20 deg. to 27 deg.). Due to this evaporation deposits are precipitated on the laths and grooves of the cooling tower. The efficiency of the latter is reduced and the laths are endangered.

A Reisert water purifier (50 cu. m. per hr.) operating on the lime process is installed at Waldenburg. The apparatus includes a cylindrical reaction tank, a distributor, two Der-

vaux conical saturators, and a gravel filter bed, 12 sq. m. in surface. The whole equipment is in the open and can be operated even when the atmospheric temperature is — 25 deg. cent. Water is circulated by an electrically driven pump. A spray equipment, operated by compressed air, is used to wash the filter. This purifying plant has been in use since 1911, and has reduced the cost of cleaning condensers from 28-42 M. ($7.00-$10.50) once a fortnight to 15-20 M. ($3.75-$5.00) once in six months. During 1915 the total cost for purifying the circulating water was 1.61 pf. per cu. m. of water, or 0.03 pf. (0.0072 cent) per kw.-hr. generated. (*Science Abstracts*, vol. 20, no. 238, section B, October 31, 1917, p. 357)

CLEANING CONDENSER TUBES IN THEIR PLACE WITH HYDROCHLORIC ACID, G. M. Robertson. Description of a method for the removal of scale in condensers where the scale is of a limy nature.

Tests were made with the condenser containing 4725 brass tubes $\frac{5}{8}$ in. inside diameter, $\frac{3}{4}$ in. outside diameter, 14 ft. long, fitted in brass tube plates with the usual tape packings and ferrules. The water box is cast iron and the cover is mild steel. The condenser was frequently scraped with different types of scrapers, but this removed only the softer stuff while the hard lime scale remained. If scrapers are made tight enough and sharp enough to remove some of the hard scale then the tubes are apt to be damaged.

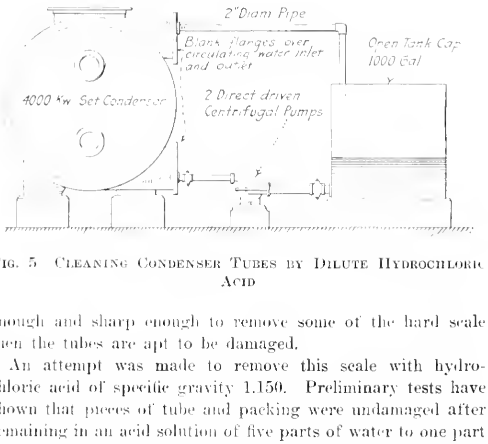


FIG. 5 CLEANING CONDENSER TUBES BY DILUTE HYDROCHLORIC ACID

An attempt was made to remove this scale with hydrochloric acid of specific gravity 1.150. Preliminary tests have shown that pieces of tube and packing were undamaged after remaining in an acid solution of five parts of water to one part of acid for 24 hours. It was also found that one ounce of acid dissolved half an ounce of scale, no matter what the strength of the solution was.

The test itself was carried out in the following way. First, a plain $\frac{1}{2}$-in. rod was pushed through every tube to make sure that they were clear. The water box and condenser covers were chipped clear of scale and the whole washed down with a hose. All the iron portions were given one coat of Bitmo solution to preserve them from the acid. The covers were put on.

The condenser was then filled with water from the 1000-gal. tank, Fig. 5, until the condenser was full and the tank had water just over the suction of the pump. The steam side of the condenser was also filled with water and a $\frac{3}{4}$-in. steam pipe fitted to the bottom of the condenser to warm the water, as acid is more active when warm. The steam was kept on the condenser for four hours, until the condenser was warm to the hand. Circulating was started from the tank through the condenser at 7.00 a.m., and one carboy of acid was added to the tank every twenty minutes until 10:30 a.m., one ton of acid being used. No more acid was added after 1:00 p.m. At 1:00 p.m. the pump was stopped, and the solution run into the tank through the pump until the top inspection door was clear. The top half of the condenser was then inspected through the inspection door, and some of the ferrules were showing clean. The inspection door was put on, and circulating started again, and more acid added to the tank at the same rate, and another ton supplied to tank by 5:00 p.m. The circulation was kept up until 7:00 p.m., when the solution was lowered again, and the top half again inspected. All the ferrules were showing clean, and there were only a few places between the ferrules where scale was still lodging. The inspection door was closed, and circulating restarted, and kept up until 11:00 p.m. The remaining solution was then thrown away to the vlei, from which our circulating water is taken, and water supplied to tank and circulated through the condenser to the vlei for five or six hours to wash away any acid that remained. The condenser covers were then taken off and the face of the tube plates, and as much through the tubes as possible, washed down with a hose with $\frac{5}{8}$-in. nozzle with about 30 lb. pressure. A few ferrules were leaking slightly at the threads; tightening up the ferrules stopped the leaks. There were no tubes leaking.

A measured sample of the solution flowing from the condenser to the tank was taken at 5:30 p.m. and analyzed for wastage of the brass tubes and ferrules. It was estimated that 5 lb. of copper from the tubes and ferrules had been dissolved. (The total weight of the copper was close to 34,000 lb.)

When the condenser was washed out after cleaning with acid, it was found that, as regards the iron parts, the Bitmo solution had been washed off in only a few small places, apparently where it had been painted over rust, but the iron work was not harmed. While the ferrules were clean when the condenser was washed out a considerable quantity of scale came out of the ends of the tubes, showing that the acid might have been kept circulating for some time longer. The scale which remained had been loosened, however, and was easily washed out.

In using the acid, it was poured from the carboy into an enameled jug holding about two gallons, and wet cloths were tied about the men's hands in case of spillage. Lime or lime water should be kept handy for the same emergency.

The 2-in. pipe shown from the top of the condenser might have been slightly larger to allow a clear escape to the gas. The circulating pump had a capacity of 2000 gal. per hour.

The cost of acid and preparing the condenser was £ 50 (about $250) and the whole work paid for itself in one week by the saving in coal due to improved vacuum.

Calcium and magnesium carbonates composed the larger portion of the scale. In addition, ferric oxide and silica were fairly abundant. (*The Journal of the South African Institution of Engineers*, vol. 15, no. 11, June 1917, pp. 276-279, 3 figs., *dp*)

A GAS-FIRED BOILER INSTALLATION, J. C. Hobbs, Mem.Am. Soc.M.E. Description of a boiler plant located in the basement of the William Penn Hotel, in Pittsburgh, which, in addition to generating power and heat for the hotel itself, also serves for heating an adjacent building.

Some of the features of construction are of considerable interest, as showing how some difficult problems of design have been effectively overcome.

The conditions affecting the construction and operation were rather severe. The plant is located under the hotel, the boiler-room floor being 50 ft. below the street surface. The plant must be operated noiselessly and produce no dirt.

The height of the stack has been fixed by the height of the hotel at about 350 ft. To take up the difference between the expansion of the steel stack and that of the building, the stack was made in short sections and supported from the steel frame of the building.

Because of the lack of area a rectangular stack was used, one joint to each two floors, and the joints instead of being left open were sealed by the special sand and asbestos joint shown in Fig. 6. Brick insulation was not used, because in the rectangular form the heat would have caused it to cave in. Instead asbestos insulation was used, as being thinner, smoother and giving more area.

As regards breeching, the principal points are the easy bends used, the method of caring for expansion and the application of the insulation.

Fig. 7 shows the details of the type of nozzle connection designed to permit expansion. The insulation is applied to the inside of the nozzle and to both the inside and outside of the breeching proper instead of on the outside only. It was deemed that the latter, while fairly effective as an insulation to reduce radiation, is dangerous, as it is possible even with a first-class boiler setting to have a temperature high enough to collapse a steel breeching if the heat is held in by the outside covering.

As regards boilers, the first ones installed were of the longitudinal type, B & W, rated at 600 hp., and were baffled with a special vertical baffle built of a high-temperature cement. The economic results obtained with this cement baffle were very good at first, but the cement soon began to fall out and the stack temperature to go up. Hence, a change was made to the horizontal-type baffle, shown in Fig. 6 (as applied to a cross-drum boiler having the same tube arrangement).

Careful consideration of local conditions has shown the advisability of using gas fuel, and a special gas burner, shown in Fig. 8, was developed. This burner permits an absolute control of the quantities of gas and air and likewise a thorough mixing of the two before their entering the furnace, without allowing the burner to fire back. Although the gas and air are kept separate up to within a few inches of the furnace, a mixture with a very fine subdivision is made, the gas and air being separated only by the walls of the small pipe.

No attempt has been made to make the gas and air control entirely automatic. It was felt that neither the air nor the gas should be controlled independently by an automatic device. It has been found that the amount of time required for gas and air adjustments is small, and it is believed that the advantage of the simplicity is more than enough to offset the costs of hand operation.

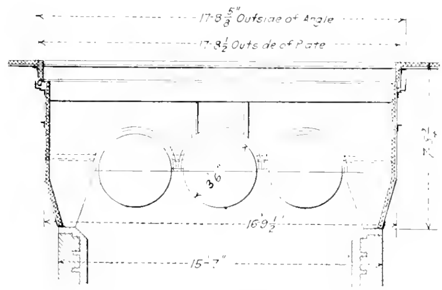


Fig. 6 Detail of Nozzle Connection in the Breeching

The proper adjustments to determine the correct ratio between the quantities of gas and air are determined by the use of a single U-tube. This, as will be noticed in Fig. 8, is connected direct to the gas chamber between the control valve and the mixing nozzles. A schedule of the correct position of the air damper has been determined by special and operating tests. For the sake of simplicity the damper position is indicated by the same figure which represents the gas pressure. The quantity of air is determined by the position of the air damper because the drop in pressure between the boiler room and the furnace is maintained constant at one-tenth of an inch of water. This figure was decided upon as a compromise between a high draft loss through the burner with its disad-

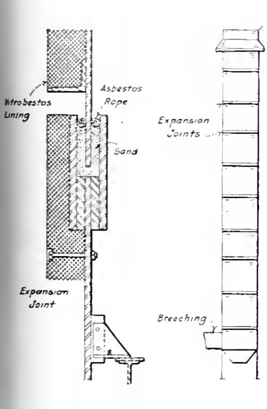


Fig 7

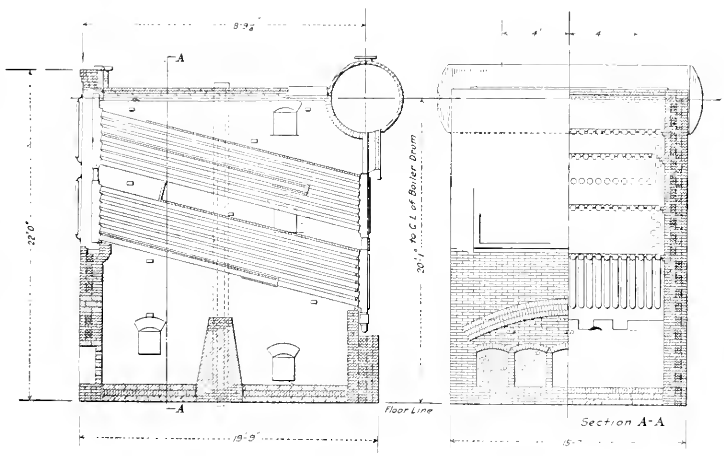


Fig. 8

Fig. 7 Arrangement and Detail of William Penn Hotel Stack
Fig. 8 System of Baffling and Wall Construction for Gas-Fired Boilers

vantage of causing an increased leakage loss through the setting, and a very low draft loss, a slight change of which would cause a large percentage of change in the quantity of air.

The brick work is simple, no checkerwork being used. With the horizontal baffling a medium-height bridge wall with the slightly raised pillar in front of each burner is all that is used, as shown in Fig. 9. The burner, as adopted, is in reality a multiple bunsen burner. Each burner consists of forty-eight 7/16-in. nozzles delivering gas from the manifold to the 2½-in. air openings.

As regards the economic performance of the plant, only the average monthly efficiencies are given in the paper. They vary from 77.2 per cent in November 1916 to 85.2 per cent in January 1917, the lower efficiencies being due to radiation loss at light loads. These figures do not represent a few hours or even a day, but are the average efficiencies for the entire month and show what has actually been accomplished by the regular operators.

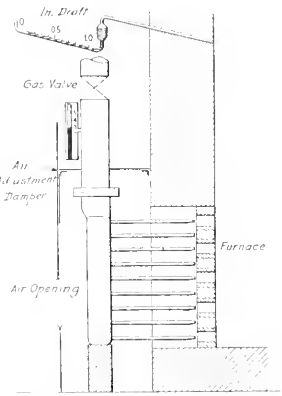


FIG. 9 ARRANGEMENT OF GAS BURNER

The writer ascribes the success of the installation to the following three factors:

1 The cutting out of the loss of draft through the damper and substituting the resistance of a longer path through the boilers, obtaining better heat absorption
2 The design of a durable burner which will give correct mixture under all conditions
3 The maintenance of the proper interest of the operators.

In the discussion which followed, L. C. Frohrieb, of the Federal Engineering Company, Pittsburgh, Pa., told about his tests of a 260-hp. water-tube boiler using natural gas for fuel in which an efficiency of 80 per cent was obtained. This was a three-pass horizontally baffled boiler with "C" tile on the lower row. One of the features was that there was no measurable draft loss through the entire setting, which was due to the fact that the setting was designed for coal.

A. G. Davis, of the Philadelphia Company, Pittsburgh, communicated a simple method of calculating the volume of flue gas which will be given over in the combustion of a unit volume of natural gas. The only data necessary for this calculation are an analysis of the natural gas to be used and a knowledge of the volume required. This method is based on an estimation of the oxygen required to burn the hydrocarbons present in the natural gas. (*Proceedings of the Engineers' Society of Western Pennsylvania*, vol. 33, no. 7, October 1917, pp. 421-456, 12 figs., *de*)

STEAM BOILERS AND ECONOMIZERS, M. R. Schulz (*Ver. d. Elektrizitätswerke*, Mitt. No. 189, March 1917. *Elektrot. u. Maschinenbau*, 35, p. 243, May 20, 1917). No boiler installation with natural draft can yield a higher thermal efficiency than 82 to 83 per cent; from 6 to 13 per cent of the value of the coal burnt goes to maintain the chimney draft, and therefore cannot be utilized in any other manner. With forced draft, up to 85 to 86 per cent of the thermal value of the coal may be utilized; if more than this be utilized, it is offset by power expenditure on the draft fan. Three tests on an inclined-tube boiler of 1000 sq. m. heating surface, with artificial draft and using coal of 7490 kg. cal. per kg. (13,480 B.t.u. per lb.), gave the following ranges of heat-balance percentages: Steam raising and superheating, 75.6-72.9; economizer, 11.1-11.3; total useful heat, 84.2-86.7; chimney loss, 10.1-11.3; incomplete combustion and radiation (boiler and economizer), 3.2-4.5 per cent; fan, 20-23 b.hp. The author finds that the principal error in steam trials is in determining flue-gas temperature, and is generally attributable to unsuitable pyrometer dimensions. As a check on economizer test results and claims, it may be taken that for 1 deg. temperature rise in feedwater in the best economizer, with no in-leakage of cold air, the temperature of the flue gases must be higher by 1.5 deg. cent. for 8 per cent CO_2 content; 2 deg. for 10 per cent, 2.5 deg. for 12 per cent, and 2.75 deg. for 13 per cent CO_2 content. In cast-iron economizers the difference is still greater. With a temperature gradient from 347 deg. to 233 deg. cent. (i. .e., 114 deg.) and 10.6 per cent CO_2, feedwater could not be raised 92 deg cent. in a cast-iron economizer; neither could water be warmed 89 deg. cent. in a wrought-iron economizer. Heat value at economizer outlet is 18.5 per cent with cast-iron, and 17.9 per cent with wrought-iron, apparatus. It does not follow that the lower the flue-gas temperature on leaving the boiler; the higher the efficiency of the utilization of coal. The CO_2 content as well as the gas temperature behind boiler or economizer must be considered. Tests on a water-tube boiler with Düsseldorf cast-iron economizer and forced draft showed 79 per cent thermal efficiency without economizer and 83.3 per cent efficiency with economizer. The author shows that flue-gas temperatures before and behind the economizer were measured inaccurately and losses were estimated too high. The gas temperatures were measured at unsuitable positions, too little attention was paid to CO_2 analysis, and it was overlooked that thermal value changed with decrease in CO_2 content, and that the CO_2 content was much lower at the chimney outlet than at the boiler outlet. The difference is 1 per cent and 3 per cent with cast-iron economizers of 144 and 250 sq. m., and increases considerably with artificial draft.

Boiler efficiency cannot be improved simply by forcing the draft. (*Science Abstracts*, Section B, Electrical Engineering, no. 238, October 31, 1917, pp. 354-355 *g*)

ÉTUDE SUR LES CAUSES DE LA CORROSION DES CHAUDIERES À VAPEUR, Ch. Chorower. *Revue Générale de L'Electricité*, tome II, no. 20, November 17, 1917, pp. 775-779, 2 figs., 2 tables. A discussion of the various causes of corrosion of steam boilers.

CAPITALIZED VALUE OF ONE-TENTH OF AN INCH OF VACUUM, C. H. Baker. *Power*, vol. 46, no. 23, December 4, 1917, pp. 762-763, 3 figs. Formulae and charts are given for calculating the capital that may be economically invested in condenser equipment for each one-tenth of an inch of vacuum gained with steam turbines. Problems are also worked out to show the application of the charts.

THE DETERIORATION OF CURTIS-RATEAU TURBINE BLADING, A. Fenwick. *The Journal of the South African Institution of Engineers,* vol. 15, no. 11, June 1917, pp. 284-287.

ELECTRIC HEAT STORAGE IN BOILERS. *Engineering,* vol. 104, no. 2705, November 2, 1917, pp. 468. Description of an electric steam generator which has been in use for some years in considerable numbers in many Italian works. In this generator the ohmic resistance of the water itself is used for the transformation of electric energy into steam. It is known as the Revel steam generator.

DIE STÜTZUNG VON DAMPFKESSELN UND VON WASSERLEITUNGEN, E. Höhn. *Schweizerische Bauzeitung,* Band 70, no. 18, November 3, 1917, pp. 207-210, 6 figs. Discussion of the methods of supporting steam boilers and water piping.

THE FORM OF BOILER DRUMS, Robert Cramer. *Power,* vol. 46, no. 20, November 13, 1917, pp. 662-664, 8 figs. Discussion of the shape of boiler drums with the view to making a boiler capable of withstanding modern high steam pressures.

NÄGRA ANVISNINGAR FÖR UTFÖRANDET AV VÄRMETEKNISKA BERÄKNINGAR, Alf Grabe. Bihang till *Jern-Kontorets Annaler,* Arg. 18, no. 9, September 15, 1917, pp. 401-425, 3 tables.

NOTE ON THE SPECIFIC HEAT OF WATER, W. R. Bousfield. *Proceedings of the Royal Society,* Series A, vol. 93, no. A 655, Mathematical and Physical Sciences, pp. 587-591. A brief abstract of this paper will be given in an early issue.

Thermodynamics

HEAT TRANSFER FROM AIR TO PIPES, Charles H. Herter. It appears that opinions regarding the rate of heat transfer from air to pipes differ considerably, and the writer cites a number of references showing a variation in k (coefficient of heat transfer from air to pipe in B.t.u. per hr., per sq. ft. of air contact surface, per deg. fahr. mean temperature difference between air and surface) from 13 to 1 B.t.u.

J. E. Seibel stated in 1916 that German engineers use the following values of k:

Air through metal to air .... 1.20 to 1.70 B.t.u.
Water through metal to air .... 2.15 to 3.15 B.t.u.

He also states that for ammonia vapor through iron coils to air, k is roundly estimated at 10 B.t.u., but does not explain why an ammonia-cooled pipe should cool air at a four-times greater rate than a brine-cooled pipe. In fact, the writer questions the existence of such a difference.

The writer also questions the correctness of Siebel's statement repeated in Marks' Mechanical Engineers' Handbook to the effect that 260 to 300 ft. of 1¼-in. pipe per ton refrigeration is a liberal allowance. He does not believe that this is liberal, because even with k as high as 2.5 B.t.u., the necessary temperature difference will be 42.4 deg. with 260 ft. and 36.7 deg. with 300 ft., and it is evident that the allowance made for pipe per ton should be doubled for economical operation.

R. W. Leonard, in a paper before the Canadian Society of Civil Engineers, October 1904, describes some tests on loss of heat from iron pipe with pipes exposed in vertical position to air outdoors in the shade and filled with hot water. From the data given, Mr. Herter calculated the value of k, and found it to be from 1.894 to 3.55 B.t.u. for pipes of various dimensions and various temperatures of air. The last value is for pipe exposed to wind blowing at 480 to 720 ft. per min.

In tests made by the Armstrong Cork Company, values were obtained varying for different conditions of test from 1.8 to 2.18 B.t.u. Various values of k are shown in Fig. 10.

Curve 1 represents values of k given in Kent's Mechanical Engineers' Pocket-Book, 1912, p. 677, for indirect hot-water radiators, where the mean temperature difference is seldom less than 100 deg. fahr. This curve probably applies to nested or deep radiators, the heat-transmitting capacity of which is only moderately high.

Curve 2 represents values obtained by passing known volumes of air through a boiler tube surrounded by steam. The formula applying to this curve is:

$$k = \frac{1}{0.026 + \frac{187}{v}}$$

where v = air velocity in ft. per min.

Curve 3 is based on data derived from Lorenz and Heinel. It gives the value of k for ordinary *brine pipes* to air, as in dry air coolers or coil bunkers with forced air circulation. This curve is intended for velocities exceeding 200 ft. per min., where, according to the authors, the influence of temperature difference disappears. The following formula for this curve is given in the original:

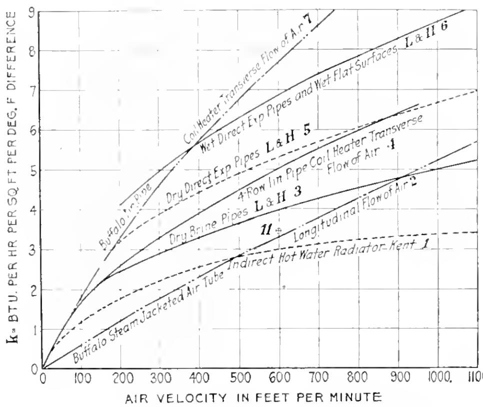


FIG. 10 HEAT TRANSFER CLAIMED BY VARIOUS INVESTIGATORS UNDER CONDITIONS INDICATED WITH AIR IN FORCED CIRCULATION

$$k = 2 + 10\sqrt{v}$$

in calories per hour per square meter per degree centigrade, where v = velocity in meters per second.

In English units, writing v in ft. per min., this formula would read:

$$k = 0.41 + 0.1458\sqrt{v} \text{ B.t.u.}$$

Curve 4 is taken from H. Recknagel, and from Rietschel, 1909. Up to 300 ft. per min. the values of k are those applying to single hot-water radiators. Above 300 ft. they apply to four-row 1-in. steam-coil heaters with the air passing through the heater perpendicular to the pipes.

Curve 5 represents values of k for *dry direct-expansion pipes,* expressed by Lorenz and Heinel by the following formula in metric units:

$$k = 16 \times \frac{2 + 10\sqrt{v}}{12} \text{ calories}$$

which, in English units, is equivalent to

$$1.333 \times (0.41 + 0.1458\sqrt{v}) \text{ B.t.u.}$$

Curve 6, giving values of k with *wetted direct-expansion pipes* as well as with wetted flat surfaces, is based on the following formula given by Lorenz and Heinel:

$$k = 2 + 18\sqrt{v}$$

in calories per hour per square meter per degree centigrade, of which one unit = 0.204817 B.t.u. per hr. per sq. ft. per deg. fahr.

Transformed into English units, this last equation becomes

$$k = 0.41 + 0.2626\sqrt{v}\ \text{B.t.u.}$$

Curve 7 represents the results of tests made on standard four-row indirect or *coil pipe heaters* composed of 1-in. pipes placed on 2⅝-in. centers, air flowing transversely through the heater. The figures of k obtained agree with the following formula:

$$k = \frac{1}{0.0447 + \dfrac{50.66}{v}}\ \text{B.t.u.}$$

where v = velocity of air through the clear area of the heater in feet per min. Up to 1200 ft. per min. they can be expressed by the approximate formula:

$$k = k_0\left(\frac{v}{v_0}\right)^{2/3}$$

which proves that up to 1200 ft. k varies approximately as the *two-thirds power of the velocity,* instead of as the *square root of the velocity,* as has frequently been stated by other investigators.

The writer also gives a simple equation representing the relation in B.t.u. per hr. per sq. ft. per deg. fahr. temperature difference in the case of flow of heat from one medium to another through metal walls of a pipe, and another equation covering the case of a pipe coated with paint or ice on its outer surface and a layer of congealed oil or grease on the inner surface.

He then proceeds to a discussion of tests by Nusselt previously reported in the Journal of the Society of German Engineers, 1909.

In the discussion which followed, F. L. Fairbanks, Mem. Am.Soc.M.E., called attention to the fact that it is quite impossible to secure an accurate heat-transfer test which will be constant, owing to the fact that all factors are variable, and the best thing is to secure some approximate figure which will cover the maximum and minimum conditions in refrigerating plants.

In refrigerating practice the tendency has been in some cases to use the minimum amount of surface that would do the work, and usually the lack of condenser surface has been dearly paid for in operation, because of the high pressure necessary to condense a given unit of gas. The writer has found it excellent economy to have surplus cooling and condensing surface to enable a plant to maintain reasonably high efficiency and economy in spite of the fluctuations which are bound to occur under the ordinary commercial operating conditions.

A. J. Wood and R. B. Fehr, Members Am.Soc.M.E., have discussed the factors involved in heat transmission from air to pipes and have classified these factors under the three fundamental heads of conduction, convection and radiation.

Tests have been carried out by the writers at Pennsylvania State College with the ultimate purpose of establishing constants for these factors. One of the phases of this investigation is the determination of temperature gradients. The importance of it lies in that the amount of heat emitted by a pipe, for example, is independent of the conditions prevailing inside the pipe, provided the surface temperature is the same for different cases, such as gas through metal to gas or liquid through metal to gas.

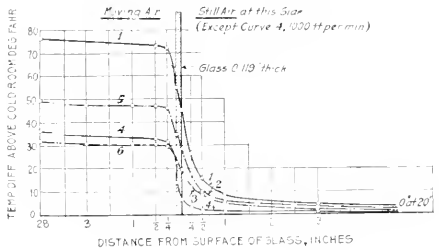


Fig. 11 Temperature Gradient on Each Side of Pane of Glass

Fig. 11 shows the results of a series of investigations on the distribution of the temperature drop from the inside of the test box through a pane of glass to the outside (cold) room. The air inside the box was agitated by an electric fan, while the air in the cold room was "still" (with normal convection) except for curve No. 4 as noted on the diagram. These test results, as obtained by electric-resistance thermometers, bring out the following: (*a*) That the "air films" offer by far the greater amount of resistance, as indicated by the large temperature drop on both sides; (*b*) that the glass, indicated by the small temperature drop, offers but a very small part of the total resistance to the flow of heat; (*c*) that the effect of moving air causes a marked change in the temperature drop on the two sides. (*A. S. R. E. Journal*, vol. 4, no. 3, November 1917, pp. 308-332, 6 figs.)

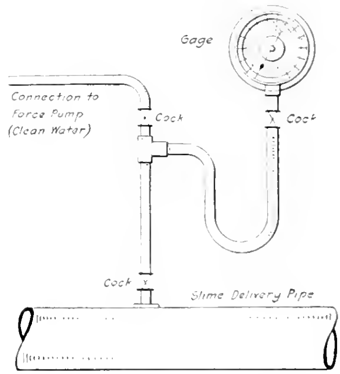


Fig. 12 Device for Measuring Slime Pressure by Bourdon Gage

Varia

Friction of Slime Pulp in Pipes, E. J. Laschinger. Data of some tests on the friction of slime pulp in steel pipes. The matter is of importance on the Rand, since in nearly all reduction plants there the slime is handled in pulp form by means of centrifugal pumps and piping.

The slime pulp consists of finely comminuted particles of rock (200 mesh and less) mixed with water in proportions

varying from 1 to 1 down to almost pure water. The solid particles, for the most part, consist of sandy or clayey constituents which are to a large extent colloidal, and fine, sharp particles of quartz which are crystalline. The fact that the interior of the pipes remains clean would indicate that the friction must be quite considerable, but not excessive, as proved by the very long life of the pipes.

At the beginning of the tests an initial difficulty had to be overcome. The pressures at various points in the pipe line were taken by means of the ordinary bourdon gages, mounted on the usual U-tubes screwed into the pipe. Owing to the sludgy nature of the thick slime pulp, it was found that the gages did not register the pressure correctly, which was due to a plug of solid matter forming somewhere in the U-tube, and interfering with the free transmission of pressure in the pipe to the gage. This was overcome by adopting the device shown in sketch, Fig. 12. The U-tube was filled with clean water at the start and before every gage reading clean water was forced through the gage connection by means of a hand pump, so as to make sure that the whole connection was clear of slime. In this way reliable and consistent readings were obtained.

The paper gives complete data obtained in the test. Only some of these, however, can be reported here.

It was found that the length of piping which would give a friction head equivalent to the velocity head in the case of the long middle section with only one bend is

$$L = \frac{D}{f}$$

where L = length in ft.

D = diameter in ft.

f = coefficient of friction = 0.0183 in this case.

In another place the figure 0.0177 is given for the overall coefficient of friction. On the whole, it has been found that the friction head for slime is about 13½ per cent less than for water. This latter figure has been confirmed in another series of tests with comparatively thicker pulp.

Since the friction head of ordinary slime pulp (measured in feet of slime) appears to be less than friction head of water (measured in feet of water), and since the pipe for the discharge of slime may have to be used for discharging water, a safe rule to the designer is to specify the pump speed, so as to elevate water to the required height, plus the friction in the pipe due to water, and the power of the motor driving the pump to elevate slime to about the same height. In practice this will mean a motor of about 50 per cent greater power than required for water pumping.

A further point to be borne in mind is to design the piping as straight as possible, avoiding sharp elbows, and particularly vertical drops of more than 20 ft.

In choosing a suitable size of piping, the velocity of flow should not be less than 4½ ft. per sec., and in most plants the velocity is from 6 to 7 ft. per sec. (*The Journal of the South African Institution of Engineers*, vol. 15, no. 11, June 1917, pp. 279-283, 1 fig., *e*)

Draft and Enrollment in Engineering Schools. In order to gage the effect of the draft on engineering schools, the *Engineering News-Record* sent a letter to 92 institutions requesting information as to the number of students enrolled at the beginning of the scholastic year for the period from 1912 to 1917 inclusive.

The data collected showed several interesting factors, among them the effect of the depression of 1914 upon enrollment and the remarkable increase in the number of students taking a chemical-engineering course. It was also found that in some schools the senior and junior classes were cut as much as 60 per cent by the operation of the selective draft and through voluntary enlistment. (*Engineering News-Record*, vol. 79, no. 22, November 29, 1917, pp. 1001-1002, 3 figs., *g*)

A New and Novel System of Vessel Unloading. *Railway Age Gazette*, vol. 63, no. 23, December 7, 1917, pp. 1033-1034, 4 figs. Description of the Baltimore pier and its system of vessel unloading recently constructed by the Baltimore & Ohio Railroad.

Catenary Overhead Construction, An Intimate Study of the Design of the Overhead System for the Montreal Tunnel and Terminal of the Canadian Northern Railroad, W. C. Lancaster. *Electric Railway Journal*, vol. 50, no. 23, December 8, 1917, pp. 1024-1029, illustrated.

Engineering Graduates and Industrial Demands, L. W. W. Morrow. *Engineering News-Record*, vol. 79, no. 24, November 13, 1917, pp. 1109-1112.

The "Ratio" Chart for Plotting Statistics, Irving Fisher. *Efficiency Society Journal*, vol. 6, no. 11, November 1917, pp. 562-586, 11 figs.

Water-Tight Doors, Eng.-Lieut. I. Toro. *Transactions of the Institute of Marine Engineers*, vol. 29, October 1917, pp. 219-233, 1 fig.

Improved Engineering Laboratories Indicate Modern Education Trend. *The Iron Trade Review*, vol. 71, no. 21, November 22, 1917, pp. 1104-1105, 9 figs.

Women in Industry, Alex. Moss. *Coal Age*, vol. 12, no. 21, November 24, 1917, pp. 888-889, 2 figs.

L'Utilisation des Mutilés pour L'Organisation du Travail, Ch. De Freminville. *Revue de Métallurgie*, 14e Annee, no. 4, July-August 1917, pp. 586-591. Discussion of the problem of employment in industries of cripples.

Women in Industry. *Cassier's Engineering Monthly*, vol. 52, no. 3, September 1917, pp. 174-185.

Design of Special Slide Rules, A. Lewis Jenkins. *Industrial Management*, vol. 54, no. 2, November 1917, pp. 241-248, 15 figs. (Part 1; to be continued.)

Charts

Charts Showing Canadian Pacific Overhead Construction, W. C. Lancaster. *Electric Railway Journal*, vol. 50, no. 23, December 8, 1917, p. 1028.

Chart of Maximum Live-Load Pier Reactions for Railroad Bridges, F. R. Sweeney. *Engineering News-Record*, vol. 79, no. 24, December 13, 1917, p. 1098.

Curves for Woven and Wrapped Hose, with Sullivan Fittings, Showing Drop in Pressure Plotted Against Air Delivered at Different Pressures. *Western Engineering*, vol. 8, no. 11, November 1917, p. 435.

CLASSIFICATION OF ARTICLES

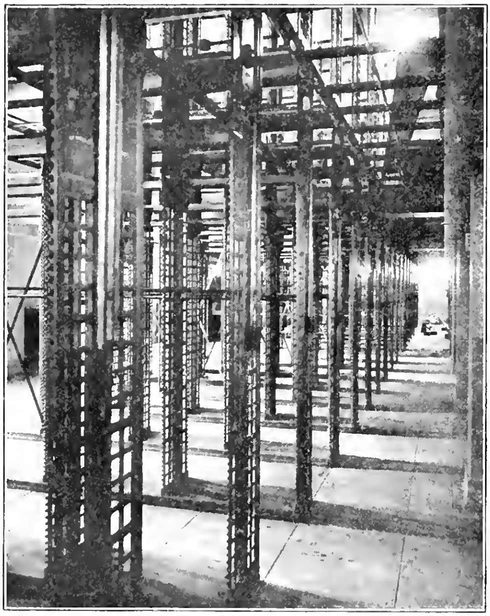
Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Survey.

LIBRARY NOTES AND BOOK REVIEWS

ARTICLES of interest from the Library of the four Founder Societies, selected list of accessions during the month, and reviews of books of special importance prepared by members of the A.S.M.E. and others particularly qualified.

THE illustration shows the new stack and work room, occupying the fourteenth floor of the United Engineering Society Building. This room, which has just been completed, will provide much needed accommodation for the book collection, which has outgrown the shelving originally provided and is now crowded to a point that interferes with prompt service.

The new stack will accommodate about 67,000 volumes, but as the Library has transferred one-half of the twelfth floor to the Founder Societies for storage room, the net gain in



PART VIEW OF NEW STACK FLOOR

shelving is only about fifty per cent of this amount. It will be possible, however, to erect additional book stacks in this room to a total capacity of approximately 100,000 volumes, which will care for the Library for some years.

The room is unusually well provided with daylight and an adequate system of electric light is being installed. No partitions have been built between the stacks and the space reserved for work rooms, thus permitting easy rearrangement at any time to meet changing requirements.

The stacks at present installed were formerly used in the Library of the American Society of Civil Engineers, and were very generously presented to us by the Society. The gift was an especially acceptable one, as it has saved not only the cost of a new stack, amounting to several thousand dollars, but also the long delay which would have been experienced in obtaining new construction at this time.

It is hoped that the new stack will be in use this month. It will enable the Library to arrange its books in better order, thus making the service to readers better. The vacated space on the twelfth floor will at the same time provide storage space for publications which is sadly needed by the Founder Societies.

War Libraries

The libraries established by the American Library Association at the Army training camps are filling a definite want by providing reading for the men and officers. The demands made on them, however, are so broad in scope that it is impossible to fill them all. Technical magazines are much appreciated, as well as those of literary interest.

The following communication from a corporal in training at Camp Wadsworth shows what is needed:

"I am a Civil Engineer and would like to be kept in touch with that profession. A periodical that I would like to read is the *Engineering News-Record*. As I am a railroad man I would also like to see the *Railroad Magazine*.

"I have also a friend in this Company with me who is a car tracer for a railroad corporation. He would like to get any books on the traffic end of railroading. If you wish, you can send anything in this line to the addresses below and we would be very grateful for your kindness."

Anyone wishing to meet this want can do so by sending the magazines to the Camp Librarian, Camp Wadsworth, Spartansburg, S. C. Similar gifts of technical journals would undoubtedly be appreciated by the men at other camps.

Notes

The Illuminating Engineering Society has presented to the Library some eighty volumes relating to the gas industry, among which are many of decided interest. These had been presented to them by Dr. William Paul Gerhard, but the society, believing that the conveniences of all would be best served by collecting all engineering material together, has secured Dr. Gerhard's consent to this disposition of his gift.

Mr. Edward Wegmann has presented to the Library a bound set of the contract specifications issued by the Aqueduct Commissioners of New York City from 1885 to 1901, covering the contracts in connection with the Croton Aqueduct. The estimates and bids for the construction of the various parts of the work have been inserted in this set, adding much to its value for reference.

BOOK REVIEWS

Empirical Formulas, by Theodore R. Running, Associate Professor of Mathematics, University of Michigan. John Wiley & Son, Inc., New York, 1917. Cloth, 6 x 9 in., 144 pp., 31 Figs. and 22 sets of reference curves, $1.40 net.

THIS is the nineteenth volume of the series of Mathematical Monographs edited by Mansfield Merriman and Robert S. Woodward. Although several books on mathematics devote one or more chapters to the derivation of empirical formulæ and there are a few very good magazine articles on the subject, this is the most complete treatise on the subject ever published and the first book worthy of the title.

The derivation of an empirical formula is the result of qualitative and quantitative mathematical analyses of certain data and the general methods are somewhat similar to those employed in qualitative and quantitative chemical analyses. The quality or form of the equation for a given set of data is found by testing with certain reagents such as logarithmic paper, tabulation of differences, graphs of quotients and products, etc., and the quantity or constants in the equation are found by substituting the coördinates of selected points by measurements from graphs, or from tabulated differences. A chemist may exercise all five of his senses in testing for the presence of various constituents in a chemical compound, but the engineer or mathematician is confined largely to his one sense of sight in observing the results of his reagents in determining the form of an equation that is best suited for the data under consideration.

There is a different test or reagent for each form of equation and the guide in using these is a set of reference curves, which are at times misleading. After the form of equation has been determined there should be no particular difficulty in determining the constants.

The subject-matter of the first five chapters of this book consists of discussions and applications of twenty-two tests or reagents based largely on the system of tabulated differences, which may be used to an advantage in many cases. These equations may be looked upon by the engineer as twenty-two tools that may be used in deriving equations that will satisfactorily represent the results expressed by data. It does seem that this number should be sufficient for such work, even though considerable difference of opinion is liable to be exercised in choosing such a collection. Many of the equations given by the author would be selected by most anyone familiar with the subject. Several of the equations given by him lead to rather complicated formulæ and should be avoided unless there is some exceptional reason for their adoption. Most any exponential formula is likely to be inconvenient or cumbersome to use, but fortunately the solutions of such may be readily performed by means of slide rules and charts.

Chapter V is devoted to the application of Fourier series to a number of ordinate schemes, which are applicable to periodic laws based on angular measurements such as wave analysis and certain theoretical phenomena. In Chapter VI is found a very good explanation of the application of the method of least squares to the derivation of empirical formulæ, in which the essentials are clearly and briefly given. Chapter VII deals with interpolation and differentiation of tabulated functions. It is of particular value in computations of precision in which a high degree of accuracy is desired. Chapter VIII gives some very practical work on numerical integration that should be useful to engineers.

The Appendix gives a very useful set of curves corresponding to each of the before mentioned twenty-two equations and is one of the most important features of the book.

Although the methods proposed by Prof. A. S. Langsdorf and Mr. Winslow H. Herschel are not pointed out as such, the principles involved in their methods are included in the author's system of tabular differences. The system adhered to by the author includes the principles of the calculus, although he uses rather simple algebraic equations in preference to differential equations and his demonstrations are very easily followed. The calculus is used in only two chapters. The matter in the other six chapters and appendix is of a very practical nature and may be comprehended without knowledge of the calculus as such.

More space could have been devoted to the use of logarithmic paper, even though this subject has been very well covered in other books. Brief discussions on dimensional consistency, when to apply certain tests, simplicity vs. accuracy and distinction between accuracy and precision, would not be out of place in such a book.

This is a practical book and should be particularly valuable to engineers engaged in research, design, time study, estimating costs, testing and any other work involving the use of tabular values derived from experimental or other observed data.

A. Lewis Jenkins.

ACCESSIONS TO THE LIBRARY

Abbott Enamel Sign Company. *New York City.* Catalogue, n. d.

Die Achate. By R. Ed. Liesegang. *Dresden, 1915.* Purchase.

Acquiring Wings. A Text on the Basic Principles Governing the Design and Operation of Modern Air Craft. By William B. Stout. N. Y., Moffat, Yard & Co., *New York, 1917.* Cloth, 5 x 7 in., 57 pp. 11 illus., $0.75. Gift of the publishers.

Air Brake Association. Proceedings of 24th Annual Convention, 1917. Gift of Association.

Air Power, naval, military, commercial. By Claude Grahame-White and Harry Harper. *New York, 1917.* Purchase.

Air Screws, an introduction to the aerofoil theory of screw propulsion. By M. A. S. Riach. *London, 1916.* Purchase.

Applied Methods of Scientific Management. By Frederic A. Parkhurst. 2d ed. John Wiley & Sons, Inc. *New York, 1917.* Cloth, 6 x 9 in., 337 pp., 55 illus., $2. Gift of the publisher.

American Bureau of Shipping. Rules for the classification and construction of Steel Ships. *New York, 1917.* Gift of American Bureau of Shipping.

American Institute of Architects. The Annuary, 1917. *Washington, 1917.* Gift of American Institute of Architects.

American Road Builders' Association. Proceedings of the 14th Annual Convention. *New York, 1917.* Gift of Association.

The Aniline Color, Dyestuff and Chemical Conditions from August 1, 1914 to April 1, 1917. By I. F. Stone. *n. p. 1917.* Gift of Arthur Worischek.

Asphalt and Asphalt Pavements, Papers on. By Clifford Richardson. 1912-1917. Gift of author.

Association of American Steel Manufacturers. Standard Methods of Sampling for Check Analysis adopted by the Association. 1912.

—— Standard practice governing the allowable variations in size and weight of hot rolled bars. Adopted by the Association 1910.

—— Standard specifications for concrete reinforcement bars rolled from billets, as adopted March 22, 1910, revised 1912 and Apr. 21, 1914.

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THE RELATION OF ENGINEERING TO INDUSTRIAL MANAGEMENT

By D. S. KIMBALL, ITHACA, N. Y.

In the preceding issue of The Journal was given a complete though necessarily somewhat condensed account of the Thirty-eighth Annual Meeting of The American Society of Mechanical Engineers. So much space was needed, however, to recount what have been referred to as the "war features" of this convention, that last month no more than a passing review of the usual technical proceedings of the meeting could be given. This issue contains an extended account of these proceedings, with discussions, oral and written, of the engineering papers presented. The issue therefore really constitutes a supplement to the preceding number.

Prefacing this discussion is an address by Prof. D. S. Kimball, member of the Society's Committee on Meetings, which is particularly timely in view of the tendency of the Society to interest itself in matters of "social economy," a course which is justified in the mind of every member at this critical period in the history of democracy.

We have all become somewhat accustomed to seeing the engineer called upon to perform new and strange duties, but few of us were prepared, I believe, to see an engineer called upon to undertake the greatest piece of constructive economics ever attempted. I refer to the work of Mr. Hoover, for Mr. Hoover is by training and practical experience a mining engineer. Yet this somewhat startling event is in full keeping with the trend of modern industry. Every day sees the duties and responsibilities of the engineer widened and it is difficult to see where the end will be. The engineer from the first has had a difficult time trying to define just what his field of activity is. This is necessarily so in any civilized community where the life of the people rests upon mechanical contrivances. Engineering, and mechanical engineering in particular, is an integral part of everyday life and necessarily assumes fresh aspects as the complexity of modern life increases. It will be increasingly difficult to set its limits and boundaries.

These matters have long been a cause for work and worry on the part of teachers in technical schools. The original conception of these institutions was to train men to design, build and operate machines within a narrowly defined field. Fifty years ago the term "mechanical engineer" conveyed a fairly distinct definition of activity; today it is almost meaningless.

The closely prescribed curriculum of the early engineering schools of years ago succeeded well in sending out men who in time made a place for themselves in the engineering field. But the men who passed through these schools were far from satisfied with the training they thus received. Their complaint, however, has not concerned the technical studies imposed upon them alone, but has embodied a demand for broader training in harmony with changing industrial conditions. The variety and scope of these demands have been great and have changed with the changing industrial field, but the demand for instruction in the subjects that pertain to industrial management has been constant, insistent and has grown steadily. Today there is not a first-class technical school in this country that is not recognizing this demand. The technical schools of today are not places where engineers, as defined by this term originally, are educated, but they are schools that prepare men, and women also, for industrial life in an amazingly broad manner. An examination of the list of graduates of any good technical school will show that twenty-five per cent of them remain in engineering pursuits in a narrow sense, the remainder going into a very wide variety of industrial pursuits. A very large and increasing proportion are found on the management side of industry.

It may be argued, of course, that while engineering may be a part of management, management is not part of engineering. And it may be truthfully stated that the engineer has been drawn over into management more because of his peculiar method of attacking problems than because of his technical or commercial knowledge; and that for this reason engineering colleges may well neglect these broader subjects and confine themselves to the time-honored engineering studies. While this may all be true theoretically, the fact remains that the industrial field is demanding men from the engineering schools who are well grounded in engineering and, in addition, know something of management. Hence we find such subjects as economics, psychology, logic, public speaking, and similar studies included in engineering curricula, and they appear no more or no less strange there than does an engineer as a food administrator.

Now what is true of the engineering schools is equally true of The American Society of Mechanical Engineers. The engineering colleges have lagged behind the industrial field in these matters, and the engineering societies in turn have lagged behind the colleges. It is interesting and instructive to read what the founders had in mind when the Society was organized in 1880. Dr. Robert H. Thurston, the first President, in his inaugural address states these objects to be "the promotion of the arts and sciences connected with engineering and mechanical construction." And the chairman of the preliminary meeting, Mr. A. L. Holley, enumerates in some detail the several branches of engineering contemplated as follows: metallurgy, railway engineering, machine-shop work, rolling mills, structural work, national defenses, shipbuilding, agricultural machinery and textile machinery, and concerning the latter he states, "The public would deem it quite outside of mechanical engineering." It is on this analysis as a basis that the first list of those eligible to election was made up, namely, mechanical engineers, civil engineers, military engineers, mining and metallurgical engineers and architects. And after reviewing the field, which to us now seems so restricted, Mr. Holley remarks, "I confess that in thinking over the range of mechanical engineering with reference to our proposed society I was astonished at its magnitude. I had never realized it before."

Only once in the statements made by the founders concern-

Presented at the Luncheon, on Thursday, December 6, 1917, at the Annual Meeting of The American Society of Mechanical Engineers.

ing the objects of the Society do we see a vision of what the future held for the Society when Dr. Thurston said, "Its province will be no less in the field of social economy than in that which has reference only to the individual needs of its members." This germ of thought has always remained in the Society and found its most widely known expression in Frederick W. Taylor's classic paper on Shop Management. But though this remarkable paper was presented to the world through the Society, comparatively little has been done by the Society to further this important line of thought. There is not even at this time a sub-committee on this field of work.

Ten years ago Prof. F. R. Hutton in his presidential address made an exhaustive review of the aims and activities of the Society which is well worth reading. He found that about fifty per cent of the membership at that time was classifiable under the headings "manufacturer," "shop executive" and "local manager." Yet the TRANSACTIONS for that year do not contain a single paper on industrial administration, though Taylor's masterpiece had been published three years before. An examination of any page of the year book will show that this relation has not changed and that the Society is far from being, strictly speaking, an engineering society, but that it represents industry in a very comprehensive and broad manner. That this view is recognized is clearly shown by the names of a few papers in the TRANSACTIONS for 1916, as for instance, How Does Industrial Valuation Differ from Public Utilities Valuation, or Graphical Control on the Exception Principle for the Executive.

What is true of the relation of mechanical engineering to management is also true of many other fields. Is the problem of electric welding one for the mechanical engineer or does it belong to the field of electrical engineering? Where shall we place oxy-acetylene welding or the thermit process? Accident prevention is certainly within the range of the Society's activity, so far as the mechanical features are concerned, but how far shall we interest ourselves in employers' compensation acts and the legislation that lies back of this important movement? Shall we discuss it as a problem in mechanical engineering or shall we also include the humane features of the problem? At the present moment a strong movement is on foot to interest engineers in the important problem of Americanization, and engineering schools are being urged to pay special attention to this matter. The subject is timely and important and no single class of men can do so much to promote it as the engineers. The problem is closely connected with industrial management; shall it become, therefore, a problem for engineers and engineering societies?

These intricate relations come before the Society largely through the work of the Committee on Meetings in passing upon papers to be presented before the Society. As would be expected from the foregoing, the papers offered cover a very wide range. The majority are well within the range of the field of engineering as commonly understood, a number are in the field of industrial management or in other fields equally removed from engineering in a strict sense. From this latter class the Committee on Meetings selects those that, in its opinion, can properly be presented, though even with this class of paper the Committee is not always unanimously agreed. Lastly, there are a number of papers presented that in the opinion of the Committee are so far removed from engineering as to make their presentation questionable, though they are sometimes valuable papers. The tendency, therefore, is rather to discourage papers which treat of matters on the "fringe" of engineering. I sometimes wonder if Taylor's paper on Shop Management, had it been presented by some one less known and under some other title, would have been accepted. It is fairly certain, moreover, that if more encouragement were given to papers of this broader character the Meetings Committee would be in receipt of many more of them, and it is not too much to expect that it would, in time, receive papers that would be as great in their field as is Taylor's classic. It is entirely a matter of how far the Society wishes to recognize its non-technical membership. It is noteworthy that the best collection of papers on the problem of employment of which I am aware is not found in the literature of engineering or industrial management, but is in the Annals of the American Academy of Political Science. I wonder how many employers have seen them. Quite a number of these papers were written by engineers and industrial executives. It is also to be noted that within the last year at least two societies have been started to carry out work that, in my opinion, belongs to this Society.

I believe the time has come, therefore, when the Society should redefine its aims and objects, and I would like to see an inquiry made into the aims and objects of our Society with a view to finding out how well the literature of the Society is meeting the wants of our membership. Or, putting it another way, if we are satisfied with the literature I think we should try to obtain a membership that is in harmony with it, a condition which, in my opinion, does not exist at present. And I should like to see such an inquiry made in a statesmanlike manner without reference to persons or groups of persons, but with the sole object of finding out what is best for the Society and what will insure to it an enduring future.

There will never be a better or more opportune time to consider this subject. Every loyal American is now asking himself what are his duties and responsibilities. Every technical school is facing a reorientation of its purposes and aims. As a nation we are facing a period of self-analysis that may result in changing some of our fundamental policies. I am not so sure, for instance, that we shall continue to be a "refuge for the oppressed of the earth" unless we are quite sure that the aforesaid oppressed are really in pursuit of the liberty and happiness that we all hold so dear. Americanization may indeed be a part of the work of all organized bodies that are interested in the existence of the Republic. If we have not at this moment a clear vision of whither we are tending, now is the time of all times to take stock of ourselves and to redirect our course, whether this course is in conformity with time honored definitions or not. Change is not necessarily synonymous with progress, but there is no progress without change. No one can doubt that the scientist and the engineer are to be the most important industrial figures of the near future. If we are faithful to our duties we shall be of greater importance politically and socially, but to accomplish this we must broaden our vision and get about our business, which is the industrial organization of our country.

At the beginning of January the Ordnance Department of the U. S. Army opened up a headquarters in the rooms of the Society for the purpose of recruiting and commissioning officers qualifying for ordnance service. The recruiting officers were Major Fred J. Miller, Capt. Henry C. Phipps, and Lieut. M. Goedecke, who comprised the examining board. Utilizing the Society's "war classification list," the board secured names of members of the Society qualified for the particular duties the Ordnance Department needed and issued calls to them. The work was kept up for several days, during which time upward of 1000 men presented themselves for examination.

POWER TEST HEARING AT ANNUAL MEETING

An Account of the Proceedings of the First Public Discussion of the A.S.M.E. Rules for Conducting Performance Tests of Power Plant Apparatus, Issued in 1915

THE public meeting of the Power Test Committee was held on Friday, December 7, and was called to order by President Hollis at 10 o'clock. The immediate object of the hearing was to discuss the various testing codes as published by the Society, and the ultimate object was to aid the Power Test Committee in such revisions as might be needed to make the codes of the greatest service to the profession, and to bring them up to date.

The members of the Power Test Committee, originally numbering eight, but increased later to twelve, were invited to sit at a table in front of the audience, and the members of the Advisory Board, composed of Society members identified with manufacturers and users of power-plant apparatus, appointed by the Council and numbering fifteen, were asked to take seats in the front row. Nine members of the main committee and nine of the Advisory Board availed themselves of this invitation.

President Hollis then addressed the meeting on the object of the hearing. He said that codes such as those under discussion were growing and changing, and that in order to make them valuable to the country at large there must be constant amendments and additions, the need for which arose not through oversight on the part of the Committee, but rather through changes in the demands of business and the use of better and different instruments. Moreover, although there might be a great many methods of generating power, and therefore a number of codes needed, there should be some definite principle underlying them all. The codes, he said, belonged no longer to the Society, but to all users of power, and therefore should represent the best effort and experience obtainable.

President Hollis explained that a program had been arranged in accordance with which the discussions of the various codes would be taken up at scheduled hours in order that the hearing might be conducted systematically. This program was closely adhered to, with the exception of the latter part when it was found that less time was needed than had been planned.

Mr. George H. Barrus, Chairman of the Power Test Committee, then presented a statement of the history of the Committee and the objects for calling the present hearing. Those present had been provided with a printed copy of his statement, which included the personnel of the Committee and of the Advisory Board. He stated that special written invitations had been mailed to some sixty engineering societies, organizations and associations interested in the subjects to be discussed. Similar invitations were sent to about forty manufacturing concerns and trade organizations, fifteen railroads and twenty-five colleges. Special invitations were sent to prominent engineers not members of the Society, to the United States Bureau of Standards, and to the Navy Department Bureau of Steam Engineering. Over half of these invitations had been accepted.

President Hollis then threw open the meeting for the discussion of the first thirty-three paragraphs of the codes embodying the General Instructions. It was decided that the discussion proceed without the reading of the paragraphs, as everyone in the audience had a copy of the complete report. It was also decided to omit the reading of all written discussions, as these would be placed in the hands of the Committee.

The oral discussion was opened by Capt. T. W. Kinkaid, head of the Engineering Experiment Station at Annapolis. Captain Kinkaid read a statement prepared by the engineers of the Experiment Station dealing with the General Instructions. Comments were made on some twenty of the subjects.

The remainder of the discussion on the first 33 paragraphs referred to details of the present general instructions, including changes in wording, methods and use of instruments, measurements, calibrations and standards. Those taking part were Messrs. Moss, Moody, Delany, Reynolds, Kruesi, Allerton, Vennum, and Greene. Messrs. Hirshfeld and Sparrow thought there should be a complete revision of the whole subject, and the President suggested that this latter point of view might be put into concrete form by a committee representing those who believed in a complete revision. He pointed out that the Society was not bound to abide by what the Power Test Committee had published up to the present time if something better and more useful could be suggested. Prof. Arthur M. Greene, Jr., thought it would be best to defer any such action until the codes had all been discussed, and in this view the President finally concurred. No further reference was made to the subject during the hearing. A little later, however, Mr. Moss expressed a conviction that no such complete revision as that suggested by Mr. Hirshfeld was needed.

Discussion of Code for Testing Boilers

At the request of the President, Captain Kinkaid continued with the portion of his discussion which related to the Code for Testing Boilers which was next in order for consideration.

E. B. Ricketts submitted to the Committee a form which he had used successfully for a number of years for reporting boiler tests and the instructions which were a part of the general scheme. He also included a chart from which many of the calculations of the boiler test could be made with a minimum of labor.

C. H. Delany made suggestions regarding tests of oil-fired boilers, and presented them to the Committee in written form. He wished the Code to include a separate tabulation for oil-fired boilers.

Prof. Charles R. Richards filed with the Committee a copy of a bulletin entitled A Study of Boiler Losses,[1] which included in an appendix a suggested code for boiler losses, a subject he considered inadequately handled in the present code.

R. Sanford Riley thought the rules for starting and stopping tests too definite for certain types of stokers where conditions in the fire were considerably different from those in hand-fired furnaces, Louis E. Strothman submitted a suggestion for the determination of boiler leakage, E. G. Bailey offered suggestions regarding the effect of the rate of steaming at the time of starting and stopping, and Captain Kinkaid presented some notes entitled, Correction for Difference in Quality of a Fuel Bed at the Beginning and at the End of a Coal Test.

[1] Bulletin No. 78, Engineering Experiment Station, University of Illinois, Urbana, Ill.

Steam-Engine Code

Sanford A. Moss opened the discussion on the Steam-Engine Code by offering his criticisms and amendments to certain sections of the Appendix dealing with this code. He also suggested that the Steam-Turbine Code come first and that the Steam-Engine Code refer to it, as he thought more tests were made of turbines than of engines.

Prof. Charles R. Richards discussed parts of the code at length and William L. De Baufre and Prof. A. G. Christie submitted written discussions.

Louis E. Strothman also joined in the discussion.

Steam-Turbine Code

B. F. Tillson suggested the CO_2 method of tests in cases where no surface condenser was in use.

S. A. Moss objected to the use of anything but a mercury gage for determining vacuum. He gave his views regarding corrections for different vacuums.

Thomas E. Keating seemed to be of the opinion that the code had never been "adopted," inasmuch as engineers who tested turbines did not seem to use it. Apparently, he said, there was something wrong with it, and if so it should be revised. He offered no specific suggestions as to what sort of revision would be acceptable, but suggested that representatives of turbine builders and turbine users be called in to assist in laying out a new code.

Prof. Arthur M. Greene, Jr., thought that the code should include some method of correcting for changed conditions which could be used in the case of small turbines where the expense of running a series of tests to determine these corrections would be out of the question.

A. H. Kruesi and J. P. Sparrow spoke regarding methods of determining vaccum.

Pumping-Engine Code

Frank F. Nickel submitted to the Committee a revised code. He was followed by Robert W. Allerton, who explained the need of a revised code from the standpoint of the use of centrifugal machinery. He also presented a scheme for making hydraulic measurements. In addition, he pleaded for a table of "terms" which would define absolutely such engineering terms as admit of several interpretations. Professor Greene also felt that an interpretation should be put upon certain terms by the Society so that an engineer might have an authority for his use of them.

At the close of this discussion, the meeting was adjourned for lunch, and reassembled at two o'clock with President Hollis again in the chair.

Compressor and Blower Code

Hugh V. Conrad, Secretary of the Compressed Air Society, opened the discussion on the Compressor and Blower Code by presenting to the Committee a number of suggestions regarding measurement of air. He called attention to the method recommended in the present code for measuring air and suggested that the orifice method be substituted.

Sanford A. Moss thought that the code should provide for the testing of electrically driven units. He also started a discussion on the term "free air," which was participated in by S. B. Redfield and William L. De Baufre. Mr. De Baufre suggested the preparation of a separate code for blowers and fans, as he thought much confusion resulted in trying to apply the Compressor Code to them.

Steam-Plant Code

The Steam-Plant Code elicited discussion from George C. Vennum and Philip E. Reynolds criticizing the phraseology of the code and calling attention to some ambiguity of terms. They also felt that condensers and pumps were not properly treated, and therefore presented suggestions for amendments to the code covering condensers of various kinds, air-removal apparatus and cooling towers.

Locomotive Code

The only speaker on the Locomotive Code was Prof. Charles R. Richards, who emphasized the need for incorporating some recognition of cinder losses. He also suggested that the Committee adopt the code used by the American Railway Master Mechanics' Association, and locomotive-testing experts be consulted.

Water-Wheel Code

Chairman Barrus opened the discussion on the Water-Wheel Code, the inadequacy of which seemed to be generally admitted by all speakers and interest in which seemed greatest of all. There were assembled in the audience as representative a group of hydraulic engineers, probably, as could be gathered together.

Chairman Barrus announced that the Committee had had under consideration for several months the work which was being done by the Turbine Builders' Association and the Machinery Builders' Society relative to standardizing the methods of conducting acceptance tests on hydraulic turbines, and that it had just received the official copy of the code which was the result of their work. This code, he said, would have the due consideration of the Committee and in many ways would be of assistance in their deliberations.

He also announced that at the invitation of the Council, the American Society of Civil Engineers, the American Institute of Electrical Engineers, and the National Electric Light Association had each appointed three representatives to confer with the Power Test Committee and to coöperate with them in the revision of the Water-Wheel Code. The conference was scheduled for the following week.

There seemed to be some delay in starting a discussion in which so many were not only interested but able to take intelligent part for the information of the Committee, until Lewis F. Moody called upon John L. Harper.

Mr. Harper said that until the present hearing his attention had never been called to the Water-Wheel Code. He pleaded for consistency of action in the various engineering societies interested in such a code if one was to be adopted, and seemed to feel that the basic need of any code was an accurate means of measuring water, suggesting, in spite of the difficulties which it apparently presented, the volumetric method. He was insistent in the statement that an adequate code, based upon correct principles, was an immediate necessity.

William M. White, who was interested in the code proposed by the Machinery Builders' Society, asserted that builders of water turbines had waited for years for some one to bring out a code under which they could make guarantees which they could carry out. He pointed out that the builders were interested in the measurement of water, but they did not care so much how it was measured as long as the turbine

was tested under the same conditions and with the use of the same weir coefficients as were assumed when the guarantee was made.

The remainder of the discussion, in which Messrs. Carle, Johnson, Moody, Allen, Herschel and Taylor took part, merely brought out the fact that all agreed as to the need of a revised code. To bring the matter to a head, Mr. White offered a resolution to the effect that it was the sense of the meeting that the code adopted by the Machinery Builders' Society was satisfactory and recommended it to the Committee for acceptance, but it was finally shown that the resolution was unnecessary.

Sub-Committees on Codes Proposed

Dr. Jacobus then spoke in the capacity of delegate from the Society of Naval Architects and Marine Engineers, suggesting the appointment of several sub-committees, each one of which was to have particular charge of a single test code, such as had already been done with reference to the Water-Wheel Code. The matter was put into the form of a resolution by Professor Allen to the effect that it was the sense of the meeting that such committees be appointed. The President assured the meeting that the Council would consider the resolution that very afternoon, and explained that it was the custom of the Council to consult with members of other societies on matters relating to their interests.

After considerable discussion, which centered around the relations of the subcommittees proposed, the Advisory Board and the Power Test Committee, the resolution was adopted.

During the discussion, N. A. Carle spoke of the American Engineering Standards Committee, of which he was a member. He said that the scheme of the committee was not the revision of standards but entirely that of acting as the connecting link between the societies and organizations who had established the standards. A standard, adopted by a society, would be referred to the committee for approval. If found acceptable to them, they would refer it to other societies interested in the subject considered, and upon universal approval, approve it as standard and recommend it for practice for one year. At the end of that time it would be stamped "American Engineering Standards." The result, he explained, would mean that some day it would be possible to say, "I want a power system of one million kilowatts capacity, American Engineering Standards."

President Hollis turned the chair over to Dr. Jacobus, who called upon Ervin G. Bailey to explain his system of measuring steam by means of carbon dioxide. The method, which is analogous to the salt-solution method used by hydraulic engineers for measuring water, was described in a paper presented to the Boston Section of the Society in May 1916.

The meeting closed with a discussion started by R. Sanford Riley on the errors in starting and stopping boiler tests. James W. Parker cited an extreme case of a test in which thirty tons of coal constituted the kindling fire, showing thereby the possibility of an enormous error which, he believed, could be avoided only by lengthening the duration of the test until the amounts of coal stored on the grates would bear an insignificant proportion to the total coal fired. Others agreed that this was a very uncertain element of any test, and expressed their belief that longer tests would avoid this error.

Chairman Jacobus asked for opinions on the question of sampling, and was answered by several members to the effect that the size of the sample should be as great as possible to insure the best results.

The object of the hearing having been accomplished and all of the codes disposed of, Chairman Jacobus adjourned the meeting at about 4:30 p.m.

IMPORTANT DISCUSSION ON VARIED POWER PLANT SUBJECTS

Proceedings of Session Devoted to Papers on Small Turbines, Waste of Coal, Bagasse as Fuel, Cooling of Water, and the Steam Motor

ONE of the busiest sessions of the Annual Meeting was the Power-Plant Session held on Wednesday afternoon, December 5, on the fifth floor of the Engineering Societies Building. Five papers, each one of them of sufficient importance to occupy the entire afternoon, were presented and discussed. Thanks to the enjoinder of the chairman, Mr. William B. Jackson, that all speakers carry the matters they wished to discuss well in their minds and come straight to the point, close attention was given to the work of the session and the long program was carried through very satisfactorily and without need of adjournment.

The five papers were on varied and timely topics in the power-plant field. They were all published in advance in The Journal and excited a wide interest, as evidenced by the large number of written discussions sent in prior to the meeting. The titles of the papers were: A Commercial Analysis of the Small-Turbine Situation, by W. J. A. London; Preventable Waste of Coal in the United States, by David Moffat Myers, member of the Committee of Consulting Engineers on Coal Conservation and Publicity coöperating with the Fuel Administrator; Bagasse as a Source of Fuel, by E. C. Freeland; The Cooling of Water for Power-Plant Purposes, by C. C. Thomas, and The Steam Motor in the Automotive Field, by E. T. Adams.

A running account of the discussion at the session, including pertinent abstracts from the written discussions, is given below. The full discussions, both oral and written, and the authors' final closures will be published in the Transactions, together with the revised papers, as usual.

A Commercial Analysis of the Small-Turbine Situation, by W. J. A. London

In his paper, which he presented in person, Mr. London developed a commercial analysis of the four types of small steam turbines now on the market and used for the driving of auxiliary machinery, dealing principally with non-condensing units. He said that in these high thermal efficiency is in many cases unnecessary on account of economic utilization of the exhaust steam, and as economy bears a definite relation to first cost, a highly efficient machine is often a mistaken investment. Moreover, operating conditions are generally such that the designer must sacrifice considerations of efficiency if they interfere in any measure with simplicity and durability.

The theoretical design, he thought, presented no difficulties, but the mechanical design is what determines success or absolute failure; and some of the problems involved and the

methods that have been employed in solving them successfully were indicated in the paper. Among these problems was that of alignment of the turbine with the driven unit, and in this connection he illustrated a two-bearing combined unit which has eliminated misalignment troubles.

He said that the average specification calls for very rigid guarantees as to steam consumption, speed regulation and load requirements that, in his opinion, are in most cases unnecessarily severe and merely tend to increase the cost of installation. After an extended survey of the situation, he was led to formulate a Code of Practice, given in an appendix to the paper. The adoption of this code would, he believed, bring about a reduction in selling prices, eliminate many of the unpleasant experiences which now often arise between manufacturers and customers, and thereby increase the popularity of the turbine-driven unit.

O. D. H. Bentley, in a written discussion, entered a defense of the type of turbine styled by the author as class "(*b*) Terry, Sturtevant and Bliss." He said that, other things being equal, the amount of energy a rotor will extract from the steam varies directly as the angular reversal. The author showed diagrammatically that the reversals in the rotor and redirecting chambers of the Terry, Sturtevant and Bliss turbines, all of which utilize the Riedler-Stumpf principle, were approximately 90 deg., but this was incorrect as the reversals were practically 180 deg. It was therefore fair to assume that this type of turbine will absorb practically double the amount of energy per reversal, compared with the Curtis.

Secondly, in the Riedler-Stumpf type, as the author states, the action is complex. This should not condemn the principle but on the other hand should indicate that even better efficiencies with this type are possible when the action is better understood. The Curtis principle has been highly developed, whereas the Riedler-Stumpf has not to date been given serious attention.

The author's statement that the Terry Company has recently developed Curtis machines would seem to indicate that they are abandoning the original Terry machine, whereas, as the writer understands it, the Terry machine is still used on small sizes while the Curtis principle is used for larger or condensing turbines only.

In regard to lining up a turbine and its driven members, he thought it was a comparatively easy matter to do this. It is more a question of education than of adapting a design to eliminate this necessity, thereby possibly getting into other troubles. Some difficulty has been experienced because engineers have assumed that it was not necessary to realign units, especially if they came mounted upon a self-contained cast-iron base and were connected by a flexible coupling. Experience has shown that after a turbine is once lined up it will retain its alignment indefinitely, provided, of course, it has a suitable foundation.

The majority of engineers seem to agree that it is more desirable to have any piece of high-speed apparatus mounted between two substantial bearings than it is to have it overhung. There is no doubt, however, that the latter is cheaper, lighter and occupies less space. The primary consideration in machinery for auxiliary service is, however, reliability, and experience has shown that overhung elements are more sensitive to trouble than those supported between two bearings.

He considered the author's Suggested Code of Practice advantageous not only to the manufacturers but also the ultimate users, but he agreed that in order to apply the idea everyone must adopt and adhere to it.

A. G. Christie took a different view of efficiency to that presented by the author, though he admitted his view might not be consistent with commercial considerations. He wrote:

"This war is bringing home most emphatically to our American people the need of economy. To the engineer this means getting the greatest number of B.t.u. in useful work from each pound of coal burned. The days of cheap coal are fast passing, and with every dollar added to the cost of a ton of coal, the gain from the use of economizers increases. Hence, great impetus will be given to the installation of such equipment and to water-treating systems which will ensure economical operation of such economizers.

"Now, with economizers in a plant, the feedwater need be heated only to 100 instead of 210 deg. fahr. where feedwater heating by exhaust steam is now used. Hence, under such conditions less exhaust steam will be required; and when steam-driven auxiliaries are preferred to motor-driven units, their economy will be closely scrutinized. It may then be desirable to pay a little more for the more economical turbine auxiliary.

"Improvement of design is not wholly inconsistent with decreased cost of manufacture. In fact we have reason to expect our designers to improve their designs with increased knowledge of steam performance and blade materials and at the same time to cheapen their product.

"The small steam turbine usually employed in driving auxiliary machinery does not require much attention as a rule. It would therefore seem that the class of labor employed in looking after auxiliaries should not be a prime consideration in determining the efficiency of the turbine, as Mr. London would lead us to believe. Still, Mr. London is quite correct in insisting on simplicity and durability."

He said that the author's discussion of alignment is very timely and deals with a point that has been a source of great annoyance to purchasers of small turbines. It is to be hoped that manufacturers will take steps at once to finally overcome these difficulties, particularly in those cases where all equipment is not supplied by one party.

He agreed with Mr. London in regard to the unreasonable demands by some engineers for numerous guarantees on each small unit that they buy. He had often felt that these men lacked data in regard to turbine performance. The demands of engineers for guarantees would be simplified if manufacturers would loosen up on this data and let engineers become better acquainted with turbine performance under varying steam and back-pressure conditions and speeds.

Mr. London argued very vigorously for standard ratings of turbines. On a previous occasion, he had urged before the Society the desirability of fixing certain standards for rating steam turbines. It would be most desirable to decide whether the normal rating should be at maximum load or at some percentage of that load. He proposed to bring this matter before the Power Test Committee at its forthcoming meeting.

J. L. Moore, also in a written discussion, considered the author's classification of the present Kerr "Economy" turbine as an original type as misleading, since this turbine is of the Rateau type, consisting of a series of single-pressure stages. The original Kerr machine, designed by Mr. C. V. Kerr in 1904, was a multi-stage turbine, consisting of a series of single-pressure stages with a steam Pelton wheel in each stage. This turbine is no longer built, having been abandoned in favor of the Kerr "Economy" type, designed by himself about ten years ago. This turbine consists of a series of single-pressure stages, each stage having a set of nozzles and a single wheel; it is therefore of the Rateau type.

The author's statement that the Moore turbine is a modified

design of the Kerr is also erroneous and misleading, for the reason that the Moore single-stage turbine is of the Curtis type, while the multi-stage machine is of the Curtis-Rateau type. The mechanical details of the casing of the Moore multi-stage turbine are radically different from the Kerr Economy turbine.

The Terry is an original type, unless the Stumpf may have been designed previous to it. The Westinghouse single-stage type as built in small sizes is also an original type and was, he believed, designed by Mr. R. N. Ehrhart about fifteen years ago.

M. Nusim wrote that turbine development and progress have been very largely influenced by a demand for higher efficiencies, and this is also true so far as small units are concerned.

The Curtis-Rateau turbine, a composite type consisting of a first-stage wheel having two moving rows of buckets followed by a number of stages having a single bucket row per wheel, has been adopted very extensively for large units of all sizes, but by a proper selection of speed it is also being applied for sizes below 1000 hp. for either condensing or non-condensing turbines. This proper selection of speed is often accomplished by the use of reduction gearing so that standard speeds for modern units of capacities below 1000 hp. vary between 5000 and 7000 r.p.m., depending on size. With such speeds, and also with a proper selection of the number of stages, steam economies are possible with small units which were formerly obtained only with large turbines.

J. A. MacMurchy[1] contributed an extensive written discussion of a number of points in the paper. In many cases he agreed with the author, and his statements were in amplification rather than in criticism of those of the author. The following paragraphs are confined in the main to this writer's criticism, as being more significant in the present connection:

"Even more important than simplicity and durability of auxiliary apparatus is the question of reliability in operation. It is absolutely imperative that the turbines driving auxiliaries shall be such that there will be no question whatever of their operating continuously. Both simplicity and reliability of operation are vastly more important than high thermal efficiency, but a skilful designer should be able to obtain the necessary simplicity and reliability, and at the same time a very high efficiency. Efficiency and reliability are not by any means incompatible.

"The author states that forced lubrication is impracticable in small machines for general auxiliary purposes. This has not been my experience, and in later designs the firm with which I am connected is arranging to provide oil pumps for every size of turbine except on a few extremely small lighting sets where ball bearings are used. This adds slightly to the initial cost of the turbine, but the advantages fully justify the expenditure. Even in quite small turbines a small and very simple oil cooler is also justified.

"The author has not sufficiently emphasized the necessity of the governor being relatively very powerful, that is, for a given percentage of speed variation it should exert strong pull on the valve stem. The governor being such an extremely important element, it should receive the same ample lubrication as that provided for the bearings.

"We do not believe there is such a thing as a flexible coupling for high-speed apparatus. Some couplings are of course better than others, but my experience is that it is better to design the machine so that flexible couplings will not be necessary.

"The shafts of the ordinary pump and blower are much too light for direct connection to a turbine to form a two-bearing unit. In many cases the critical speed will be found to be below the running speed, and often so near the running speed as to cause trouble. In geared sets this is quite permissible because of the slow speeds at which the pumps and blowers usually run, and the greater ruggedness of the apparatus.

"The author expresses the opinion that the usual speed-variation requirements are too exacting, and while regulation within 2 per cent is obtainable with entire stability and no tendency to hunt, at the same time there is no necessity for so close regulation; and, in fact, in most cases it is quite undesirable.

"The author discusses the advisability of adoption of a maximum-rating standard. The purchaser, in ordering a turbine, should specify the steam pressure available at the throttle and the power required. The manufacturer should not be required to estimate how much this should be deviated from, and if he furnishes a turbine which meets contract conditions, it should be considered satisfactory."

"It is recommended that the machine be considered as having met its guarantees if the steam consumption on test be within 5 per cent of the guaranteed figures. I am at a loss to understand what possible advantage there can be in this 5 per cent leeway. With a clause of this kind in the specifications, bidders would merely deduct 5 per cent from their expected performance, and nobody is deceived except possibly the purchaser. It would be very much better to hold the manufacturers to specific water rates, and expect the manufacturer to have sufficient margin in his guarantees to take care of the variations in machines.

"The author recommends that oil rings be furnished on machines designed for forced lubrication. I can see no possible advantage in this requirement, and these bearings can be made much better if they are not complicated with oil rings."

Herbert B. Reynolds wrote that the author states that high thermal efficiency is unnecessary in the small turbine if all the exhaust steam is used. This is true if the exhaust steam is used for heating or in manufacturing processes where any deficiency in the exhaust steam would have to be made up by the use of live steam. However, in the case of a power station where the exhaust steam from the auxiliary turbines is used for heating the feedwater, the steam consumption of the small turbines plays an important part in the efficiency of the power station. It is true that the feedwater heater recovers all of the heat in the exhaust steam, but it does not recover the boiler losses which are incurred during the generation of the steam.

C. P. Crissey contributed a comprehensive written discussion in which he said that there is no doubt that in many cases needlessly severe guarantees are requested by purchasers of small turbines, and that the author has done a service in bringing this to general attention.

Any code of practice to be successful must first provide that the turbine meet the requirements of service, and not be primarily for the convenience of the manufacturer.

Regarding steam consumption, as a rule one guarantee point is sufficient; that is, the ultimate operator is fully protected by a guarantee at a single load, one speed and the given steam and exhaust conditions. If other load points are required they should not go below one-half load; quarter-load guarantees should not be required.

When guarantees are given on a condensing turbine, they should not be asked for under non-condensing conditions.

The purchaser is justified in requiring that certain loads be developed under abnormal conditions which are bound to occur. For instance, the author states that the output is reduced about

[1] Pittsburgh, Pa.

20 per cent when the steam pressure drops 10 lb., with an increase of 2 per cent moisture and a rise of 2 lb. back pressure. An experienced purchaser will state the load required and the average conditions of operation at which an economy guarantee is desired, and then specify that the load shall be carried at somewhat poorer conditions which he foresees are liable to occur in ordinary operation. If the purchaser is inexperienced the code should protect him by specifying that the maximum load must be developed if the steam pressure drops a certain percentage, this drop being sufficient to allow for a change in quality or reasonable change in exhaust condition. To meet this requirement the turbine should be supplied with a hand valve opening additional nozzle sections, which, when open, are under control of the valve gear. The cost of the addition is well worth while as a simple matter of insurance.

While economy guarantees on a condensing turbine operating non-condensing should not be required, it is quite reasonable in some instances to demand that a certain fraction of the rated output be developed non-condensing, the purchaser bearing in mind that the demand should not be greater than necessary to safeguard the actual operation of his plant.

It would also be well for a code to prohibit bearing temperatures of 250 deg. fahr.

There is absolutely no reason why the power requirements of pumps and blowers should not be known just as accurately as the outputs of turbines, and they are so known in properly conducted organizations.

It is quite possible to obtain satisfactory operation with a two-bearing unit having a small overhung turbine wheel, but it is a type which, in the nature of things, should be built by manufacturers of combined units. The case is entirely similar to the rigid frame and three-bearing units commended by Mr. London when both parts of the unit are built in one shop. When built by different parties the proposition is, as he says, entirely different. Whether the driven machine is generator, blower or pump, if trouble develops, neither one of the manufacturers or an arbitrator can determine at which door the fault lies.

There are very good reasons why units having four bearings and a coupling have not been more generally superseded by two- or three-bearing sets. This is best illustrated by turbine-driven pumps. In this case a multiplicity of pumps must be driven by a given size of turbine, and on the other hand a certain size of pump must be capable of being driven by several sizes of turbines to meet the demands of various services and customer's requirements. In many cases where economy is of prime importance gears must be interposed between the turbine and pump. It is therefore apparent that an overhung turbine with two bearings or a three-bearing set is an obstruction to producing sets upon a manufacturing basis. Practically every set is a new design that requires careful calculation to prevent trouble from critical speeds or deflection of the wheel which will cause rubbing of the buckets. All this is true when both machines are produced in the same shop. If manufactured in different shops, lengthy correspondence is required to determine whether the pump manufacturer can increase the size of shaft through impellers and bearings to carry a heavier turbine wheel, etc. As no customer is going to wait upon such determinations, it follows that the average agent and some manufacturers will take a chance, with the result that the customer receives an untried and, in many cases, thoroughly unsatisfactory unit.

Customers should guard themselves against two- or three-bearing units that have not been operated with the same distances between bearings, the same diameter of shaft and the same loads upon the shaft, especially when the responsibility is divided between two manufacturers.

The author replied to Mr. Bentley that the relative angle of the steam on the wheel of the Terry type was not 180 deg. He indicated on the blackboard just what the angle was.

Replying to the discussions upon lining up units, he said that two or three pump manufacturers he had talked to had stated that "of the troubles reported in our plants, 90 per cent were directly or indirectly due to faulty lining up of the machine." He considered this matter of lining up a serious proposition.

Mr. Nusim brought up the question of consumption and cost. The water rate has a direct bearing on the cost, and it is a question whether it is more economical to pay for the most highly efficient machine or a cheaper machine. Small turbines can be made much more efficient if the customer will pay the price.

In reply to Mr. MacMurchy he said that adding an overhung rotor puts up the critical speed of the combination.

A five per cent variation in the guarantee would save a lot of trouble. In Europe it is standard practice, even in the larger machines, that all guarantees are accepted or rejected on the basis of 2 per cent either way.

He thought that forced-feed lubrication is an additional complication to be avoided on small turbines. On the other hand, oil rings are a good thing, because with them you are sure of getting oil in the bearings, and they guarantee a supply of oil to the machine in starting up.

Preventable Waste of Coal in the United States, by David Moffat Myers

In the second paper of the session, David Moffat Myers endeavored to show how, by employing proper operating methods in boiler plants, it is easily possible to save at least 10 per cent of the coal now burned for steam-making purposes. Such a saving would release cars for other service equivalent, say, to the coal-carrying capacity of the Pennsylvania Railroad lines east of Pittsburgh, equal to 1,000,000 fifty-ton carloads per year, and the direct money saving to the industries would be around a quarter of a billion dollars, figuring the coal at $5 a ton.

The author stated that the object of the paper was to open a discussion which, he hoped, would lead to the formulation by the Society of definite recommendations of means for the reduction of the present great preventable waste of fuel in our industries, largely through faulty, careless and uninformed operation of boiler plants, and to the offering of the services of the Society to the Government for the organization, furthering, and, as far as possible, execution of the plan which may as a consequence be adopted.

He presented two plans which he thought worthy of consideration. "The one might be termed the autocratic method. This would involve the use of authority to compel coal consumers to execute such measures of economy as the proper authorities might prescribe for any given case, limits to be set as to expense to the user. Such limits might be in terms of a percentage of his present yearly coal bill. Alterations should be directed chiefly to purely operating improvements. Many objections would probably be made by consumers against this plan, but once in effect the majority would no doubt realize its pecuniary advantage to themselves. But its tendency might be too strongly opposed to democratic principles.

"The other plan would be largely an educational one, in which patriotism and efficiency would furnish the motive forces required. The teaching must be accomplished with the

utmost simplicity and directness. This is a big task, but with the technical and executive ability represented in this Society, these things may be accomplished.

"The requisite information much reach the owners and managers of industries, and there must be simple instruction sheets for the engineers and firemen. The vital importance of daily accurate records of coal and water must be taught and information given regarding practical appliances for automatic measurements of both.

"Blank forms might be sent in advance to plant owners in order to be advised by them, first, whether they would be willing to coöperate with a governmental organization offering to assist them in reducing their coal consumption, and second, to obtain such data as to size, type, equipment, operation and fuel consumption of the plants as would enable a classification which would permit a Government board of experts to send such instructions as would include the information needed for any one class of plants."

It is significant that in all the voluminous discussion which this paper brought out, there was practically no disagreement whatever with the author's statements in regard to the waste of coal. Seemingly, almost everyone took these statements for granted, and the trend of the discussion was to emphasize the need of either the author's "autocratic" or "educational" methods of saving coal, or else to describe some other plans for accomplishing the same end. Many of the discussers gave examples of how they had secured results in particular cases, contributory to the one great result desired by all—saving the ten per cent of our coal used for steam making, which, in turn, is two-thirds of our total production.

Walter N. Polakov wrote that of the author's two plans the first one is so unfortunately worded as to create prejudice against it. It reads ". . . the use of authority to compel coal consumers to execute such measures of economy as the proper authority might prescribe in any given case." The plan really means *the abolition of privilege to waste fuel in inefficiently conducted plants, by giving priority in coal deliveries to those who prove that they do use it efficiently.*

This priority can be determined by:

1 Rating by experts (nominated by the national engineering societies and supported by public opinion and the Government) of plants in the indispensable industries which are entitled, because of coal-saving methods in use, to priority in coal supply.

2 Receiving of applications by a special service bureau of The American Society of Mechanical Engineers, from the low-rated plants for assigning the expert help.

3 Serving the needs of such inefficient plants by offering services of recognized experts in power-plant management for direction of the work.

4 Organizing a staff of steam, electrical and combustion engineers, whose members will be assigned to carry out the work in the plants of the applicants under the direction and supervision of experts.

5 Charging for such services an adequate compensation to cover the expenses involved (salaries, traveling and office) but no profit.

Mr. Myers's second plan, "an educational one, in which patriotism and efficiency would furnish the motive forces required," Mr. Polakov thought, is doomed to failure for the following reasons:

a Teaching efficiency by a correspondence-school method will accomplish little good, is incompatible with the professional dignity of this Society and lacks the personal touch.

b Endless variety of equipment, grades of fuel available, personality of men, nature of load, climatic conditions, etc., make the preparation of "simple instruction sheets for engineers and firemen" impossible, and if these are made they are so general as to be useless.

c No instructions of real value could be given unless examination of the plant was made.

d Keeping records, logs, etc., necessitates instrument equipment and measuring devices. All of this is good only when the data are used and interpreted by a trained man and this is done continually. Too many plants have no instruments at all; most of those that have keep them as ornaments due to the lack of proper organization.

e If the regular employees failed to secure high efficiency it is not because of the lack of "circularized education" but chiefly on account of 1, lack of time to carry out investigations and tests, all the time being absorbed by routine duties; 2, absence of instruments, facilities or encouragement; 3, lack of experience in this highly specialized line of research work.

f The education should begin with the owners and managers, not with the firemen.

g The very principle of "teaching" and "instructions" given to manufacturers and plant owners by the Society is undemocratic and un-American. They do not want or need to get something for nothing. Producing for the country but not without profit, they can prefer to pay for what they get if the benefit is commensurate with the expense.

h "Educational" talks and circulars usually degenerate into debating societies wasting time needed for deeds.

i Any half-measures with good intentions falling short of accomplishing valuable results are dangerous, as they chloroform the public conscience.

To sum up, the problem is to be solved by groups and individuals available through this Society for the service of those who know that more power can be gotten out of a pound of coal. There is no necessity of compelling plant owners to improve their methods, since in such a step lies their self-preservation. But there is an urgent necessity from the national standpoint to conserve the fuel by preventing its waste by ignorance or indifference. The valuation of plant methods to establish ratings for priority in coal deliveries is therefore recommended.

Percival R. Moses,[1] in a written discussion sent in subsequent to the meeting, described still another method whereby a saving in the amount of fuel burned may be obtained, greatly in excess of that which may be obtained by improvement of the individual plant. Broadly put, the saving would be effected by shutting down the inefficient plant and obtaining the power supplied from such plants from an efficient source.

Emmett B. Carter agreed with Mr. Myers's idea of a campaign of education among the firemen, but thought that we should feel some hesitancy in recommending the establishment of a bureau of such magnitude as would be required to carry on the work proposed, because we lack the men. The bureau will mean a very large force of men, valuable technical men, who can ill be spared now from other important work.

It is this same lack of intelligent men which is causing the waste of so much of our coal in the first place. Almost one-half of the coal being consumed for steam is used by the railroads, and the great problem confronting the railroads now is not how to burn the coal economically, but how to get the men to burn the coal at all.

[1] 366 Fifth Ave., N. Y.

C. R. Weymouth wrote that in his opinion the possible saving in coal consumption due to increased boiler efficiency would be materially less than stated by Mr. Myers. The biggest coal users of today were the mammoth public-utility companies, who had already been compelled to employ the best brains available and boiler-room efficiency engineers as well to maintain their economy of power production at a maximum, and it was inconceivable to him that they could save 10 per cent in their fuel consumption, or even half of that amount. There were no doubt many smaller users of power where the yearly bill was such that they were not warranted in employing an efficiency engineer, and in these plants a saving would be possible if expert service were available.

Mr. Weymouth suggested the formation of a committee of engineers representing the various classes of coal users, and familiar with this subject, to make a preliminary canvass of the situation from the data available, including census reports. The findings of this committee would indicate the extent to which this subject should be further investigated and recommendations made to the Federal Fuel Administrator. This investigation should also cover the question of availability of engineers and fuel experts to give instructions as to the better firing methods, should it be found that a large fuel saving is possible. His observations indicated that nearly all mechanical engineers are busy in some department or other in connection with the war, or vital industries, and that comparatively few men will be available to carry on a fuel-saving compaign, even should it be found that such a campaign might give beneficial results.

Whether the committee's findings indicate that a large fuel saving could be made, all engineers will agree that a campaign of some character should be made to reduce the waste of coal. Mr. Myers's suggestion that instructions be issued to firemen in simple language is a very timely one. We have had textbooks and technical papers almost without limit prepared for the benefit of technically trained men; but there has never been, to his knowledge, a suitable primer giving the elementary principles of combustion and the essential knowledge for a fireman. The preparation of such a primer could be well undertaken by the committee proposed, and it could be given wide circulation with surely beneficial results.

Any attempt to curtail the coal supply as a means of compulsory increase in boiler efficiency would, to his mind, lead to a chaotic condition. Whatever is done must be done voluntarily, at least initially. Variations in load factor, rate of demand, etc., complications of red tape, are such that any limitation of the quantity of coal supplied a given user would likely give rise to regrettable complications and curtailment of necessary output.

While there are minor improvements in boiler plants which can be made at this time, it must be borne in mind that the present-day trend in increased economy of fuel calls for higher steam pressures, higher degrees of superheat, larger prime movers, centralized generating stations—things which, if now generally put into effect, would immediately tax certain manufacturing facilities which should be left undisturbed for the production of the war's necessities.

A. F. Graves[1] gave an interesting example of what could be done in a specific plant, even in one which had always taken pride in boiler-room economy.

An instrument board was installed in the boiler room, with water- and steam-flow meters, temperature recorders and draft gages. With this means of studying all conditions, series of tests were run on the boilers for the purpose of finding the most efficient operating conditions at all loads, and printed instructions issued to the firemen so that they could always maintain these conditions. By this means a saving of about 12 per cent of the coal bill has been made. Possibly some ammunition factory is using that very coal to make the rifles that will help to put "our boys" over the top.

All lines of manufacturing must be kept moving, and with the present car shortage, the *knowing how* to prevent waste of coal would do much to keep up the supply.

It seems only fair to rate a plant for its wastefulness as well as its economy, and that the plant which can burn the coal most efficiently should have priority in coal deliveries.

[1] Strathmore Paper Co., Mittineague, Mass.

R. K. Goodlatte[1] expressed as his written opinion that great good would be accomplished if the Society, backed by the Fuel Administration Board, would inaugurate an active campaign toward the end of preventing waste in industrial plants.

He suggested publishing posters giving simple instructions for hand and stoker firing, cleaning of fires, watching scale prevention, coal weighing, water measuring, etc. These instructions could be made vital and forceful by periodical visits by practical men with authority to enforce them, if necessary, under threat of coal-supply regulation.

E. P. Roberts suggested two ways of saving fuel—reducing the smoke loss by correct design and operation, remembering that the loss due to smoke from bituminous coal burned in towns and cities is seldom less than $1.50 per ton, and adopting "sensible heating."

Sensible heating is heating that satisfies the senses rather than the dry-bulb thermometer. Sensible heating is paying proper attention to humidity, securing the result of lower thermometer (dry-bulb), greater comfort, better health, lower fuel bill, etc.

Albert A. Cary, in an extensive written discussion, alluded to the author's statement that "The saving or wasting of one-fourth of the coal consumption of any industrial plant depends *entirely* upon the efficiency of its operating management" as the text upon which the balance of his paper is founded. He continued:

"In order to secure the desired conservation of fuels in such plants, Mr. Myers advises the services of the expert in operating management, by compulsion or otherwise; he suggests what Mr. Polakov has aptly termed a correspondence-school course, which, in the light of our experience, is not a wholly worthy suggestion.

"The expert in operating management—provided he is properly qualified and thoroughly understands his business, including the proper handling of the fuel used—can undoubtedly secure very desirable fuel savings; but his efficiency depends very largely upon the coöperation he receives from the plant owners and their employees, as well as their willingness to equip their plant with all the needed apparatus and to maintain and use them continuously after the expert concludes his work.

"Aside from the training of a boiler-room force by such experts, there are other matters which cannot be relegated to a second place of importance in considering the requirements for reducing the waste of fuel.

"Proper furnace design and construction, adapted to the use of the particular kind of quality of fuel used, furnish unquestionably the very keynote of the whole question of fuel conservation. By the term *furnace design* in a boiler equipment is included not only the furnace with its equipment, but

[1] Delawanna, N. J.

also the entire boiler setting, flue and draft-producing equipment.

"Let us concentrate with greater earnestness upon the design and construction of our furnaces. Let us study our available refractories for furnace linings with greater care, as well as the high-temperature cements, the mortar used, and the red bricks used to enclose our settings.

"After equipping our plant with proper furnace settings which are adapted to produce the highest possible efficiency with the particular fuel available, our expert in operating management can come into the plant and do his most efficient work by instructing the men how to operate the furnaces in the most efficient manner. He can train them in the use of the instruments required to keep the plant constantly in its highest operating conditions, and there are many other needed duties requiring his attention to produce the most economical and requisite results which will reduce the amount of fuel and labor required.

"Turning now to the personal factor which enters so strongly into our fuel-economy problem: In our larger central power stations, the men who handle the coal and operate the boilers have been well trained, and they generally know that they *must* obey instructions or lose their jobs. In the smaller plants, we find a wide variety of firemen, some of whom are splendid fellows, who are anxious to learn, and those who take a pride in their work; while others strongly resent the intrusion of an outsider to show them how to operate their plant more economically. This latter class is responsible for the largest wastes of fuel occurring in steam plants.

"Many of these men are certainly not fitted for the position of firemen, and, unfortunately, many employers seem to think that the only qualifications needed are that they be strong, husky men, who can stand up before a hot fire and shovel in a lot of coal every time the furnace door is opened, and then to pull out the ash and clinkers from the grates or ashpit once a day.

"In order to stop our enormous coal wastes in industrial and other plants, these so-called firemen are the first men we should get under control, and, after giving this matter considerable thought, I have reached the conclusion that there is one way in which this can be done practically.

"To meet the present emergency, I propose that the War Coal Board take the necessary measures to bring all the firemen in this country under their control by requiring the firemen to take out and hold a United States license.

"The applicants for these licenses must show some qualifications which would entitle them to hold such privileges, but it is doubtful whether it would be possible, at the beginning, to have all of these applicants examined before qualified examination boards.

"Future applicants should be required to pass an examination before such boards, and qualify in a satisfactory manner before receiving their licenses.

"By this means, a better class of men will gradually displace the many fuel-wasting incompetents who are now disgracing the firemen's trade.

"This process would thus tend to 'weed out' the incompetent men who are keeping good, deserving and competent firemen out of jobs which belong to them, and thus, eventually, the status of the firemen would be raised, and their better fuel-saving work will merit them a higher rate of wages, which the owner can well afford to pay out of such savings effected in his steam plant.

"On the other hand, the stubborn, unpatriotic, penny-wise and pound-foolish owners of coal-burning plants, where glaringly wasteful conditions exist—who refuse to spend a cent to better their conditions and 'do their bit' in the conservation of fuel in this time of need—will meet with a rude awakening, and they will learn a lesson which will ultimately result greatly to their advantage and save them many dollars which would otherwise be hurled up their chimneys.

"This proposed method is now but a war measure, but after the war it is bound to result in a great benefit to the owners of coal-burning plants and to the country at large."

Lewis S. Maxfield suggested that the Government perfect the use of our peat deposits and deliver this fuel to the industries with instructions as to its proper use, instead of trying to make our industries do with less of the very first element of their existence. With the present high cost of labor and materials few power plants are in a position to undertake extensive improvements which would render them more efficient in the use of coal.

We have extensive peat bogs, the amount of combustible matter in which, it is estimated, exceeds that in all our known coal deposits. Peat is being used extensively in Europe as a fuel, and several large industrial plants report satisfactory operation with it.

The most successful method of utilizing peat at present seems to be in the gas producer, which will handle peat with a moisture content of 30 to 35 per cent, which is obtainable by air drying.

He admitted that many difficulties were met with in the use of peat, and as its use extended other problems would come up, but he thought they would be solved as have those incident to the use of coal.

John E. Muhlfeld considered that the autocratic and educational plans of procedure outlined were not in themselves sufficient for the consumers of coal to use as a basis for authorizing the capital expenditures that will, in the majority of cases, have to be made in order to produce the desired results and thereby secure an adequate financial return on the investment to be made.

Furthermore, particular stress should be laid on the fact that the more effective use of fuel should and can be made to bring about improved conditions in plant operation and labor, as well as conservation in fuel and financial returns.

Each power plant is, in itself, an individual engineering problem, and blanket instructions and advices cannot be of the greatest value.

There is no lack of patriotism among the coal users and the engineers of this country, and he doubted if any of them are "selling the United States short," but localized engineering improvements and supervision along practical lines for the purpose of modernizing plant equipment, and its maintenance and operation, are essential for the greatest accomplishment.

The scope of the procedure for the conservation of coal, steam-railway facilities and labor could be materially broadened by including

a The utilization of existing by-products of mining operations that are useful for steam-generating purposes, but which are now being wasted.

b The development and use of vast deposits of sub-bituminous coals and lignites lying adjacent to steam-railway lines.

The fact that one of our allies, Brazil, has recently, through the efforts of its government engineers, made possible the effective and economical use of its native coal, which has heretofore been deemed practically worthless, and thereby diminished its dependence upon imported coal for railway operation and industrial development, is worthy of our serious consideration.

The amount of useful coal now being wasted through existing methods of mining is great enough to more than offset the present shortage, and the reclamation and utilization of this by-product, for which labor, material and plant for mining have already been employed, in conjunction with the development of new sources of coal and lignite supply tributary to the points of consumption, are of paramount importance.

B. G. Elliott described the method employed by the University of Wisconsin to reach the firemen and engineers in power plants by means of lectures, demonstrations, and class-study groups.

The firemen and engineers are organized in a class group and are met each week by a traveling instructor who lectures and demonstrates to them on the various problems connected with the economical combustion of fuel. The class groups usually meet for a period of eight to ten weeks. At the end of the class and lecture work, the members of the class are usually gotten together for a boiler test conducted according to the best modern practice. This test is held at one of the plants of the community, the apparatus and recording devices being sent from the University. The men are required to work up the test on specially prepared forms.

When there has not been a demand for an extended class course, the subject is presented by means of an individual lecture and demonstration on coal, its composition and combustion. The manufacturers and the business men, as well as the firemen, are invited to attend this lecture, which has proved to be a very effective method of bringing the problem before this group of men who are interested more from a financial than from a technical point of view.

Michael M. Podolsky[1] proposed a "coöperative" plan for solving the fuel problem, the plan to be under the control and supervision of the Government, but to be under the management of specialists nominated by the Society in conjunction with the mining, electrical and chemical engineers.

The main feature of his plan was the organization by the fuel consumers of a national society for fuel saving, the work of which would be carried on by each member contributing annually on the basis of, say, 5 to 7 cents per ton of coal consumed.

The functions of this society would be mainly to disseminate information regarding fuel saving, to provide help to the Fuel Administrator, to recommend to the Government steps for relieving and preventing fuel shortage, to investigate and report upon new methods for saving coal, to establish special schools for firemen, to hold exhibitions and give prizes for best inventions and to aid inventors of fuel-saving devices.

The work of such a society would be under the direction of a council and would be carried out under its direction by a manager and staff.

This discusser voiced as his belief that only by the fullest coöperation between the Government, the coal consumers and the engineers on the widest scale could the fuel problem be solved. Notwithstanding the meager development of the coöperative idea in this country, the A.S.M.E. could institute such a coöperative method as described with the greatest practical results. He suggested appointing a committee to consider the plans presented in the paper and discussions and draw up a war plan, perhaps in collaboration with the Federal Fuel Administrator.

William L. Cathcart wrote that the United States is now the leading coal-producing country. Two-thirds of our total production is burned for steam making, with an approximate waste—as Mr. Myers very conservatively estimates—of 10 per cent, through lack of efficiency in the operation of boiler furnaces. That is, with the war industries of our French and Italian allies retarded and their civilian population freezing from lack of coal, we are wasting about 50 million tons a year.

It is a truism to say that this is an engineer's war, and, in many of its most important features, a mechanical engineer's war, both on land and sea. So, for the prevention of this huge waste, this colosssal drain on the war energy of our allies and ourselves, our Government officials may rightfully look to the membership of this Society for information and suggestions leading to a definite remedial plan.

The paper presented by Mr. Myers covers broadly the whole problem of fuel economy, as applied to steam making on land. In the writer's view, a specific program developed from it, and based upon it, is what is needed urgently, not only for the prosecution of our own war aims, but for sorely needed aid to our allies—a need that will increase steadily until victory is won.

It should be noted, too, that the economies produced from the execution of such a program would be *permanent,* lasting after the war, an enforced lesson in the value of fuel economy.

America is not alone in her prodigal waste of fuel. Sydney Brooks says: "There is very good reason, therefore, why Great Britain should observe the utmost care and economy in her methods of getting coal and of using it, and in her management of the entire coal industry. So far, her methods have been those of shiftlessness and improvidence."

But, if Britain can learn, so can we. Our trouble is not unwillingness. It is simply indifference as to the value of fuel economy. And, so far as the adoption of proper remedial measures is concerned—although specifically the user will profit—it is now broadly a question of patriotism, and the managers of our industrial plants will scarcely be lacking in that.

However, there might readily be a fair number of cases in which it would be difficult to secure compliance with a mere official request to adopt methods of fuel economy. Further, the education of firemen alone scarcely seems to be a practicable solution. The pressure on those firemen for that education should come from the owners and managers of their plants. This sort of efficiency grows best from the top down, not from the bottom up.

In the relatively few cases in which it might be necessary to bring pressure on owners or managers, Mr. Myers's comment suggests the necessary "big stick." Let the Government allow them only a quarterly or yearly amount of coal which will produce, when burned with full economy, the number of pounds of steam they require normally. If they choose to waste their allowance, let them shut down until they get their next allowance. The rigid control which the Government is now exercising, through the Federal Trade Commission, on the newsprint industry should be a lesson to such possible recalcitrants. These are war times, not the lax days of peace.

L. P. Breckenridge, Chairman of the Committee of Consulting Engineers on Coal Conservation and Publicity coöperating with the Bureau of Mines and the Federal Fuel Administrator, said that the ideas presented in the paper and discussions were excellent, but the question was whether they were immediately available. We must save coal and save it quickly, and anyone with suggestions should send them to Mr. O. P. Hood, at the U. S. Bureau of Mines, or to himself.

He said that Dr. Garfield, U. S. Fuel Administrator, was now preparing material to send out broadcast emphasizing the very great necessity of saving coal. Engineers should coöpe-

[1] Standard Steel Works Co., Burnham, Pa.

rate in this campaign, preferably through the representative of the Fuel Administrator in each state.

As examples of what could be done in this connection, the engineers of the Experiment Station of the University of Illinois have sent out valuable material regarding the use of the coal consumed largely in Illinois. The Fuel Administrator of Illinois should have the assistance of these men. The engineers in Connecticut, Virginia, Pennsylvania, and other states should similarly coöperate with the fuel administrators of these states, and much good will result.

Wherever engineering societies exist, some plan should be started, with the slogan "help save coal." Get in touch with the state or the city fuel administrator and offer aid. Get Government bulletins from the Bureau of Mines and distribute them at a lecture to "owners, managers and firemen." Help the local papers select facts and help them avoid "fiction." The important thing is to get sound directions to the fellow who is handling the shovel both in the home and in the factory.

Norman G. Reinicker agreed with all that had been said about operation, but considered that the biggest gain was not in operation but in design. Given a plant and the conditions to operate under, the results are probably 85 per cent due to design and 15 per cent to operation. He thought it was unfortunate that we should have reached the stage of having to save coal now, when we might have saved it a long time ago when plants were originally built, by putting in the proper apparatus.

In designing or remodeling a plant we should take into our confidence the manufacturers of the apparatus. They can give very valuable suggestions.

Improvement in designing does not refer alone to coal saving, but also labor saving. If we can build an ashpit that will hold 24 hours' ashes, instead of holding only one dump and requiring a man to be on duty during the whole of the 24 hours to handle the ashes, we can save considerable labor.

Even at the present time we can make our biggest saving, possibly, by changing the apparatus—scrapping some of the old stuff. It is a bad time to do it, of course, because the manufacturers are loaded down with other orders, but we should try to slip in some of these orders for new apparatus from time to time.

Waldron C. Beekley emphasized the extended use of exhaust steam in process heating as a means of fuel conservation. By putting in apparatus to properly use exhaust steam in heating water for various processes, the coal consumption can be reduced 30 per cent.

He noticed in Mr. Myers's paper a suggestion that the Society present some recommendations to the Government in regard to the way in which this fuel problem could be met, and he thought it would be very desirable if the above point could be followed up.

J. S. Lane said that the author's statement: "It is evident that we now require an extension of the idea of education, but in such form as directly to affect the men who run the boiler plants of our country, for in their hands is the saving or wasting of one-fourth of the fuel which they consume," was made just as though these men had the matter all in their hands; and, while it is true they do have a good deal in their hands, yet Mr. Cary hit the nail on the head in wanting the right furnaces and the right apparatus. Even though you teach the average fireman the best ways of firing, when your back is turned he will go back to his old way.

Many boiler plants both small and large are now fitted with appliances that automatically and continuously maintain balanced-draft conditions in the furnace, supplying just the right amount of air required for combustion, maintaining a uniform steam pressure, and allowing the hot gases the longest possible contact with the heating surfaces of the boiler; and a further elimination of the human element can be effected by the use of a mechanical stoker, automatically controlled by the balanced-draft regulator so that the feed of fuel is varied in proportion to the supply of air.

The author also speaks of the railroads, saying "We are now threatened with a serious coal shortage due chiefly to the overstrained carrying capacity of the railroads." It is believed, however, that if the known methods of saving fuel are employed, thus relieving the railroads from carrying some of it and leaving the saved part in the ground for the use of those who are to come afterward instead of burning it all up now, railroads, coal users, and the general public will be benefited.

Edward N. Trump said there was one way of reaching the man who shovels the coal into the furnace which had not been touched on, and that is to make it to his interest to save the coal. He had found in increasing the efficiency of their coal plants from 50 per cent, which they used to consider fairly good, to 85 per cent, a very large part of that increase was produced by making it of interest to the men who did the work to produce these economical results.

If you give a bonus to your fireman, you will be sure to have some result. He had found at least ten per cent saving by paying a bonus to the fireman, and also by working one shift against the other, that is to say, making it to their interest to improve the saving.

Installing such a plan has not proved difficult. If you have the necessary instruments you can, in the first place, determine the amount of carbonic acid in the waste gases. You can measure the water. In addition, you can take samples of the ashes and determine the amount of carbon. If at the end of a month, having these three things, you work out the efficiency from these items, and work each shift, one against the other, you will get results which will be surprising—save at least ten per cent of the fuel with the same apparatus and without any changes whatever.

Combustion is a chemical phenomenon and can be diagnosed and controlled only by chemical means; and you have to have apparatus to do that; and it ought to be so that the fireman can tell instantly, so that it shows right on the front of every boiler, what the condition of his fire is; and that, in addition to all of the other things which have been brought up, will bring the maximum efficiency.

The chairman said there is another phase of this situation, and that is the fact that we are endeavoring to work out a plan by which concrete, nation-wide propaganda can be put into operation, taking into account thousands and thousands of power plants. Furthermore, we have a situation at the present day complicating the normal conditions enormously in that the personnel of our fireroom forces is in a condition of ferment—our manufacturers do not know today how many of the men who are in their plants will be with them tomorrow; and to carry the thing further, they have not the slightest idea as to how many of their trained firemen, and their firemen who know their equipment, they will have two or three months hence. Consequently, we have some added critical and difficult aspects of the subject, but that is no reason why the Society should not do everything in its power to work out the best that can be done in this matter. He was personally inclined to believe that with collective coöperation we ought to

be able to do everything Mr. Myers has said, and possibly do a shade better.

The author in closing the discussion stated that he was surprised that some of the discussers did not understand the relation between equipment and operation in their effect upon efficiency. There is a mathematical equation which expresses this relation, which is as follows: Efficiency in any process is equal to the efficiency of the mechanical equipment multiplied by the efficiency of the human factor. This may be expressed: Efficiency equals $E \times H$. For example, in the matter of fuel economy, if we have a furnace perfectly designed and adapted for a specified fuel and purpose, we may regard our equipment as having an efficiency of 100 per cent, but if the man who operates the furnace is drunk, the efficiency of the operation will be zero.

Take it the other way around, and suppose we have a perfect fireman but the grate has fallen out of the furnace; our efficiency will again be zero. Thus, as stated, the formula $E \times H$ truly expresses the relation between equipment and operation in determining the efficiency of any process.

Consequently we must of course endeavor to obtain the highest attainable efficiency both of equipment and of operation, in order to realize the maximum of combined or ultimate efficiency.

The point of all this is that by improving the efficiency of operation alone, the combined efficiency is susceptible of great and immediate improvement. Without loss of time and without expenditure for new or changed equipment, an average saving of 10 to 20 per cent of coal can be effected in factory boiler plants. Therefore, in a fuel-saving campaign, adequate measures must be directed first toward obtaining the maximum improvement possible in the way of purely operating economies. Later, the equipment side of the proposition should be given urgent attention.

The immediate problem before us is to develop ways and means for putting into effect these economies which I have shown may equal 50 million to 100 million tons of coal saved per year. These savings may go into effect at once.

I regret that the greatest volume of discussion on my paper has been directed toward technicalities. All competent engineers who have studied the fuel problem know the technical side of the situation, and if I had been allowed the time and space, I could have presented all of the technical information and suggestions which have been involved in this discussion. All good fuel engineers know these things; the bad ones do not count.

The present situation does not call for technical discussion, but it does call for *ways and means* for putting into effect the knowledge which we now have and in such a manner as to save the 50 million to 100 million tons of coal per year which can be saved. A few very interesting suggestions on ways and means have been brought forward in the discussion.

Let me first state most emphatically that education will comprise an essential feature in the campaign for saving coal which will be adopted and successfully prosecuted in this country: education of the owner, education of the firemen.

Incentive must be added to education so that manufacturers and owners will *desire* to coöperate in the fuel-saving campaign. It is probable that for the most part patriotism and efficiency will provide sufficient incentive, but to this may be added the shutting-down of inefficient plants in case of necessity. It would not be fair to the highly efficient plants to cut off their coal supply while wasteful plants were literally throwing away coal. The whole question resolves itself into that of ways and means for executing the measures of economy which all fuel engineers know are necessary at this time. It is desirable to work as far as possible through existing agencies and organizations. For instance, the federal, state and local chambers of commerce are already working along these lines to some extent and they should be encouraged and helped from headquarters by bulletins on fuel economy, the furnishing of lecturers, starting of schools for firemen, etc. Then the manufacturers' associations will be of very great value. They should be urged to pledge themselves to a campaign of fuel economy in their respective localities. They should get together for meetings devoted to the subject; they should obtain the best fuel engineers in their vicinity to lecture to them; they should get the services of these men to visit their plants and make suggestions and adopt further sensible plans for saving fuel.

Any plant owner who failed actively to install methods for economizing in the use of fuel in his plant would be considered a bad citizen by the other members of his association who would be working for governmental interests. This bad citizen would be made to feel the displeasure of his neighbors and would probably take heed and give attention to his own plant. If this did not work, then the Government could compel him to bring his plant up to a suitable degree of efficiency or limit his coal supply.

Mr. Podolsky in his discussion, made a suggestion along these general lines in which he suggested a national society for fuel saving. The local manufacturers' association to which I have alluded, could, if found desirable, be combined to form such a national society or association. This constitutes one of the most valuable suggestions that has been made in the discussion.

While our problem relates principally to fuel saving, labor saving is also important. Mr. Reinicker has brought out this feature in a limited way in his suggestion regarding an ashpit to hold 24 hours' accumulation. Of course this phase of the subject could be developed indefinitely, but this is aside from the present object. Mr. Reinicker, however, is wrong in his statement that "the results are probably 85 per cent due to design and 15 per cent to operation." As I demonstrated in the first part of my discussion, the combined efficiency is equal to the efficiency of the equipment multiplied by the efficiency of operation, and in my own practice I have found that in most factory plants a saving of 10 to 25 per cent can be made by modification of operating methods alone. I can quote cases where improvement has been as high as 50 per cent. Further savings, depending upon the original design of the plant, can be made by suitable changes in the equipment.

Mr. Beckley brings out the fact that there is a large saving to be made by the utilization of exhaust steam. This point was brought out in my paper in Par. 23. The actual saving, however, in case all the exhaust from an ordinary factory engine is utilized would approximate 90 per cent instead of the 30 per cent which Mr. Beckley quotes. (See my paper entitled The Heating Value of Exhaust Steam, presented at the annual meeting of the American Society of Heating and Ventilating Engineers in January 1915, in which I gave a formula for determining the heat value of exhaust steam from any engine, pump or turbine. In this paper are given curves from which the heat value of exhaust is determined graphically).

Mr. Trump's discussion is extremely valuable as he is bringing out the new idea in boiler-room management of giving the firemen an interest in the coal which they are able to save by intelligent effort. The statement which he has made should be convincing since it is based on actual experience in his own large plants. I have designed bonus systems for many plants

in this country. The reason that many bonus systems have failed is that they have not been suited to the particular case and local conditions for which they are supposed to be designed. But the bonus system will be increasingly used in this country during the coming years in connection with boiler-house accounting systems. Every plant in the country which burns as much as five tons of coal per day should have some kind of an accounting system to indicate at least approximately the efficiency of the boilers and furnaces. The best system is continuous weighing of coal and water by modern methods supplemented by ue-gas analysis. But where this complete system cannot be installed for practical reasons, a flue-gas-analysis system can be and should be installed. The United States Fuel Administration should endorse this specific measure in formulating a program to be sent out through the State Fuel Administrators to the industries.

Mr. Polakov speaks slightingly of what he is pleased to term "by correspondence-school methods." I did not suggest correspondence-school methods but I did suggest education by every possible means, both by personal teaching and by bulletins and circulars prepared specifically for definite purposes. Mr. Polakov's method is quite suitable for private consulting practice such as his or mine, and I follow his thorough methods in my own practice. But Mr. Polakov has evidently not considered the difference between a private practice and a national practice. For instance, were we to carry out Mr. Polakov's idea it would require four thousand Mr. Polakovs working eighteen months at a cost to the Government of $36,000,000 to make an inspection of three or four days in each industrial plant in the country. In the first place, we have not got four thousand Polakovs, neither can we wait eighteen months, and $36,000,000 is too much to pay for it. His plan is impracticable when it comes to a large-scale proposition.

What we require at the present time is a constructive policy and program which must be taken up by the United States Fuel Administration in a comprehensive manner. The plan must involve all the elements which I have suggested and there is no doubt but what such a plan will be formulated and adopted with large results. The 50,000,000 to 100,000,000 tons of coal a year can be saved and must be saved.

Bagasse as a Source of Fuel, by E. C. Freeland

This paper was awarded Honorable Mention in the Student Prize Contest, 1917, and was included in the Power-Plant Session because of its connection with the fuel problem to which Mr. Myers's paper was devoted.

In it the author discussed the nature and value of bagasse as a fuel, and described methods for calculating its fuel value, methods used in drying and boiler furnaces for burning bagasse.

He said that the heating value of a pound of average dry Louisiana bagasse is found by experiment to be 8300 B.t.u., and despite a high moisture content of about 50 per cent it is therefore a valuable fuel. While in former years not much attention was paid to the drying of bagasse before burning it, many authorities now claim that a great saving can be effected by such procedure.

David Moffat Myers, in an extended written discussion, said that his most recent experience in connection with bagasse burning occurred during seven weeks in Cuba last winter, where he was retained to investigate and report upon the conditions of boiler-plant economy in six sugar mills. He submitted the following observations relating in particular to his investigation of a mill in the eastern part of the island, near Manzanillo Bay, with a capacity of 3750 tons per 24 hours.

In this section of the island the fiber content of the cane is only about 10 per cent, whereas in some other parts it runs as high as 12 per cent, thus giving in the latter a bagasse of greater heating value, while the mill requirements for steam are less owing to the lesser quantity of juice extracted. Consequently, the mill supplied with cane of the higher fiber content has a great advantage in respect to economy in the use of auxiliary fuel.

In Cuba, in a perfectly designed and properly balanced sugar mill, i.e., where the exhaust steam produced is no greater than the demand for it, and where all the condensation from modern multiple-effect evaporators is returned to the boilers, the by-product bagasse is sufficient to supply all the steam when all departments of the plant are working in harmony. But where these conditions do not obtain, and there are numerous examples, auxiliary fuel in the form of wood, oil or coal must be burned.

In Cuba, wood is the most common auxiliary fuel and the cheapest in cost per million B.t.u., although the connected labor is greater than with either of the other fuels.

There is no trouble whatever in obtaining a very high-grade combustion with bagasse, even with very crude methods and furnaces. When the supply of bagasse was coming regularly and no wood was used in the furnaces, the CO_2 ranged from 10 to over 17 per cent. When wood was fired in with the bagasse, especially by some of the methods commonly employed, the furnace efficiency was immediately reduced to a degree indicated by a CO_2 content of from 3 to 6 per cent.

By changing the method of firing the wood with certain furnace alterations, a great improvement was obtained both in more uniform steam pressure and in a substantial reduction of the amount of auxiliary fuel required.

From the standpoint of the mill owner the cost of the auxiliary wood fuel—formerly about $300 per day—was a matter of only secondary importance. But the difficulty in maintaining uniform working steam pressure was of vital importance, since the inability to do so was reducing the normal capacity of the mill by an amount of grinding equivalent to $500,000 per year in output of sugar.

Stated briefly, the causes for this loss due to inability to hold steam were as follows:

1 Irregularity in feeding the furnaces, due largely to ignorant labor without white-man supervision. Supervision was installed and a large improvement immediately effected.

2 Wrong method of firing wood with furnaces ill-adapted to the purpose. This was corrected and furnaces improved, with an additional improvement in steam pressure and substantial reduction in auxiliary fuel.

3 Draft regulation entirely wrong. Plan was prepared for convenient regulation by uptake dampers to control fires and steam production.

4 Grate surfaces with natural draft burned 300 lb. bagasse per sq. ft. per hour when clean after Sunday shutdown, but clinker on furnace walls grew so rapidly that by the middle of the week the grate area would become so restricted that the capacity of the boilers was seriously reduced and formed a chief factor in the inability to hold steam. This trouble was corrected in the new furnaces designed and installed by the writer by using larger grate surface. This resulted in ability to obtain boiler capacity at all times.

5 Owing to the surplus of exhaust steam in this badly balanced plant and to other causes relating to the design and

operation of the whole mill, sufficient condensation was not available for boiler feed. Consequently, raw water had to be used as a make-up supply. This water was from wells, and its analysis showed it to be of the most detrimental character for boiler feed that the writer had ever found. The boilers, as a consequenuce, were covered with heavy scale, pitted badly and were constantly springing leaks.

The effect on fuel economy and steam production need hardly be described.

The remedy recommended was a lime-soda process of purification, filtration and storage for the raw water, and this system has been specified, purchased, and will soon be installed.

Other changes were recommended and are being installed, and there is no doubt that when the improvements are all in effect the production saving of about half a million dollars per year will be accomplished.

In further regard to the combustion of bagasse, there is one point that is likely to be overlooked unless the combustion engineer is familiar with the operation of sugar mills. A bagasse-burning boiler plant is subject to a very critical disadvantage not imposed on any other kind of a boiler plant. There is no storage supply of fuel *at the furnaces* available for instant use when occasion demands. When the boiler pressure begins to drop rapidly, the natural method employed in coal-fired steam plants is to increase at once the feeding of the fuel and the supply of air to the furnaces. This method is not applicable with the usual design of sugar-mill boiler-house equipment. The bagasse carriers keep an approximately uniform stream of the fuel moving along over the furnace tops as the mills supply it, and it is fed directly from the carriers through adjustable gates and feeders to the furnaces. Any surplus bagasse travels to the end of the conveyor, where it discharges in a pile on the ground. This pile forms the only available storage of fuel.

Consequently, when a shortage occurs or when additional steam is quickly drawn from the boilers, there is no adequate method of meeting the emergency. The result is apt to be a serious drop in steam pressure, causing longer cut-off of mill engines and a further increase in the demand for steam. The excessive time required to pitch from the surplus pile into the conveyors, added to the time consumed by the travel of this bagasse to the furnaces, renders this method of storage of little or no avail. Therefore, unless auxiliary fuel, such as oil or coal, is immediately fired as the steam pressure begins to fall, the effect is so bad that at times it becomes necessary to shut down the mills to raise steam to working pressure.

This problem, it is believed, is more important than that of drying the bagasse, which must necessitate a complication of plant not desirable under the difficult conditions of ignorant labor which must be depended upon in Cuba.

In fact, the problem of bagasse burning cannot successfully be considered merely as a combustion problem, although, of course, that forms one of the factors. But other factors enter more importantly in an efficiently operated sugar mill. Some of these have been touched upon (in the beginning of this discussion), and they include considerations relating particularly to the scientific design of the whole mill combined with its operation.

If there is trouble and delay at the mills, the bagasse supply is interrupted and the best furnace design is of no avail; unless intelligent supervision of the regulation of bagasse feeding and of dampers and cleaning of fires is provided, scientific boiler and furnace equipment helps but little; if a shutdown occurs at the evaporators, the mills are badly affected.

The matter of boiler efficiency in a sugar mill is inflexibly connected to, and affected by, the operation of the production functions of the entire mill. Consequently, an efficient boiler plant becomes largely a by-product of these other conditions relating to the general management of the mill and the harmonizing and correlating of its functions.

Such very large savings can be accomplished along these lines, given a well-designed boiler plant, that such an apparatus as a bagasse dryer would not generally be favorably regarded by plant owners unless its installation and operation could be effected at low cost and its design were such as to require little or no attention and is virtually fireproof.

In the operation of the plant referred to, upon which Mr. Myers conducted a large number of tests on combustion and evaporation, when the CO_2 ran above 16 per cent there were usually found considerable amounts of CO. In one test for which a heat balance was computed, the CO produced a loss equal to about 12 per cent of the available heat in the bagasse as fired.

The corresponding flue-gas analysis was 14 per cent CO_2, 3.5 per cent O_2 and 3.7 per cent CO. This represented an average run of 3¼ hours.

The extent to which the CO_2 could be raised without formation of CO depended upon the furnace design, the larger combustion chambers making possible the higher values of CO_2 without loss due to CO. With some of the settings tested, 15 per cent CO_2 could be maintained with but an occasional trace of CO.

When bagasse is burned at high rates of combustion (200 to 300 lb. per sq. ft. of grate surface per hour), the time required for complete combustion is lengthened so that extra large combustion chambers must be employed if a high CO_2 without CO is to be obtained. Owing to the large volatile content of this fuel, the completion of combustion occurs at a point much later in its travel than in the case of coal under equally favorable conditions. Consequently, with horizontal tubular boilers, the combustion in many cases under forced conditions will not be completed until the gases enter the tubes at the rear end. A consequence of this is a comparatively high temperature of gases in the combustion chamber, thus rendering a large tube surface of especial value for absorbing as much as possible of the remaining heat.

The rapid filling up of combustion chambers by deposits of ash which fuse to hard clinker forms an added reason for providing very large combustion spaces in the design of furnace and setting. In the case of vertical-pass water-tube boilers, the boiler should be set sufficiently high and with such arrangement of arches and baffles as to complete the combustion before the gases enter the spaces between the tubes.

Following are a few brief notes relating to the available heating value of Cuban bagasse, weight of bagasse per boiler hp-hr., etc., selected by Mr. Myers from his report on the plant referred to:

FUEL VALUE OF BAGASSE AND BOILER HP. OBTAINABLE

Assume mill to grind 300,000 arrobas[1] of cane per day with 75 per cent extraction, giving 75,000 arrobas of bagasse per day. Then, bagasse per hour = 3120 arrobas = 78,000 lb. = 39 tons of 2000 lb.

Available heating value of bagasse calculated for this plant, B.t.u. per lb. as fired	3,800
B.t.u. per boiler hp-hr. (= 34½ × 970.4)	33,479
B.t.u. to generate 1 boiler hp-hr. at 60 per cent efficiency	55,798
Pounds of bagasse to generate 1 boiler hp-hr. = 55,798/3,800	14.7
Bagasse available per hour when grinding 300,000 arrobas of cane per day, lb.	78,000
Boiler hp. from bagasse when grinding 300,000 arrobas of cane per day = 78,000/14.7	5,310

[1] An arroba = 25 lb.

Boiler hp. from bagasse when grinding 250,000 arrobas of cane per day 4,430
Boiler hp. from bagasse when grinding 200,000 arrobas of cane per day 3,533

The heat value of the bagasse was computed in two ways, first by formula, and second by an assumption of dry heat value (which Mr. Myers confirmed by bomb-calorimeter tests) and calculating the heat-moisture loss. The results agree within 2 per cent. Both computations follow:

Method 1. Calculation from this mill's analysis of February 19, 1917, with B. & W. formula, assuming according to Noell Doerr that $G = S/10$. Formula:

$$\frac{8550F + 7119S + 6750G - 972W}{100} = \text{B.t.u. per lb.}$$

Percentage analysis from laboratory:

H_2O	47.05
Fiber	44.55
Sucrose	6.81
	98.41
Glucose (assumed $= S/10$)	0.68
Total	99.09

Other gums and substances not shown by analysis.

$$\frac{381{,}000 + 48{,}400 + 4500 - 45700}{100} = 3882 \text{ B.t.u. per lb.}$$

Method 2. Assume 8300 B.t.u. per dry lb. ("Steam," Babcock & Wilcox Co.) and 47 per cent moisture. Then, total heat $= 0.47 \times 8300 = 4399$ B.t.u. per lb. as fired.

With flue temperature = 512 deg. fahr. and temperature of bagasse = 82 deg. fahr., heat to evaporate moisture =

$$0.47\,[(212 - 82) + 970 + 0.48(512 - 212)] = 585 \text{ B.t.u.}$$

Total heat per lb. as fired	4399 B.t.u.
Heat to evaporate moisture	585 B.t.u.
Available heat per lb. as fired	3814 B.t.u.

This checks to within 2 per cent of the value obtained by Method 1.

Available heat per lb. of combustible =

$$\frac{3814}{100 - (0.47 + 0.01)} = 7340 \text{ B.t.u.}$$

(Ash assumed at 2 per cent.)

H. L. Hutson wrote that the author's paper starts a train of thought which it is interesting to follow, namely: "What will our descendants do when the supply of stored sunshine in the shape of coal and oil is exhausted and they have to grow their own fuel from year to year?"

Taking Mr. Freeland's figures and assuming for Louisiana an average crop of 20 tons of cane per acre, we find that this would yield five tons of bagasse, which would have a fuel value equal to about one ton of coal. By a little figuring it can be shown that we can grow this fuel at about eight times the cost of coal.

Our descendants will, no doubt, use their fuel more economically than we do and may, in many cases, get more than eight times as much useful work out of it. In fact, in China, the ratio is no doubt larger than this, as they will cook their food in an oven heated by a bundle of stems of cotton or other crop, and then sleep on top of the oven by night and use it as a seat by day.

In parts of the tropics, alcohol made from molasses is cheaper than gasoline, and the efficiency of this fuel used in an internal-combustion engine is several times better than that of a steam engine using ordinary fuel.

The Cooling of Water for Power-Plant Purposes, by C. C. Thomas

This paper presents the results of an extended experimental investigation into the conditions governing the cooling of the condensing water of power plants by means of spray ponds. This investigation involved determining the efficiency of the cooling process under varying conditions of pressure at the spray nozzles, the temperature of the water to be cooled, the power required to circulate the water, the height of sprays above the pond surface, the effect of wind velocity on the cooling range, etc., and the work resulted in a large collection of data, much of which is presented in the text.

As a result of his experiments the author developed a new form of spray head or nozzle which is so adjustable that the film of water discharged may be broken into either a uniformly fine spray, or mist, or a large number of small drops, as desired. This method of spraying is particularly applicable to low-pressure work, a pressure of 10 in. of mercury giving an exceedingly fine spray, and 8 in. usually sufficing.

Probably the most completely controlled means for cooling water in large quantities is found in the forced-draft cooling tower. The newly developed spray head, however, provides for control of the system in a manner which, while somewhat less complete than in the case of the cooling tower, yields results comparing very favorably with those for the tower, and can be installed and operated at a much lower cost.

B. R. T. Collins, referring to efficiencies with water falling on the bare cement bottom of pond as compared with those when the pond contains its normal amount of water, wrote that the author's curves show 10 to 15 per cent higher efficiency with a full pond, thus controverting his statement in regard to the advisability of constructing a pond with practically no water in it. He believed the result shown by the curves indicates that a bare pond absorbs heat from the surroundings more readily and conducts this heat to the water sprayed upon it, thus raising the temperature of the water and reducing the efficiency. Hence, a certain depth of water should be carried in the pond to prevent this, 2 or 3 ft. being the best depth when everything is taken into consideration.

The author stated that the loss from cooling ponds with non-adjustable nozzles, in windy weather, is as high as 10 or 15 per cent. His experience is summed up by a typical case of a test made on a pond with non-adjustable nozzles at Hutchinson, West Virginia. An accurate record of all make-up water delivered to the pond during the month of August was kept, and this showed a total loss due to evaporation, drift and leakage, of 1.33 per cent of the water sprayed. The capacity of this pond was 3000 gal. per min.

There is one disadvantage in using adjustable nozzles such as the author describes when installed over a natural pond. The water in these ponds generally contains a certain amount of vegetable growth. This tends to clog the spiral slot, resulting in reducing the capacity of the nozzle appreciably, and increasing the size of the drops to a very considerable extent. This occurs in the course of a short period of time, about 10 to 15 min. after starting with a clean nozzle. This, of course, is an inherent difficulty with all nozzles of this type. It is fair to assume that an artificial pond or basin would become foul in the course of time, and cause the same difficulty.

The results reported in the paper bear out his experience in that the highest efficiency of a spray-cooling system is obtained in hot, humid weather, and the lowest efficiency in cool, dry weather. This is an advantage which a spray system has over cooling towers, as his experience has shown that hot, humid weather reduces the efficiency of towers to a very considerable extent. This, he believed, is due to the fact that the air is in contact with the water a much shorter length of time with a spray system than it is with a cooling tower of standard manufacture.

Edwin Burhorn contributed the following written discussion of the paper, the title of which he thought somewhat misleading, as it was entirely too broad, the subject-matter being devoted to cooling water by means of spray nozzles, particularly to a form of spray nozzle devised by the author:

Spray nozzles are used for cooling water for power-plant purposes but can also be used for cooling water for any purpose. Furthermore, there are many other methods of cooling water than those mentioned by the author and these different methods should have been covered by the author in order to fully justify the selection of the broad title of the paper.

The paper is interesting as far as it goes, but is not conclusive and leaves much to be desired. It is in line, however, with most of the papers that have been submitted from time to time covering various methods of cooling water, these limiting themselves to a particular apparatus. Attempts have been made to devise some general formula that could be used in connection with cooling towers, but on account of the many variables in connection with such work, the subject was given up. The process of cooling water is of such consequence and so vitally affects the efficiency of many operations that it is highly desirable that some reliable investigation be made regarding the relative value of the different methods available.

Among these methods are the plain cooling pond, spray nozzles alone or in connection with cooling ponds, cooling towers operated by means of air forced in by fans, or cooling towers in which the air is exhausted, cooling towers operating under the action of natural draft created by a stack, and cooling towers of the so-called "atmospheric" type, which operate through the action of natural air currents.

It should be borne in mind that all cooling systems are dependent on atmospheric conditions and vary with varying atmospheric conditions, and the maximum point of cooling is that of the temperature of the wet-bulb thermometer and not the temperature of the dewpoint. If the cooling system were so designed, with proper cooling surface, etc., it could reach the temperature of the wet bulb under all atmospheric conditions. From a practical standpoint, however, it is not advisable to so design such apparatus, as the great cost would not be justified by the additional reduction in temperature.

A comparison of the various cooling systems should include not only the cooling apparatus itself but also the auxiliary apparatus such as pumps for pumping the water and fans, if any, for creating an artificial circulation of air. In other words, the cost of operating various systems per annum should be investigated so that reliable data could be obtained. The interest on the investment and depreciation should also be taken into consideration and an investigation of this character would undoubtedly be of exceedingly great value. It would involve, however, considerable labor and expense.

Referring to the paper,[1] it will be noted that the curves in Figs. 7 and 8, showing the variation of efficiency of the adjustable spray head, were obtained by adjusting the spray head to suit the weather conditions existing at the time. It would be interesting to know how such adjustment is made and on what basis, as the weather conditions change from day to day and very abruptly even in a single day. It seems somewhat impractical to adjust these nozzles to suit all weather conditions. In a large installation, also, it would seem impossible to make this adjustment without shutting down the water supply or constructing a series of tunnels underneath the collecting basin to give accessibility to the adjusting rods. It is also somewhat difficult to tell whether the nozzle is adjusted for the most efficient conditions without carrying on a continuous series of tests unless the object were to attain a temperature of the wet-bulb thermometer, and of course in that case the nozzle would be adjusted until that temperature was obtained. The results of tests, however, seem to indicate that the reduction of temperature is, under most conditions, over 10 deg. above the temperature of the wet-bulb thermometer.

The curves in Fig. 10 are intended to show the wide variation of efficiency when proper adjustment of spray head is neglected. It is therefore of considerable interest to know how the spray heads can be kept properly adjusted to suit the ever-changing atmospheric conditions. The black circles refer to non-adjustable nozzles and the other circles to adjustable nozzles operating "without any attempt to obtain high efficiency." There does not seem to be much choice between the two types of nozzles and it would have been interesting to have seen the results for a period of one year where the adjustable nozzles had been operated with an attempt to obtain high efficiency.

In reference to Fig. 12, in which the efficiency is lower with a bare pond than with a full pond, Professor Thomas seems to be surprised at the results. This should not be at all surprising, as it is what would naturally be expected. The full pond offers considerable evaporating surface in addition to the surface exposed by the spray, and, furthermore, the evaporating surface is near the ground level where it can take advantage of prevailing air currents. On the other hand, the bare pond most likely did not offer the same amount of cooling surface as the full pond, and, furthermore, what cooling surface there was, was quite some distance below the ground level. This would therefore make it less accessible to air currents and naturally there would be less evaporation with the bare pond. The same reasoning may explain why the spraying on superposed inclined cement plates showed a falling off of efficiency owing to the fact that the cement plates may have offered obstruction to the prevailing wind currents and also reduced the cooling surface by collecting the spray into larger drops. No details showing the inclined cement plates were given and therefore a definite conclusion on this point cannot be reached.

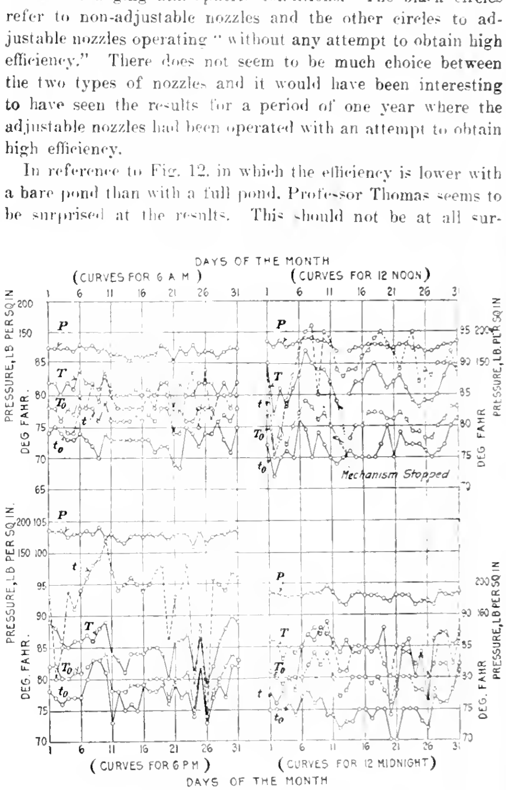

FIG. 1 CURVES SHOWING HIGH EFFICIENCIES WITH ATMOSPHERIC TOWERS

The effect of wind velocity on cooling range is indicated in Fig. 14, but not very much is said on this subject. This,

[1] The figure numbers given here are those in the complete paper as published in pamphlet form.

however, is a very important matter in obtaining satisfactory results. As the cooling of the water is done partly by convection and partly by evaporation, it is absolutely necessary in order that this process may continue that the air be in motion. Where the humidity is 100 per cent, all cooling is practically by convection, and the amount of cooling is limited entirely by the amount of air that passes over the water to be cooled. It can be readily seen, therefore, that under certain conditions a higher wind velocity will give very much better results. It is seldom, however, that the air is absolutely quiescent, there being at all times some wind movement; but even where there is no wind movement, the action of the heated water on the air would tend to create upward air currents and thus facilitate the action of the cooling. Were this not so, there would be absolutely no cooling possible unless there were wind movement. The efficiency of the cooling apparatus is based not alone on the range of cooling but also on the loss of water from all causes. Professor Thomas reports on the loss "due to evaporation." There is, however, an additional loss due to windage and this must be carefully known, as the total loss is what must be made up, and, if purchased, will represent an item of expense that should be taken into consideration. The loss from windage will depend on the velocity of the wind and also the size of the pond, and the size of the pond should be dependent on the maximum pressure of discharge at the nozzle.

The Johns Hopkins pond has an area of 962 sq. ft. and the amount of water handled varied from 20 gal. to 300 gal. per min., as indicated in Fig. 8. In the first case the area was about 48 sq. ft. per gal. per min., whereas in the second case the area was about 3.2 sq. ft. per gal. The loss of water due to windage would of course vary considerably, particularly with the average wind, but apparently no data are given on this important subject.

The loss due to evaporation would depend on atmospheric conditions and where all the cooling is done by evaporation the loss would be about 1 per cent every 10 deg. the water is cooled. It should be noted that Professor Thomas states the loss from non-adjustable nozzles in windy weather is as high as 10 to 15 per cent, but he does not show how with an adjustable nozzle the loss can be reduced by merely adjusting the nozzle. The windage loss might be greater with an adjusting nozzle owing to the fine spray, whereas the loss due to evaporation should be the same regardless of the nozzle, provided the cooling results are the same.

There seems to be some mistake in regard to the loss due to evaporation at the pond at Sparrows Point, Md., given by Professor Thomas as 0.31 per cent. At this pond, apparently, the water was reduced in temperature from 178 deg. fahr. to 125 deg. fahr., or a reduction of 53 deg. Unless the test was made in winter where there was no evaporation, or very little, then undoubtedly the loss should have been much higher: and particularly in the summer where the air temperature is high, the greater part of the cooling will be done by evaporation and in this case, if all the cooling were done by evaporation, the loss would have been, theoretically, 5.3 per cent.

Professor Thomas also endeavors to prove the advantage of the adjustable spray nozzle over the ordinary type of spray nozzle and states that the adjustable nozzle permits "regulation of the spray to suit weather conditions and to minimize loss of water and inconvenience to the nearby buildings due to driftage in windy weather." This is an admission of the inefficiency of the spray nozzle in general and a claim for an improvement due to the adjustable type of nozzle, but no proof is offered to justify the conclusion.

The curves in Fig. 8 show a variation of efficiency of the adjustable spray head with variation of capacity, but a close examination of the three curves shows them to be very nearly identical, the variation being only slight and hardly any advantage on this account.

Professor Thomas also states that "it has been somewhat surprising to find that very good cooling effect frequently obtains in very humid and even in rainy weather." He does not refer to any particular tests that have caused the surprise, but bearing in mind that it is possible to cool the water to the temperature of the wet-bulb thermometer, nothing would be surprising unless the temperature were reduced below that of the wet-bulb thermometer.

The results of cooling with spray nozzles were also compared with a few selected tests of one type of cooling tower, but as this cooling tower was not necessarily the most efficient obtainable, the comparison is not a fair one. The details of construction of the cooling towers were not given and the amount of water circulated in the cooling tower at the time the tests were made may not have been the full capacity of the tower. The data given were not sufficient to make these tests of any value for comparison. If, however, the cooling towers were all operated under their figured capacity, they show a variation *in efficiency* that seems to indicate improper design in some cases.

In Table 2, test No. 4 shows an efficiency of 0.928, whereas test No. 5 shows an efficiency of 0.391. If Professor Thomas would compare the results of his spray nozzles with the results that have been obtained with atmospheric-type cooling towers, in which the water has been reduced to within 1 to 5 deg. of the temperature of the wet-bulb thermometer, varying with the atmospheric conditions, he would then find that his results do not compare very favorably with those of that type of cooling tower.

Attention is also called to Table 8, showing tests of nozzles with spiral cores, and it is noted that on the test of nozzles consisting of two 1-in. sprays, high efficiencies are shown, namely, 0.798 in one case and 0.883 in the other. Table 7, of tests of the Thomas spray head with and without screen, does not show any test where the efficiency equals these, the highest shown being 0.75, in test No. 106, using the Thomas head with wire screen.

The spray-nozzle system undoubtedly has a field of usefulness but it is not adapted for cooling water where high efficiency is necessary or advantageous, such as in refrigerating and ice-making apparatus and steam turbines. In these plants the lower the temperature of the water used for cooling, the higher the efficiency of the apparatus, and cooling towers of the atmospheric type are able to cool the water to within 5 deg. of the temperature of the wet-bulb thermometer, whereas with the spray nozzles it is shown to be practically impossible to reach closer than 10 to 15 deg. of the wet-bulb temperature. In certain uses where high efficiency is not necessary, or for temporary service only, the spray nozzle is well adapted.

In order to show the high efficiencies actually obtained in practice with towers of the atmospheric type, the chart shown in Fig. 1 is submitted. This chart shows by curves the daily temperatures, during the month of July, the readings being taken each day of the month at 6 p.m., noon, 6 a.m. and midnight. These tests were taken from a tower in regular operation at Dallas, Texas.

Attention is called to the generally close shape of the curves of the temperature (T_o) of the water leaving the tower and the temperature (t_o) of the wet-bulb thermometer, and

particularly it should be noted that in several cases the temperatures were identical and the maximum variation about 5 deg. The wind velocity of course varied, and it should be noted that very little advantage could have been obtained in any of these tests had the wind velocity been higher than it really was.

This fact proves merely that the tower was properly designed and of sufficient surface in order to cool the water within 5 deg. of the wet-bulb thermometer under practically the worst possible atmospheric conditions. Furthermore, under the best atmospheric conditions the water was reduced to the temperature of the wet-bulb thermometer.

A. G. Christie, who presented the paper in the absence of the author, said in reply to Mr. Collins that they had found the bare pond not so efficient as the pond with a considerable amount of water. On the other hand, a full pond was not desirable in the North. There was a mean in the depth of pond which gave general efficiency—in their own particular pond about 18 to 20 in. instead of 3 ft.

The Steam Motor in the Automotive Field, by E. T. Adams

In this paper the author stated that the tremendous increase in the demand for automotive power has outdistanced the ability of the gasoline engine to meet this demand, chiefly on account of the condition that the supply of fuel is not now equal to the requirements.

The steam unit has many advantages for automotive service. Its high torque at low speed, its overload capacity, its smooth, flexible speed and power control have remained the standards of excellence, reached for but never attained by any gasoline motor.

The design of the steam unit is simple and many features of construction have been introduced which tend toward long life and low cost of upkeep.

Numbers of new steam trucks, tractors and pleasure cars are in service, or in process of manufacture or design. This effect and this demand will have a profound influence on the automotive industry.

John Younger, in a written discussion, entered a defense of the gasoline-propelled vehicle. He wrote that there has been a marked trend in design to improve carburetors to a point where kerosene can be used, and this, of course, to a certain extent, if successful, will practically double the quantity of gasoline available. There are today many internal-combustion engines running reasonably satisfactorily on kerosene, and the next year or two should see tremendous strides in the use of this or even slightly heavier fuels.

The author's statement that "the chief force which is bringing about the increased use of the steam motor is its superior fitness for automotive service, especially in the commercial field," is somewhat doubtful when the situation is studied at large. So far as he could see, there is no great demand, or any demand to speak of, for a steam automotive vehicle, for the simple reason that they were tried out as recently as ten years ago and practically abandoned. If you turn to the situation in England, where steam vehicles using coal, coke and gasoline have been used for some fifty years, you will find that the gasoline truck and the kerosene truck have supplanted the steam vehicle almost entirely. The same condition is found in the agricultural-tractor industry at the present moment, where the steam vehicle, which has so long been used by the farmer, is being actually forced out by the internal-combustion engine.

The upkeep of the gasoline truck, even with inexpert service, is not a serious handicap to the business. The cost of repairs on the gasoline motor truck is surprisingly low. Repairs lower than two cents per mile are very commonly met with.

The seeming simplification of the steam vehicle is so purely on the chassis. The engine, as Mr. Adams stated, is very similar to the gasoline engine. The rear axle, the front axle, the frames, the springs, the driver's seat, the radiator, or rather the condenser, are all duplicated in the gasoline-driven truck. This leaves practically the transmission and clutch, and this mechanical device, which usually gives absolutely no trouble, is replaced by a high-pressure steam boiler with its elaborate piping and connections and firing; so far this has not been worked out satisfactorily.

Before becoming too enthusiastic on the advantages of the steam motor in the automotive field, the whole history of the subject should be studied without any bias, and present-day installations of trucks of all kinds, not only in this country, but abroad, should also be studied very closely, and the repairs, etc., analyzed.

The author takes the very broad standpoint that whether steam will actually supplant gasoline or not is of minor import. It is quite possible that there can be a field for the two types, side by side, and anything that will help conserve our fuel supply must be worth while.

Wm. Clinton Brown[1] contributed a written discussion upholding the use of steam tractors. He said it was possible to produce a steam tractor having a total weight, including fuel, water and operator, around 125 lb. per b.hp. This is a machine lighter and far more compact than the majority of gasoline tractors. It is even only about one-quarter of the weight and less than half the size of the standard type of steam tractor of the same power.

John Sturgess presented a written discussion, which merits publication in full later, endorsing in general the author's conclusions, which he considered self-evident, but criticizing some of his references to details of construction.

He wrote that although the author referred to the extreme simplicity of the connection between motor and axle, the simplicity of the entire power plant merited equal emphasis. The modern automobile type of steam engine has but fifteen moving parts, compared to some hundreds in the internal explosive engine and its transmission.

The author stated that modern steam cars are of the multicylinder type. He had no knowledge of any steam car using or proposing more than two cylinders, for nothing would be gained thereby.

The author further stated that the uniflow type of engine is largely used, giving as the reason its simplicity and economy when operated non-condensing. He knew of only one advocate of the uniflow engine for automobile use, and he did not believe any claim was made by that advocate that cars have really been placed in the market as yet. In practice this design does not prove any simpler than, if as simple as, the contraflow, while in its application to automobile needs grave difficulties are encountered which do not occur in stationary practice.

He could not agree with the author's summary of boiler practice. As yet the water-tube type has not proven its commercial success, never yet having been marketed. The flash type is practically abandoned, owing to its several difficulties, including those of temperature and pressure control. On the other hand there are some thousands of cylindrical fire-tube boilers in daily use under every kind of service, in many cases

[1] Syracuse, N. Y.

the boilers being eight to ten years old. Among these, to his knowledge, there has not been one single case of destructive explosion due to construction methods.

He contested the author's statement that in spite of its high economy and honorable record in service, the system of converting oil under pressure into a vapor, and burning with a Bunsen type of burner, with pilot light for starting, is steadily being displaced by more modern design. His statement implies that there is a different practice already in vogue, which he doubted. Recent proposals have been made, but these could hardly be dignified by the title "modern designs."

Summarizing our present-day knowledge, as a basis for continued development, the author alluded to the clear-cut demands of the public growing from extended past experience with both steam and gasoline. Notwithstanding the efforts made, almost single-handed, against a deluge of fashion, to popularize the steam car, the writer thought the public generally is as yet uninformed as to steam-car performance.

J. D. Nies[1] and Allen C. Staley also contributed somewhat extensive written discussions in full agreement with the main argument of the paper, and emphasizing the leading features which the author brought out but differing with him in details.

Mr. Staley's discussion took up particularly the type of boiler of the steam automobile, and gave the arguments for and against the fire-tube and water-tube types respectively.

Mr. Nies considered one by one the desirable features of an automobile power plant, as enumerated in the advertisements of gasoline cars. These features are smoothness, flexibility, great reserve power, hill-climbing ability, acceleration, absence of gear shifting and low cost of operation. He then demonstrated how the steam motor compared with the gasoline motor in all these features.

[1] Lewis Institute, Chicago.

Edwin N. Trump emphasized the advantages of using a uniflow engine in the steam automobile. This engine gave a very flat economy curve, but the very high initial pressure gave such a high initial torque, at least double the ordinary running torque, that it was possible to start a uniflow-engine steam truck under conditions under which it would be impossible to start a gasoline truck.

Many people are interested in the steam truck because they feel that it will give them an ability to start a load and keep the truck going under conditions absolutely impossible with the gasoline engine.

The author, in closing, thanked the discussers for the courtesy of their retorts.

He said that it was really a romance of engineering that this development had, perhaps, first taken place in the field of the pleasure car, whereas sound business sense and engineering ability indicated that it is in the field of trucking and similar work that the steam unit has its best place.

He felt we were now at the start of what would become a tremendous industry, vital to the best interests of the country and of very great importance in the field of farming and trucking.

He had not desired to raise questions as to whether this design or that design were better, but merely to call attention to a new engineering problem which is before us in its infancy and which must be shaped and formed according to what is best for the country as a whole.

DISCUSSIONS OF PAPERS ON VARIED SUBJECTS

Opinions Expressed at the First General Session of the Annual Meeting, when Papers on Heat Transfer, Surface Resistance, Air Purification, Balancing, etc., Were Presented and Discussed

THE first General Session was called to order at 2:30 p. m. by Prof. Charles R. Richards, who acted as chairman. Six papers were presented at this session—the last two by title—as follows:

The Transfer of Heat Between a Flowing Gas and a Containing Flue, Lawford H. Fry.

A Study of Surface Resistance with Glass as the Transmission Medium, H. R. Hammond and C. W. Holmberg. Awarded Student Prize, 1917.

Apparatus for Cooling, Drying and Purifying Air, W. J. Baldwin.

Recent Developments in Balancing Apparatus, N. W. Akimoff.

Plotting Blower-Test Curves, A. H. Anderson.

Cross-Current Predeterminations from Crank-Effort Diagrams, Louis Illmer.

Mr. Fry Discusses Heat Transfer

The first paper to be presented was one by Lawford H. Fry, in which he developed a logarithmic formula covering the important thermodynamic process of the transfer of heat between a flowing gas and the wall of the containing flue, which formula, within the range of experimental data available, has been found to give satisfactory results.

E. A. Fessenden submitted a written discussion, in which he said that Mr. Fry's paper is a distinct contribution to the study of the transmission of heat by convection. While much excellent experimental work has been done, apparently no one has heretofore succeeded in correlating and harmonizing the results of many investigators so satisfactorily as is done in this paper. Formulæ showing the relations between factors involved in heat transmission by convection have been proposed in so many different forms that it has been difficult to realize that any connection exists between them. Instead of using these formulæ, proposed by various experimenters, Mr. Fry has gone to the original data and demonstrated that all the results may be satisfactorily represented by a single equation. The data are thus no longer more or less chaotic, but consistent, not only for each separate series of experiments, but for all. That this is true for data gathered under a wide variety of conditions encourages the belief that the real solution of the problem is brought nearer.

The general formula, Eq. [1], proposed at the New Orleans meeting in 1916,[1] was based upon two series of experiments and confirmed by several other isolated sets of data. No attempt was made at that time to evaluate the constant M. A little later, a full account of these experiments was published,[2]

and an empirical equation was given which satisfied these particular tests, namely,

$$M = 0.195U^{[illegible]}$$

where U is the weight of gases per hour per tube multiplied by the hydraulic depth in inches. The experiments did not cover a sufficiently wide range of conditions to warrant proposing this as a general formula.

Fig. 1 shows several sets of experimental data plotted upon log M and log U as coördinates. Since $U = Wr$ and log U = log W + log r, this method of plotting differs from that used by Mr. Fry only in shifting points horizontally by an amount depending upon r. The amount of displacement is constant throughout any single series, so that the slope of the lines connecting the points is unchanged. The data plotted include all those used by Mr. Fry, and in addition the following:

curves to be drawn to represent them, but they do indicate that the author's Equation [2] for M in its present form does not apply universally. It should be emphasized, however, that these latter data are very much beyond the range of those investigated by the author of the paper. In the Heine boiler the gas passage through the prism occupied by the tubes is not of circular cross-section, but is the space left around 3½-in. tubes on 7-in. centers, staggered. The hydraulic mean depth of the gas passage is about 1.31 in., and for a single tube the perimeter is 10.996 in. In order to conform to the author's Equation [2], the points for tests on the Heine boiler should cluster around the line marked H-H. Instead, the actual points indicate values of M about $2\frac{1}{4}$ times as large as are given by the proposed equation. A similar discrepancy is indicated for the Nicolson experiments.

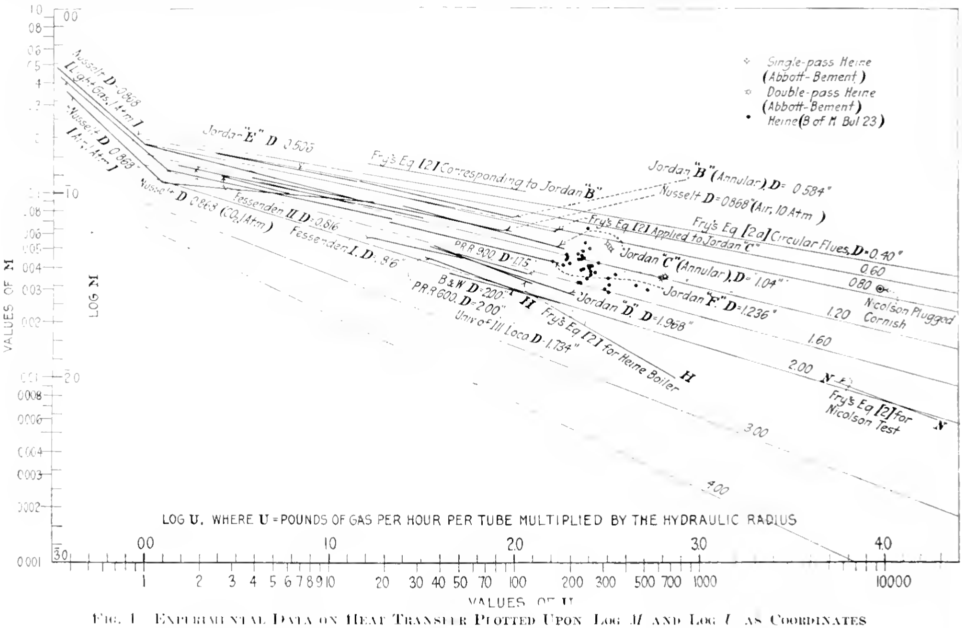

Fig. 1 Experimental Data on Heat Transfer Plotted Upon Log M and Log U as Coordinates

1 A series of tests made upon a consolidation locomotive.
2 Some tests made by the United States Bureau of Mines upon a Heine boiler.[4]
3 Some tests made upon single- and double-pass Heine boilers by Abbott and Bement.[5]
4 Nicolson's tests upon a Cornish boiler, in which a firebrick plug was inserted in the flue, leaving an annular gas passage 1½ in. wide.[6]

In order to reduce confusion, the separate experimental points for the tests used by Mr. Fry and for the additional locomotive series are not shown, but the heavy lines in the figure represent quite accurately the tests indicated. The light lines are plotted from the author's equation [2a] for flues of circular cross section. The other three groups of tests did not cover a sufficiently wide range of conditions to permit

A somewhat similar discrepancy may be shown for flues of circular cross-section larger than those covered by the experimental data. For example, in an ordinary return tubular boiler with 4-in. tubes, 16 ft. long, operating with 65 per cent overall efficiency and at rated load, with 18 lb. of air per pound of coal, an average of about 135 lb. of gases pass through each tube in an hour. The hydraulic depth is 0.933 in., and by the author's Equation [2] the value of M is 0.00912. If the water temperature is 366 deg. fahr. (corresponding to 150 lb. gage pressure) and the flue-gas temperature 600 deg. fahr., the temperature of the gases entering the tubes by Equation [1] is only 730 deg. fahr. Under the operating conditions assumed above, we might reasonably expect a furnace temperature of 2000 deg. fahr. to 2200 deg. fahr. The tempera-

[1] Trans. Am. Soc. M. E., vol. 38, p. 407.
[2] University of Missouri Bulletin, vol. 17, no. 26 (Oct. 1916).
[3] University of Illinois Engineering Experiment Station Bulletin, no. 82.
[4] United States Bureau of Mines, Bulletin 23. (Boiler no. 1).
[5] United States Bureau of Mines, Bulletin 18, p. 155.
[6] *Power*, Feb. 7, 1911, p. 222.

The boiler used in the Bureau of Mines tests had tiles completely encircling the lower row of tubes, forming a tile roof to the furnace. In computing M the furnace temperature was taken as the temperature at the entrance to the tube bank, and for the end of the tube bank the temperature was taken as that of the flue gases. Thus the assumed temperature drop through the tube bank is undoubtedly too high, with a corresponding error in M. This does not account for the large departure in the values of M from Mr. Fry's curve, since their allowances for the errors in the assumed temperature drop would reduce the values of M possibly 20 to 30 per cent.

ture drop from furnace to tube entrance would then be about 1300 deg. fahr. to 1500 deg. fahr., i.e., about 91 per cent of the total heat absorbed by the boiler is taken up by the shell by radiation from the firebox and by convection in the combustion chamber, leaving only about 9 per cent for absorption by the tubes. This is decidedly inconsistent with our usual ideas as to the value of the tube surface. If the temperature at entrance to the tubes is assumed to be, say, 1700 deg. fahr., the value of M is 0.0325. Rather curiously, considering its limited basis, the value of M for the same conditions computed from the formula $M = 0.195U^{-.43}$, mentioned above, is 0.0284. In the footnote on page 18 of the paper, it is stated that Eqs. [2] and [2a] are both applicable to flues of circular cross-section. They do not give exactly consistent results, however. For example, for the case of the return tubular boiler just considered, Eq. [2] gives $M = 0.00912$, while Eq. [2a] gives $M = 0.00812$.

Within the limits of the experimental data investigated, the author has apparently succeeded admirably in adapting the basic formula to widely varying conditions. Beyond these limits, i.e., for tubes larger than 2 in. in diameter and for passages of irregular cross-section, more experimental work is necessary before any very definite extension of the author's formula can be obtained. The Heine boiler tests and the Nicolson test, shown in Fig. 1, suggest that Mr. Fry's straight lines may be tangents to rather flat curves. Inspection of the author's Fig. 13 suggests that possibly the values of B and m, instead of being represented by straight lines, may lie on curves of parabolic form. This would increase B and decrease m for passages of larger "effective diameter" and thus increase M.

E. R. Hedrick wrote that there were reasonable grounds for supposing that there is really a break in the behavior when W had what was called by the author the critical value of (about) 5 lb. per hour. Also it was possible that a different relation for the effect of the flue diameter will have to be worked out when experiments were available in which a greater variety of values of d occurred. Possibly the relations suggested by Fessenden and Haney (Univ. of Mo. Bulletin, vol. 17, no. 26) might be found at least helpful in settling this question.

The author referred early in the paper to the fact that "no attempt is made to measure the rate of heat transfer." However, it should be emphasized that any formula that gave the temperature (or the heat-content) of the gas in terms of the distance along the tube, implied directly a law for the rate of heat transfer. This was the reason that the Osborne-Reynolds hypothesis led to a definite law for the drop in temperature along the tube, which enabled us to compare it directly with such experiments as those of this paper. It was shown in the paper by Professor Fessenden and himself (Trans. A.S.M.E., vol. 38, p. 407) that their formula [18], which is identical in meaning with formula [1] of Mr. Fry's paper, led directly to the formulæ [24] and [25] of their paper:

$$d\theta/dx = -m\theta \log_e(\theta / \theta_w)$$

or

$$d\theta/dx = -2.3026\, mR_0\theta_e^{-mx}$$

where the notation is that of their paper. From these, it was but a step to show that the rate of heat transfer (per degree difference in temperature per square foot of heating surface per second) was expressible by the formula

$$\frac{C_p w}{\pi d} \frac{1}{\theta - \theta_w} \frac{d\theta}{dx}$$

where w is the weight of gas passing per second, C_p the specific heat of the gas, and d the diameter of the tube. Hence, the rate of heat transfer was proportional to

$$\frac{C_p\theta}{\theta - \theta_w} \log \left(\frac{\theta}{\theta_w}\right)$$

In any event, the rate of heat transfer was certainly not proportional (simply) to the difference in temperature, as was abundantly shown by the experiments quoted in this paper.

J. F. Barkley[1] wrote that, after an extended experimental study along the lines of the subject of the paper, he felt that any equation which included all the physical factors involved in such a heat transfer would unquestionably be too complicated for practical purposes. It seemed to him that there would always be necessary a simple equation, such as that of Osborne-Reynolds, including, perhaps, a few of the main physical factors. These together with experimental constants would serve to obtain desired quantities within certain ranges.

The temperatures taken by the author from the B. & W. experiments were derived by calculation, using the specific heat of the gases. The specific heats of gases, particularly at temperatures from about 1500 deg. fahr. up, were not well agreed upon by the best authorities. This variation amounted to several hundred per cent at 2500 deg. fahr. What was needed was some experiments where a heat balance could be taken which would show the possible inaccuracy of the data, plus or minus.

As to the accuracy of the formula, he would like to ask what the maximum possible per cent error would be if one were to solve it for some quantity, say, the length of a tube.

Gottfrid L. Ostgren asked whether there were any published data on formulæ to be used for calculation of heat transfer for large flues, over 2 ft. in diameter, or circular or rectangular cross-section. Frequently an engineer had to design a furnace where he was using waste-heat gases to heat air in a closed space, for instance, in an annealing furnace, and the question of determining the proper radiating surface in order to obtain a certain temperature in the annealing furnace was rather important. He had occasion to construct an annealing furnace of that type not very long ago, and while he had struck the temperature very closely, he had found that when doors were opened on the two sides of the furnace and the temperature dropped, it took a rather long time to get the temperature back again. By putting conical deflectors inside the flue, where the waste gases were passing, it was possible to obtain more contact between the heat units and the steel flue, which improved the transfer quite considerably.

D. S. Jacobus said that the heat-transfer rate of conduction from the gases to the cooling surface was only one of the elements to be considered in designing a boiler. For example, the effect of radiant heat on the tubes nearest the furnace was an important element, and unless this was included in an analysis of efficiency the results would be considerably in error. When it came to the final analysis and securing the maximum efficiency from a boiler, the rate of heat transfer must be considered, and it was necessary to balance up a loss in draft against securing a higher boiler efficiency.

There were a number of elements that had to be taken into account in designing a boiler; for instance, the effect of radiant heat. It was necessary to expose enough of the heating surface of the boiler to the radiant heat to keep the temperature of the furnace within the limit that present-day brickwork will stand.

[1] Asst. Efficiency Engineer, Carnegie Steel Co. E. T. Works, Braddock, Pa. Formerly with United States Bureau of Mines.

Again, the entering velocities of the gases between the tubes should not be made too high. If the area for the flow of the gases was unduly constructed there might be trouble, especially at the higher ratings at which boilers are run today, when the tubes become fouled through the accumulation of soot, which would lead to an excessive draft resistance.

It was also necessary to provide a sufficient furnace volume and a proper length of travel for the burning gases in order to consume the products of combustion, and also to prevent a blowpipe action on the boiler tubes.

An interesting addition to this valuable paper would be an analysis combining the draft losses with the variation of heat transfer to determine the theoretical proportion of the areas between the tubes for the flow of the gases to give a maximum heat absorption for a minimum draft resistance. An answer to this problem has been found by experiment and practice for certain classes of boilers, but it would be interesting to have

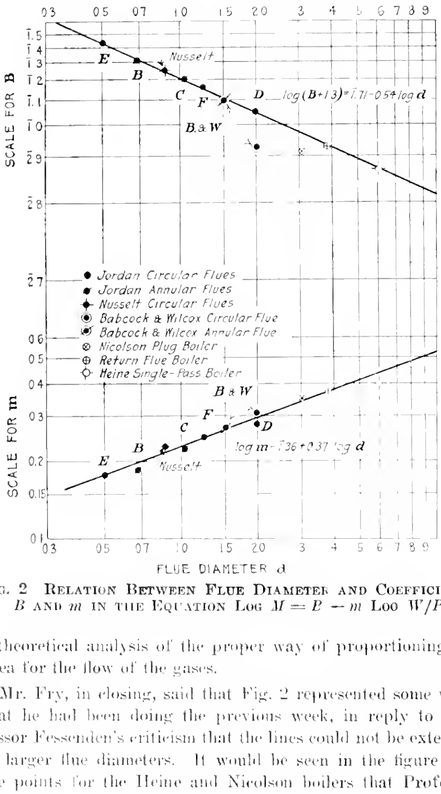

FIG. 2 RELATION BETWEEN FLUE DIAMETER AND COEFFICIENTS B AND m IN THE EQUATION LOG $M = B - m$ LOG W/P

a theoretical analysis of the proper way of proportioning the area for the flow of the gases.

Mr. Fry, in closing, said that Fig. 2 represented some work that he had been doing the previous week, in reply to Professor Fessenden's criticism that the lines could not be extended to larger flue diameters. It would be seen in the figure that the points for the Heine and Nicolson boilers that Professor Fessenden referred to, were well taken care of in both lines. If the Heine boiler tests of Professor Fessenden were replotted on the basis of weight of gas divided by perimeter, they would be found to show agreement with the author's lines plotted on the logarithmical basis.

He believed that a formula of this sort could be applied to the condition that Mr. Ostgren spoke of in air flowing through the inner flue, if it was possible to get the mean temperature of the flue wall.

In conclusion, he desired to point out that the paper referred to the point that was mentioned by Dr. Jacobus in regard to the loss of draft, viz., that by decreasing the flue diameter the rate of heat transfer could be increased, but that this would be done at the expense of loss of energy in forcing the gas through the flue. The loss of draft—loss of head—in passing through the flue was the price that must be paid for increased heat transfer, and if a formula similar to that used for loss of temperature could be obtained to take care of loss of head, it would be possible to figure out exactly what had to be paid for a given rate of heat transfer, and to calculate for any kind of a boiler with greater certainty.

He would add that two of the important series of tests mentioned in the paper were carried out by the Babcock & Wilcox Company, under the direction of Dr. Jacobus, who had courteously placed them at his disposition.

MR. HOLMBERG PRESENTS PAPER ON SURFACE RESISTANCE

The next paper to be brought before the session was one by Messrs. H. R. Hammond and C. W. Holmberg,[1] which had been awarded the Student Prize for the year 1917. In introducing Mr. Holmberg, who presented the paper, Chairman Richards feelingly referred to the sudden demise, during the previous week, of Mr. Hammond, who had hoped to present it in person. The paper describes an investigation of heat transmission through glass and gives a formula by which the combined coefficients of transmission, as well as the conduction values for the glass inside air surface and outside air surface, may be calculated.

Prof. A. J. Wood, in a written discussion, called attention to the fact that tables, for the most part, give conduction values only. To apply these to the usual practical problems it was necessary also to know the values for the surface effect. The table in the paper showed the effect of temperature range on heat transmission, and this was found to influence the results to a considerable degree.

On December 3 Prof. R. B. Fehr and he had discussed, before the American Society of Refrigerating Engineers, the results of recent work at the thermal testing plant of The Pennsylvania State College. Among other constants given, it was stated that under usual temperature conditions and for "still" air, the total surface transmission for *both sides* of glass, corkboard and building paper was found to average about 22 B.t.u. per 24 hr. per sq. ft. per degree difference, which value was approximately 0.9 B.t.u. per hr. per sq. ft. per degree difference. Pending the results of more extended tests, this value was believed to be a safe one for general practice.

L. B. McMillan submitted a written discussion in which he said that the conclusions which the authors had reached regarding the importance of the air-film effect were in accordance with the theory on the subject and checked closely with the results by other investigators. However, their work showed more forcibly than ever the need for full and complete data on the subject of surface resistances.

Considerable work had already been done on this subject—much more than would appear at first thought. For example, it had been nearly one hundred years since Péclet made his classical experiments, determining radiation coefficients for a number of materials, and these, in connection with convection coefficients, indicated the rate of flow from the surface or conversely the surface resistance. One reason why there seemed to be such a scarcity of data on surface resistances was that this relationship of surface resistance to surface transmission was very generally overlooked.

Dulong had built on the work of Péclet and worked out equations for the radiation coefficients at various temperatures.

[1] 354 Senator St., Brooklyn, N. Y.

These were given in Kent's Pocket-Book, together with tables prepared by Box which facilitated the finding of the coefficient at any temperature. This would go a long way toward filling the need except for the fact that Péclet's coefficients had been found to be very considerably too low. For example, Paulding (Stevens Indicator, vol. 19, p. 393) has shown that Péclet's coefficient of 0.64 for iron was much too low, and that modern tests proved that this coefficient should be about 0.87.

Péclet's results were therefore of interest mainly for their historical importance, and because of the thoroughness with which he had attacked the problem, even at that early date.

Fig. 3 showed results of some of the modern investigations[1] as compared with Péclet's results, and illustrated how well the modern tests agreed, even though made by widely different methods. For example, the tests by Barrus, Brill, Jacobus, Eberle and that labeled "Stevens Indicator" were condensation tests, while those by the writer were by the electrical method, and yet the results were in very close agreement, while the curve showing Péclet's results fell far lower.

The data referred to were not presented as being directly comparable with the results presented by the authors of the paper under discussion, as these did not refer to glass surfaces. However, the data were of similar nature, as the results shown in the figure represented surface conduction for cylindrical surfaces where the character of surface was that of an ordinary steel pipe.

In pointing out the difference between Péclet's results and those of modern tests this was not intended as a criticism of Péclet's work, for considering the time at which it was done it was a great achievement, but now, with infinitely better facilities for research, we should repeat his work on even a larger scale than that which he attempted, and in addition to having the coefficients for various surfaces and laws showing how they vary with temperature, we should have also the laws showing the effect of wind velocity, humidity, etc.

This, however, would be a very large undertaking and could not be handled by one individual or concern, though some of the larger manufacturers of insulating materials had well-equipped laboratories and would be glad to coöperate in such a movement. The Bureau of Standards had done much creditable work along this line, and would probably do more, but great results could be accomplished in the university laboratories and experiment stations as had been shown by the paper under discussion.

The foregoing might appear at first thought to be rather much of an academic discussion, but it decidedly was not, and a few illustrations would show how useful these coefficients were in the solution of everyday engineering problems.

For example, a great deal of data regarding conductivities of materials was now available, and with complete information as to surface resistances the calculation of heat-flow problems would be much less of a bugbear than it had been in the past.

Furthermore, the only effect which wind velocity could have upon the heat losses from a surface was to decrease the surface resistance, therefore this effect could easily be isolated and determined. The same was true of air humidity, except where the material was affected by moisture.

As pointed out by the authors, the surface resistance was the greater part of the resistance to heat flow through good conductors of heat, and for accurate solution of problems of this kind accurate data on surface resistances must be had.

Furthermore, it was often desirable to estimate beforehand the temperature of the surface of a stack or furnace when the thickness and character of the walls and the temperature of the inside of the furnace were known.

As an illustration of the use of surface resistances in the solution of an actual problem, a 4-in. brick wall might be considered, the conductivity of the brick being taken as 6 and surface conduction as 2. This would make the rate of heat flow $= 1/[1/2 + 4/6 + 1/2] = 1/1.67 = 0.6$ B.t.u. per sq. ft. per deg. temp. dif. per hour. It was to be noted that the combined resistances of the two surfaces were greater than the resistance of the four inches of brick.

If in place of the brick the wall had been 4 in. of a good insulating material having a conductivity of 0.5, the rate of heat flow would then have been equal to $1/[1/2 + 4/0.5 + 1/2] = 1/9 = 0.11$ B.t.u. per sq. ft. per deg. temp. dif. per hour. In this case the resistance of the material was 8 times the combined resistances of the two surfaces.

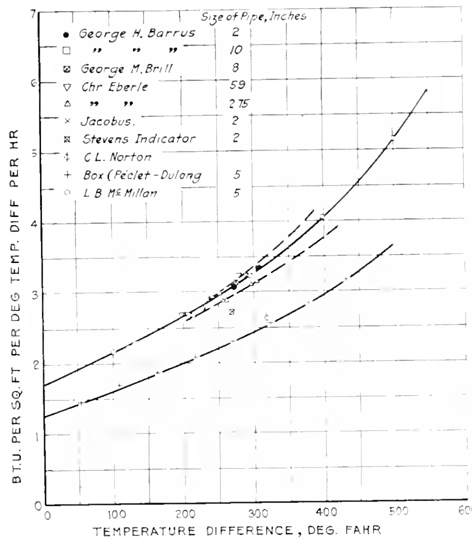

FIG. 3 COMPARISON OF RESULTS OF VARIOUS INVESTIGATORS ON HEAT TRANSMISSION FROM BARE PIPE SURFACES TO AIR

Therefore, while these things could be done with a considerable degree of accuracy, even with the data now at hand, it would be quite an advance to have full and complete information. This was particularly true regarding the good conductors of heat, for the data now available served very well in insulation problems where air resistance was the small part of the total resistance.

Returning again to the paper under discussion: The authors stated under Conclusions that the greater resistance was at the outside surface of the glass, and attention was called to the fact that this referred to the conditions of test and was not made as a general statement, as the resistance of the inside surface during these tests was greatly dissipated by the air circulation.

Also, it would seem from former investigations that the curves in Fig. 6 of the paper should bend upward at the higher temperatures instead of downward. However, a wider temperature range might be necessary to make this change con-

[1] Geo. M. Brill, Trans. A.S.M.E. vol. 16, p. 827. Geo. H. Barrus, Trans. A.S.M.E., vol. 23, p. 791. C. L. Norton, Trans. A.S.M.E., vol. 19, p. 729. Prof. D. S. Jacobus, Stevens Indicator, vol. xix, p. 12; Stevens Indicator, vol. xix, p. 388. Chr. Eberle, Verein Deutscher Ing., Mit. über Forschungsarbeiten, Heft 78. Thomas Box, Practical Treatise on Heat and Kent's Pocket-Book. L. B. McMillan, Trans. A.S.M.E., vol. 37, p. 921.

siderable, and for the given range the figures were probably very nearly correct.

In conclusion, he wished to repeat that he believed it would be well worth the trouble to investigate through a wide range of conditions the surface resistances of various materials.

Prof. E. A. Fessenden thought the temperature-gradient curves given in the paper were important, and it seemed to him that it might very well be emphasized in this connection that, where total transmission was being sought, the thermometers for measuring temperature should be placed at a considerable distance from the surface to get on to the horizontal part of the curves and away from the sloping gradient—possibly 10 inches or a foot or more away, but at least not near the surface.

Arthur K. Holmes called attention to the fact that in Fig. 5 the conduction of heat through glass seemed to vary between 18 and 22 B.t.u., while in another place it was stated that "the combined-coefficient values check up thoroughly well with the values 0.96 (dry glass) and 1.1 (wet glass) for a single window," or about one-twentieth as large.

L. B. McMillan said that in one case where the temperature went up to 500 deg. and the thermometers were placed at least 5 ft. away, unless they were shielded by a sheet of paper between them and the heated pipe, they would still, by radiation from the pipe, show a higher temperature than the room air. He therefore thought Professor Fessenden was quite right in saying that it was the temperature of the room air that should be taken as the lower temperature.

Mr. Holmberg, in closing, said that Mr. Holmes had mentioned that the conduction values given for glass seemed to be about 15 to 20 times those that were spoken of in regard to the combined-coefficient values as checking up fairly well with the values 0.96 and 1.1 for a single window. It was to be noticed, however, that in this connection it was said that, "Moreover, they [these values] show that the transmission varies linearly with the temperature differences." So, it would seem, they were speaking of transmission values. The transmission value took into account not only the conduction of the glass but the two surfaces, and it was the two surface values which so reduced the amount of heat that would go through there as to give that decreased value.

The glass itself was a very good conductor, and if taken by itself, without any surface resistance, there was very little resistance to heat going through; but with the two air resistances taken in conjunction with it, it gave the bottom curve on Fig. 5, marked "Transmission," which represents the value spoken of in the paragraph referred to by Mr. Holmes.

Lest misconception should arise regarding the conduction curves plotted in Fig. 5, he would say that the abscissæ represented total temperature differences (inside to outside of glass). As indicated in the table preceding the figure, the conduction curves were plotted merely for the purpose of comparison with the total-transmission curve. It was also to be noted that in formula [2] k should be replaced by $1/k$.

Mr. Baldwin Describes Apparatus for Purifying Air

The next paper, by W. J. Baldwin, described an apparatus for purifying air and regulating its temperature and humidity by mechanical means. In principle it consists of the use of a cold spray for the purification process, after which the excess moisture, together with particles of dust, excess CO_2, etc., are separated from the air by centrifugal action. In one of its original forms the device was applied to the porthole of a ship for the purpose of drawing into the cabin large quantities of air but excluding rain or spray. It has also been used to remove CO_2 from vitiated air, as in the compartments of a submarine, and for removing particles of dust from the gases of combustion in a chimney.

In lieu of reading the paper, Mr. Baldwin gave brief particulars of views which he had projected on the screen, showing various forms of the apparatus and uses to which it had been applied. The largest apparatus at present in use handled from 16,000 to 20,000 cu. ft. of air per minute. It was a dry apparatus and was used in the Flatbush Gas Company's plant on one of their boilers, and had been in use for over a year. It removed 96 per cent of the dust that would ordinarily escape up the chimney and 46 per cent of that dust was so fine that it would go through a sieve of two hundred mesh.

It was desirable, said Mr. Baldwin, not to use water when handling chimney gases. If water was used acids would be condensed, and the fuse would give out in a very short time, especially if salt water was employed. In New York and in Brooklyn where a salt-water spray running over an apron was used, it attacked the iron so rapidly that it disappeared in a few months.

In portland-cement mills the apparatus when operated dry would recover 83 per cent of the cement escaping from the top of the chimney, floating out over the country, and when water was turned on, 100 per cent.

The apparatus could also be used for throwing down and removing by-products from escaping gases from mechanical plants and gas-producing apparatus, etc.

Mr. Akimoff Describes His Latest Balancing Apparatus

In the paper by Mr. Akimoff were described new methods which he has recently developed and applied in a new type of machine for combination static and dynamic balancing. In operation a clamp is attached to the body to be balanced, whereby a known centrifugal force is introduced when the body is rotated, for the purpose of neutralizing the static or dynamic unbalance of the body. By suitably constraining the motion of the rotating body, either the static or dynamic unbalance, or the combination of both, may be accurately measured through the adjustment of the clamp.

Clarence P. Crissey, who opened the oral discussion, asked the author if any rotors had been balanced on his machine and then run at or through critical speed, and if so, did experience indicate that it would be commercial to design multi-stage apparatus having packings between stages, with a critical speed below but in close proximity to the operating speed? In other words, could apparatus be balanced so closely that the critical speed could be disregarded?

In reply Mr. Akimoff said that he thought it was a problem different from dynamic balance. It seemed to him that dynamic balance proper ended when a body was balanced in such a way that in a perfect vacuum, without any outside effort, it would run perfectly and without any oscillation whatsoever. Machines could be built commercially, without very much trouble, because it was just as easy to get a near balance as to get perfect balance by the means described, and, of course, vibrations would not be set up except by the action of some outside agency. Torsional vibrations were an entirely different proposition and were due to the distribution of mass on the line of the shaft. The torsional problem, which was very difficult to solve, was illustrated by a plain shaft with a flywheel on either end.

H. G. Reist asked whether there was any method of marking the shaft or indicating where the counterweight was to go.

In reply Mr. Akimoff said that the amount and location of the counterweight were fully indicated by the position of the clamp, which could be quickly adjusted after a few trials. There was a way of making the clamp so that the adjustments could be made without stopping the machine, but that would be the subject of a communication by him at some future time.

Mr. Reist said that with reference to the matter of getting a balance that would run at critical speed, he might say that this was practically done in a different type of balancing machine in which the rotating body was supported by a flexible cable, but the effect was practically similar.

W. J. Baldwin described a method which he had devised and successfully used for balancing fans and other machines having parts attached to a central hub. It consisted of two radial arms adjustable at any angle to each other on the shaft of the machine. If these arms when both opposite the "heavy" side of the machine did not hold the machine in running balance, they were made heavier. If they were found too heavy they were shortened. Minor adjustments were made by moving slightly one of the arms.

F. Van Buren Connell said that recent developments in the automobile and airplane industries had emphasized greatly the subject of balance, which already was known to be very important, and was now considered a distinct branch of mechanical engineering and not a shop method at all. Up to the present time the methods of obtaining balance had been very crude. One of the old standbys had been the parallel ways referred to, which were only good for static balance, and then only under conditions of light weight and small journal bearing. With large journal sizes and heavy weights the results showed such a discrepancy that they positively prohibited the use of parallel ways for obtaining even static balance. With Mr. Akimoff's machine results were obtained with a mathematical exactness that had never been obtained before, and there was no guesswork about it—it was not a hit-or-miss system. By systematic trial adjustments they obtained the exact amount of unbalance and the exact plane in which they should drill or add weights to give that balance.

The subject of balancing was an extremely important one and a very practical one, too, because the actual work of indicating could be done by a mechanic. There should be an efficient balancing engineer, however, a new species, to direct the mechanic's work, because the subject required something more than the trial methods and the horse sense that had been applied to it so far.

Mr. Illmer's paper, an extended abstract of which was published in the October Journal, was then presented by title. No discussion being forthcoming, the meeting was declared adjourned.

Professor Anderson on Plotting Blower-Test Curves

In his paper, which was presented by title, Professor Anderson described a new method of plotting blower-test curves, and demonstrated its utility by the solution of problems from graphically recorded test data.

Diagrams were given for impellers with blades tilted forward, blades radial, and tilted backward. Curves showed rates of discharge in cubic feet per second and volumes discharged per second per horsepower.

J. M. Spitzglass, in a written discussion, said that the curves given disclosed many interesting features in the characteristic properties of the various types of blowers, which could not be very well shown in the usual pressure-volume curve of the blower. It was interesting to note that in Fig. 1, representing the characteristic curve for blades tilted forward, the volume lines were uniformly converging toward the higher speed, so that some of them crossed each other, even within the limited region of the curve. This would indicate that at the higher speed of this special blower there was practically no variation in the pressure for any volume delivered by the blower, or rather the least variation in the pressure would change the volume from a maximum to a minimum, and vice versa, and it would be very inefficient to use a blower of that kind where a more or less constant volume of air was required.

In Fig. 2 the volume lines were less converging than in Fig. 1, while in Fig. 3, the characteristic curve for blades tilted backward, the volume lines were practically parallel to each other, which meant that in this kind of blower the volume of air delivered could be kept more or less uniform, even though the resistance to the flow should vary to a certain degree.

In this experimental case the discharge of the fan was varied by the use of different-sized orifices at the outlet of the fan. In the practical operation of blowers it was not so easy to control the resistance offered to the flow of the air. The air might be blown through a thick fuel bed, which might vary in height and also in resistance, and in such cases it was not the static pressure, nor even the mechanical efficiency, that interested operators as much as the number of cubic feet per horsepower that could be obtained from the blower, and curves plotted in this manner showing the amount of air that could be obtained for any condition were very valuable for that purpose, because they showed at a glance under what conditions it was possible to obtain the maximum quantity for a given amount of power used on the blower.

Regarding the mechanical efficiency shown for the given blowers, he wished to ask why the efficiency was so low, not being much over 40 per cent in any one of the given blowers, and why the blower with the blades tilted backward showed the lowest efficiency of all, when theoretically this kind of blade should show higher efficiency than the others.

F. R. Still wrote that while the author's curves were interesting, and perhaps might be valuable for some purposes, he thought the most useful curves for all purposes of fan or blower application were those of the kind employed by the American Blower Company, which were developed from characteristic curves plotted from test results. In his opinion, no other method covered the performance of a fan so completely, and at the same time cleared up what otherwise was so frequently very puzzling in results from fan installations, especially to those who did not have to deal with fans frequently enough to understand them thoroughly.

G. F. Gebhardt wrote that he had applied the authors' curves to comparative tests of a number of fans of various makes, and found that the commercial characteristics most desired were brought out in a much more satisfactory manner than with the customary method of plotting results. It was true that considerable time was required to plot the curves as indicated, but the ease with which the various problems involved might be calculated from the graph might greatly justify the initial expenditure of time. No claims were made in the paper as to the accuracy with which the investigation was conducted, but he had had the privilege of studying the test methods used and had been greatly impressed with the painstaking and exacting care with which all measurements were made and recorded. The paper, though brief, was a marked acquisition to the art of blower testing. He would like to ask the author

why the capacity curves between 0 and 35 cu. ft. per sec., Fig. 1, had been omitted.

C. M. Spalding wrote that the curves given in the paper brought out very clearly certain phases of blower action, and that it would be very desirable if the author would add some definite information about the dimensions of the fans, and would also tell whether the blades were plain or curved, etc.

In examining the data presented, he had been interested to see what other aspects of the matter would appear by taking the information furnished by the author and comparing it in other relations, more especially as regarded the relative performance of the three types of fans. He had constructed the tables which follow by taking two values as a common basis for all three types of fans and setting against them the variable values of the other items covered in these data. The variable items were stated both in the actual values taken from the curves and in the proportionate values by assuming some one of the three types of the fans as unity, or rather 100 per cent, and comparing the performance of the other two types of fans. It would be noted that these tables did not select the most favorable condition of operation of all three types of fans, as in order to make the comparison it was necessary to select as a common basis points which appeared on all three of Professor Anderson's curves, but even with this limitation they were very interesting.

TABLE 1 COMMON BASIS: PRESSURE AND R.P.M.

Basis		Performance						
			Total Output, Cu. ft per sec.			Efficiency, Cu. ft. per sec. per hp.		
Press., inches water	R.p.m.	Values	Blades tilted forward	Blades radial	Blades tilted backward	Blades tilted forward	Blades radial	Blades tilted backward
1.50	1400	Actual	73 0	57.0	32.5	15 00	17.95	20.05
		Relative	100.0	78.0	44.5	74.80	89.50	100.00
1.25	1400	Actual	76.3	60.9	39.5	15.10	18.40	21.40
		Relative	100.0	79.8	51.8	70.60	86.00	100.00
1.00	1400	Actual	80.0	64.1	45.0	15.20	18.90	22.45
		Relative	100.0	80.1	56.3	67.80	84.30	100.00
1.25	1300	Actual	68.0	54.6	31.2	17.35	21.05	23.50
		Relative	100.0	80.3	45.8	73.80	89.70	100 00
1.00	1300	Actual	72.0	58.2	37.4	17.50	21.70	25 20
		Relative	100.0	80.9	51.9	69.50	86 20	100.00
0.75	1300	Actual	75.0	61.8	43.1	17.62	22.30	26.57
		Relative	100.0	82.5	57.5	66.40	84.00	100 00

TABLE 2 COMMON BASIS: TOTAL OUTPUT AND CU. FT. PER HP. PER SEC.

Basis		Performance						
			Pressure, inches of water			Rev. per min.		
Total output, cu. ft. per sec.	Efficiency, cu. ft. per sec. per hp.	Values	Blades tilted forward	Blades radial	Blades tilted backward	Blades tilted forward	Blades radial	Blades tilted backward
40	16	Actual	2.40	2 16	1 93	1278	1405.0	1612 0
		Relative	124.30	112 00	100 00	100	110.0	126.1
40	19	Actual	2.14	1 83	1.52	1182	1295.0	1477.0
		Relative	140.70	120.30	100.00	100	109.5	124 9
40	22	Actual	1.77	1.55	1 17	1100	1220.0	1382 0
		Relative	151 20	132 40	100.00	100	110.0	125 8
50	16	Actual	2 12	2 02	1.70	1282	1433.0	1680 0
		Relative	124.70	118 70	100 00	100	111.8	131 0
50	19	Actual	1.80	1 63	1.25	1196	1329 0	1546.0
		Relative	144 00	130 20	100.00	100	111.0	129 4
50	22	Actual	1.32	1.32	0 87	1122	1258.0	1440 0
		Relative	151.70	151.70	100.00	100	112.0	128 2
60	16	Actual	1.87	1.63	1.29	1333	1470.0	1770.0
		Relative	145 00	126.30	100.00	100	110.3	132.8
60	19	Actual	1.40	1 23	0.78	1238	1378.0	1615 0
		Relative	179.30	157.60	100.00	100	111.2	130 4
60	22	Actual	0 92	0.89	0.37	1143	1300.0	1490.0
		Relative	248.70	240.50	100.00	100	113.6	130 2

TABLE 3 COMMON BASIS: TOTAL OUTPUT AND PRESSURE

Basis		Performance						
			Efficiency, Cu. ft. per sec. per hp.			Rev. per min.		
Total output, cu. ft. per sec.	Press., inches water	Values	Blades tilted forward	Blades radial	Blades tilted backward	Blades tilted forward	Blades radial	Blades tilted backward
45	2.000	Actual	17.75	16.90	14.95	1219.0	1378.0	1703.0
		Relative	100.00	95.10	84.20	100.0	113.0	139.8
45	1.625	Actual	20.70	20.27	17.25	1145.0	1281.0	1583.0
		Relative	100.00	97.90	83.30	100.0	111.9	138.3
45	1.250	Actual	23.50	24.33	20.25	1071.0	1184.0	1463.0
		Relative	100.00	103.60	86.30	100.0	110.5	136.6
55	1 750	Actual	17.45	16.67	14.90	1250.0	1430.0	1775.0
		Relative	100.00	95.50	85.40	100.0	114.4	142.1
55	1.375	Actual	20.38	19.80	16.80	1175.0	1338.0	1670.0
		Relative	100.00	97.20	82.50	100.0	113.8	142.1
55	1.000	Actual	24.42	23.60	19.30	1100.0	1246.0	1565.0
		Relative	100.00	96.50	79.00	100.0	113.2	142.2

The author in closing said that Professor Gebhardt brought up the point of why the curves between 0 and 30 cu. ft. per sec. had been omitted in Fig. 1. This was due to the fact that for less than 30 cu. ft. per sec. the curves overlapped and would have been indistinguishable in the small scale to which the figures were drawn for the cuts. Curves drawn to a larger scale than shown in the figures illustrated the performance of the blowers very clearly.

He had not yet had the privilege of reading Mr. Still's remarks, but had no doubt that the information he had to offer would be instructive.

Mr. Spitzglass' application of the curves to forced-draft practice was important. Another application was that to ventilation systems where it was necessary to move air against the friction in the ducts. The correct speed for a certain friction head and volume might be readily selected, or if the friction head was diminished by shutting some of the air outlets the proper blower speed might be determined from the chart and the blower slowed down, resulting in economy of power.

FURTHER DISCUSSIONS OF VARIED PAPERS

Proceedings of the Second General Session at the Annual Meeting, with Authoritative Papers by F. W. Dean, L. C. Loewenstein, H. L. Gantt, C. J. Ramsburg and C. H. Bedell

At the second General Session of the Annual Meeting, at which Vice-President Arthur M. Greene, Jr., presided, the following seven papers were presented, the first, by F. W. Dean, and the last four—contributed by Local Sections—being read by title:

An Account of the Engineering Work of E. D. Leavitt, F. W. Dean.

A Volume Regulator for Blast-Furnace Engines, L. C. Loewenstein.

Expenses and Costs, H. L. Gantt.

By-Product Coke and Coking Operations, C. J. Ramsburg and F. W. Sperr, Jr., contributed by the Philadelphia Section.

The Submarine, C. H. Bedell, contributed by the New York Section.

Combined Stresses, A. Lewis Jenkins, contributed by the Cincinnati Section.

The Trumble Refining Process, N. W. Thompson, contributed by the San Francisco Section.

Dr. Loewenstein Presents His Paper

The paper presented[1] by L. C. Loewenstein dealt at length with the problem of properly regulating the quantity of air supplied to blast furnaces and had for its main object the description of a new instrument, named a volume corrector, which, when used in connection with an impact-float constant-volume governor, will correct for any changes in the temperature, barometer and humidity, so that the air supplied to a blast furnace will, at all times, under any atmospheric conditions, deliver a perfectly definite and predetermined weight of oxygen to the blast furnace, and is so designed that it requires only one setting for each correction.

C. P. Crissey, in a written discussion, said that, in addition to the methods mentioned, it was also perfectly commercial and good practice to test turbo-blowers by means of a nozzle placed at the inlet, which made it unnecessary to disarrange the discharge piping or waste the air.

Referring to the author's remarks on the orifice method of measurement, he stated that he was unaware of any objection to attaching a parallel section at the end of the orifice. On the other hand, experience had not shown this to be necessary when the nozzle was properly shaped. The impression should not be gained that nozzles without the straight portion were inferior in accuracy or in any other respect.

The author had described a very ingenious device, but it was not automatic in its operation, and until something automatic was developed he believed that tables and charts would be more satisfactory for use in giving equivalent settings for the sliding weights on the scale beam of the air meter.

R. J. Wysor,[2] in a brief written discussion, said that the author assumed that a constant weight of air should be delivered to the furnace under all conditions, whereas, from an operating standpoint, it was frequently found advisable to change this weight for different furnace conditions, beyond that corresponding to varying atmospheric conditions. Again, the author took no cognizance of leakage after the blast had left the blower, that is, through the cold-blast main, stoves, hot-blast main and bustle pipe, with the numerous valves, seams and joints, offering opportunity for loss of air. This loss in different plants varied from probably a minimum of 5 per cent to a possible maximum of 25 per cent. And at each furnace it was a widely variant quantity due to changes in pressure and temperature of the blast, atmospheric conditions, state of repair of the system, etc. In other words, no matter how accurate the governing device might be, there was still considerable difficulty in delivering a fixed weight of oxygen to the furnace per unit time.

Linn Helander thought that a clearance space of 7 per cent was rather high, and that 3 per cent was more usual; also, that the variation in pressure of from 10 lb. to 30 lb. seemed a very large increase in pressure for a single blowing engine.

Again, as to the clearance in which the expansion of the air occurs, at the end of the stroke the pressure was up, and it was full of high-pressure air. Assuming that the pressure went down to atmospheric at a point further on, it would be necessary to subtract the clearance volume from the corrected volume, which would be 7 per cent from the 11.8 per cent mentioned in Par. 7, or 4.8 per cent.

Dr. Loewenstein, replying to Mr. Crissey, said that a nozzle without a straight portion could be used, but in that case there was no way of telling whether the jet as it left the nozzle covered the entire area.

In regard to using tables or charts for setting the sliding weights, he would say that there were three variables, and an infinite number of combinations. As to the barometer, this could be set to each 0.1 in. of variation in the instrument. Similarly, there were an infinite number of variations of temperature and humidity, and any one who had attempted to get up a set of tables or a set of curves would realize how difficult it was and how voluminous it would be, and secondly, how much easier it would be to use the instrument by the three settings, and automatically get the reading, than to go over a set of tables and probably make a mistake. Also, the superintendent in walking through a blast-furnace plant could easily check up the three settings by the operators and see that the barometer, temperature and humidity were exactly corresponding to the instruments hanging close to the main instrument. He could not do that as readily if he had a set of tables to check.

In reply to Mr. Helander he would say that the statement as made in the paper was absolutely correct in reference to volumetric displacement, because the clearance space between the cylinder head and the piston was not the entire space. It included all the spaces down to the valves, and it was positively known that the volumetric efficiency of blowing engines was seldom above 85 per cent in operation. The statement that a blowing engine could go from 10 lb. pressure to 30 lb. pressure dealt with extremes that did not occur in ordinary blowing, but distinct cases were known where a blowing engine normally

[1] To be published in the March issue of The Journal.

[2] Blast Furnace Department, Bethlehem Steel Co., South Bethlehem, Pa.

operating at 12 to 15 lb. went all the way up to 30 lb. when the clearance tightened up.

Mr. Gantt Discusses Expenses and Costs

H. L. Gantt then presented his paper on Expenses and Costs, in which he claimed that there were in every manufacturing enterprise expenses which did not contribute either directly or indirectly to the production of goods. Such expenses, he maintained, should not be considered as a part of the legitimate cost of the goods, but should be kept in a separate account. Further, the expenses in this account should be classified according to their various causes, and strenuous efforts should be made to eliminate these causes and thereby reduce this non-productive expense. This was particularly important in time of war, when all of our energy was needed for productive purposes.

Frederick A. Alden, in a written discussion of Mr. Gantt's paper, said he thought that one of the most vital causes of idleness of machinery was apt to be the fact that one machine might be adapted for but one or a few operations, while if a more universal type of machine had been purchased other operations might be performed on it. In advising upon the exploitation of a new manufacture, he had always maintained that unless such manufacture was of a major type, it would be one which would cause idleness at times due to lack of demand for the finished article, as most articles had a variable demand. Hence, that unless a variety of articles could be manufactured upon the same machine with a slightly different setting, the manufacture of the article in question would not be a paying proposition. Many companies made but one or a few lines of goods or fabrications, and in consequence always had certain machinery idle at times. One remedy for this idleness would be the manufacture of auxiliary products or by-products.

Many factories had machinery and stock idle which had ceased to be useful through breakage and wearing out of the former and no demand for the latter. He felt strongly that anything which could not be used within a reasonably short time should be sold, if salable, junked if not salable, and if neither of the above were possible, converted into fuel or disposed of as rubbish. There was too great a tendency to hold on to machinery and material hoping that it might be used some day. Considering the cost of such holding, which is the cost of idleness, including storage costs, use of valuable space, further depreciation, loss of interest on investment, a rapid and early conversion into available cash should always be the rule, based upon immediate possibilities as stated.

Major Frank B. Gilbreth commended the paper in unstinted terms. The principle Mr. Gantt had called attention to, he said, carried a little further, was identical with the scheme of dumping American manufactures abroad. In other words, the average cost accountant, if let alone, would so sprinkle certain costs that he could go to the management, particularly to the financial management, and boast of the fact that he had but a trifling amount remaining undistributed somewhere. That might be a proof of great merit among cost accountants, that they had distributed and redistributed cost items, but the more they were distributed and redistributed improperly, the more the self-deception, and if a plan had been laid out for the distribution of overhead expenses among various items for a normal business, how could more money be made by making more than it was originally intended to make and not distribute or redistribute any part of the overhead expense?

Major Gilbreth then described an improved arrangement of bulletin board that would make possible a quick judgment on this matter, by means of which the head of a sales department with a single glance could tell which of a certain bank of machines that had been brought together on account of their mnemonic classification, were going to run out of work, and could then go out and telephone to neighboring shops for immediate work, if necessary, and take on jobs which would keep down the idle time, as Mr. Gantt had pointed out. The board also showed the names of those men handling machines who had been proved to be the most efficient on them, which seemed to definitely help out the employment department in "evenizing" the necessary shifts that had to be made among the machines.

Henry Hess disagreed with the author that the matter under discussion was primarily a question to be solved by engineers rather than by financiers. There was a time in the history industries, he said, when there was a sharp line of cleavage between the shop, the so-called production end, and the office, usually termed the non-productive division, each managed by specialists. That was the heyday of the engineer and producer, and the financier, as separate people. If that period had not actually passed, it certainly was passing, and it was rather unfortunate that the author should apparently reaffirm this unfortunate division.

There should be no consideration of an important question of cost of production by the engineer as an engineer, or by the financier, as a financier. Any such question must be considered by both. The broad statement was made that certain expenses due to relative inefficiency of production were not part of the legitimate cost of goods. There always would be and must be some not absolutely necessary costs, the amount varying with relative efficiency of business management in a given business, and that cost must be and would be passed on to the consumer. An increase caused by an undue amount of such cost would simply lead to a refusal on the part of the purchaser to buy the goods, and therefore the consumer thus automatically applied the necessary corrective.

So far as Mr. Gantt's suggestion involved a careful subdivision of costs, it was wholly admirable, provided that each such subdivision was for the purpose of its careful scanning, with a view to its reduction. It was this reduction that was of importance, regardless of the allocation of any element of cost to any group of accounts.

Adolph L. De Leeuw, referring to Mr. Gantt's statement that there was no great difficulty about getting the expense for material and expense for labor, asked if, say, 30,000 tons of pig iron were bought at \$14 a ton, and a year later 20,000 tons were left, and the price of pig iron had gone up to \$58 a ton, what was the expense of the material? If it was said that the material should be charged at \$14 a ton, well and good; but if the 30,000 tons gave out, and 30,000 tons were purchased at \$58 per ton, on the expectation that it would go up to \$80 in the near future, but instead the price went down again to \$14 a ton, then what would be the price of the material? \$58? But who would buy the product on the basis of \$58 for pig iron?

There was no question about the advisability or the desirability of keeping a plant working, but in the plant with which he was connected there were large portions of the buildings devoted entirely to special operations, and each machine used was absolutely good for one operation and one piece and for nothing else. Furthermore, even if they did not increase the capacity, and should run the shop 50 hours a week, they all knew there were 168 hours in the week. Was this machinery

idle for the other 118 hours? If it was and the shop ran overtime, then was it idle or negatively idle?

A. L. Williston said that most manufacturers he had come in contact with seemed to regard overhead as one of those mysterious things that could not be analyzed, that it was necessarily a constant. It was not a constant, and Mr. Gantt had called attention to one of the variables that affected it. A very large percentage of all the confusion in the matter of accounting had been due to the fact that we were in the habit of expressing costs in figures and we had been confused in thinking that costs which were expressed in figures were a constant. There was hardly a single item of cost in any manufacturing operation that was a constant, and we should get into the habit of thinking of these things as variables, studying the laws of their variation, instead of thinking of them as constants and trying to memorize those constants.

Walter N. Polakov thought that the points raised by previous discussers were relatively unimportant compared with the big question: If it costs us something to do nothing, why shall society at large pay for our inefficiency and for our idleness? In England and France and Italy the slogan now was, "The idle hand assists the enemy," and we might equally well say that the idle machine assisted the enemy, because the fact was that if we left our machinery idle or inoperative, the results were the same as those due to the sinking of our ships, the blowing up of munition factories or the burning of grain elevators.

His work in the public-utility and power-plant field had been such as to make him believe the idleness question was just as important, if not more so, in that particular branch of industry as in others with which he was not so familiar. Mr. Polakov then had thrown on the screen a chart representing averages obtained from some seventeen power plants and showing that but half the capacity was utilized on the average daily run.

Carl G. Barth called attention to the fact that twenty-five years ago F. W. Taylor had covered everything that had been brought up by the previous speakers and that he had done as much for accounting as he had in the management of the plant and in other details. It was his hope that he could eventually give the world the benefit of what Mr. Taylor did.

H. M. Wilcox said that in the standardization and wage-payment systems which had been developed, attention had been concentrated almost entirely on productive labor.

He could say from personal experience that a very complete analysis of idle-machine time had shown the Winchester Repeating Arms Co. where it could eliminate a great deal of time, and in a great many instances they had been able to establish standards and definite forms of wage payments other than day pay to compensate their so-called non-productive workers for what they had done in limiting the idle time of equipment and organization.

As to the effect of idle-machine time on cost, from their present data, covering six or eight months, they had plotted the curve shown in Fig. 1, and had found that the average curve drawn through all the points, amounting to several hundred, was an equilateral hyperbola. The shop factor was taken as the actual burden earned by the machinery at machinery-hour rates divided by the actual burden charged against the various shops. The first 5 per cent of idleness, it would seem, had little effect on the cost; the next 10 per cent had more, and the more inactive the machinery became the more rapid the losses were. He believed that in the reconstruction period after the war this question of idle-machine time would be one of very vital importance.

Carl G. Barth said that he considered the most vital thing in cost was that it be known where every penny went. The first thing was to be able absolutely to tie up every expense, no matter how it was done. Most people, however, used an overhead expense factor that they had inherited.

His method was to get the most simple distribution of the expenses, without any analysis whatever — put it all on wages, but tie up the cost so that he would have the whole burden. Next, he took the expense item for each department, in labor. Then he found a more equitable way of dividing the more general expenses of the various manufacturing departments, so that each department was separated, and then they were responsible for what they got from the office and the other auxiliary departments. Then he went through the cost on the basis that each problem was a whole, and finally, in the last refinement, he distributed it.

The author had said that he did not know what to do with the expense of idleness. In his opinion he would have to charge it to profit and loss; and nothing else could be done with it.

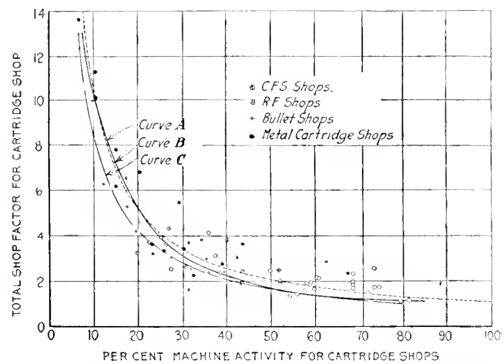

Fig. 1 Relation Between Machine Activity and Total Factor for Cartridge Shops

(48 hours per week = 100 per cent activity)
Curve A:—Plotted from monthly reports of May, June and July, 1917.
Curve B:—Geometric equilateral hyperbola of equation $xy=100$, where x=per cent machine activity and y=shop factor.
Curve C:—Theoretical equilateral hyperbola of equation $xy=80$.

Mr. Gantt, in closing, said he had suggested the year before that the expense of idleness might be put in profit and loss, as mentioned by Mr. Barth. He did not care whether this was done or not. If one man put it on profit and loss and the other put it on his product and based his selling price on the cost of his product and the other did not, the one who did not would not sell his goods in competition with the other man, and then he would have more of his plant idle and more of this item to consider.

Two years ago a man had told him the cost on a certain article was 30 cents a dozen and that they could be bought for 26 cents a dozen, and had asked him whether to buy them or make them. The cost consisted of 8 cents a dozen for material, 10 cents for labor and 12 cents for overhead, and the plant was running one-third full. On being told that the overhead if the plant ran full would be about 5 cents a dozen, he had said to the man that if the plant was run full the cost would be 23 cents instead of 30. A competitor running full time

would have less cost and so would sell where he could not, making the man's cost go up more because he would have still more idle time.

Mr. Hess had been more fortunate than he had in the fact that the financiers had not interfered with the operation of his plant. His experience was that as soon as the engineer began to show the plant was being interfered with by the financier who did not know anything about manufacturing, then the trouble began.

If we could show those expenses attributable to management and mismanagement, and show where they belonged, instead of placing them on the workmen, we could soon make the salesmen and the financiers sit up and take notice. It had been done in a number of cases, and no one who was using this method would think of giving it up.

So high an authority as the Chief Constructor of the United States Navy, referring to his paper presented last year on this general subject, had said that it was the only system he knew anything about which would do justice to the arsenals and the navy yards.

In regard to Mr. De Leeuw's questions, no general answer could be made. There were some present who had been wrestling with these questions for the past two years, and they were satisfied with the answers they had reached. The answer would not be the same in different plants. He would not think of a set of rules to go by, for rules without fundamental principles were as misleading as they could be. If we got the fundamental principles right and could not work out rules, we were on the wrong job. If we worked out the fundamental principles and could not apply them, we must get something to help us. In the past we had tried to run things according to precedent and by rules; and we had reached the end of it. The old business schemes did not work any longer. It was necessary for us to eliminate waste and expense, and not cover them in the product and give them to the public to digest. If we attempted to digest them we should be beaten by Germany.

A SESSION ON TEXTILE SUBJECTS

With Authoritative Papers on Labor-Turnover Records, Accident Prevention, and Moisture Content of Textiles, and Discussions by Textile Men.

THE Textile Session of the Annual Meeting was held on Thursday, December 6, at 2:30 p.m., under the auspices of the Society's Sub-Committee on Textiles, Vice-President Charles T. Plunkett acting as chairman. Three papers were presented at this session, namely:

LABOR-TURNOVER RECORDS AND THE LABOR PROBLEM, Richard B. Gregg.

ACCIDENT PREVENTION IN THE TEXTILE INDUSTRY, David S. Beyer.

THE MOISTURE CONTENT OF TEXTILES AND SOME OF ITS EFFECTS, William D. Hartshorne.

MR. GREGG PRESENTS HIS PAPER

In the first of the papers to be read, Mr. Gregg considered the various causes that have given rise to the serious problem involved in the shifting of workers from one factory to another, and urged that the same rational methods of analysis be employed in its solution that have long applied in the cases of production and factory-operation problems.

Albert L. Pearson, commenting on the author's mention of illumination of work place and amount of accident risk as two important causes for labor turnover, wrote that in designing a lighting system the aim should be to have illumination which would approach, as nearly as possible, daylight efficiency in production. As a result the workmen would be better satisfied and the amount of second-quality work would be reduced. Good lighting was conducive to cleanliness and helped to prevent accidents. Moreover, a well-lighted place was attractive, while a dimly or poorly lighted place was just the reverse.

Lewis Maxfield wrote that as long as any concern persisted in maintaining low wages, long hours of service and unsanitary factory conditions, it would experience a large labor turnover because its employees would be continually leaving for factories where the conditions were the reverse of those mentioned. There was no doubt but what the labor problem was what it was today just because we had failed to remember at all times that the laborer was human and should be treated accordingly. It was indeed true that industrial conditions as affecting the worker were changing for the better, but there still remained a considerable field for improvements.

Walter M. Kidder wrote that the aim of all investigation of the subject under discussion was to disclose the cause for the rate of labor turnover. The best experience of those who had given the subject ample study was that foremen were not likely to ascertain the real reason for quitting in a large number of cases, or to place it on record uncolored by their own attitude respecting each of them. It was vital to get at the real reason in order to bring it under future control. In some cases it could be learned by some other person much more dependably, for example, by the employment agent, or superintendent, or paymaster, or by some officer or member of the firm who had a faculty for gaining the confidence of employees. In every case of voluntary quitting this step should be taken, even though it added to the burden of some busy man to listen to the stories he must hear in order to sift out the basic truth of the real cause.

George H. Perkins cited a remarkable instance of low turnover in the mill of the Naumkeag Steam Cotton Co. of Salem, Mass., which was destroyed by fire in 1914; 20 months later, shortly after starting the rebuilt mills, it was found that 72 per cent of the 1600 old employees were at work in them.

Lawrence W. Wallace said that the manufacturing plant with which he was connected had worked out a comprehensive program for combating the problem of labor turnover, and that in spite of the chaotic conditions at the present time and the unrest, in recent weeks the tendency in their labor-turnover curve had been downward. He would suggest that valuable information would be found on this subject in the Annals of the American Academy of Political and Social Sciences, and a great deal of the material they had in their program came as suggestions from reading in those publications.

W. D. Hartshorne thought that the sum mentioned by the author for the cost of training a spinner was very small, and the method of training might account for it. As a rule, the

method of training spinners was to put them on a job and let them go at it, and this generally involved a great deal of cost.

Arthur C. Jackson said that, on the theory that the proper place to draw workers from was the immediate vicinity of the plant, his company was making an industrial census of the community within a radius of one mile from the plant, and advertising the desirability of working within walking distance of home and in a shop that had certain attractions which they felt theirs had. In this way they hoped to reduce the turnover somewhat.

Herbert M. Wilcox thought that in formulating a constructive program for reducing labor turnover, an important factor was recognition of length of service. This should be not only in the form of wage remuneration, but in the conferring of soms sort of stripe or medal, so that old employees would hold a more honorable position with the organization than men who had been employed a comparatively short length of time.

Charles H. Bigelow said that the company with which he was connected was now furnishing every one of its 1000 employees with a paid-up insurance policy, based on six months' employment, of $500. For each year they had been in the service $100 was added, up to $1000. That, he thought, would keep down the labor turnover to some extent, because a man got some benefit by staying with the concern. The company carried the policy as long as the man remained in their employ.

Arthur Brewer said that his concern, the Bridgeport Brass Company, had adopted the same scheme of life insurance and had also insured employees against accidents which might occur within or without the shop, and also in the case of sickness.

By way of addition to Mr. Wallace's remarks, the author stated that both the May 1916 and May 1917 issues of the Annals of the American Academy of Political and Social Science contained excellent material on methods of reducing turnover. This was an aspect of the problem that his paper did not attempt to deal with.

R. F. Burnham[1] said that in his plant, employing about 5000 men, in the last two years and a half they had taken on over 20,000 men, the turnover had been that great. Recently they had adopted the method of placing all the labor under an employment manager, who had the authority for hiring and discharging all men. If a man sent out to a foreman did not suit the latter, the man was not discharged, but was sent back to the employment manager and put in another department. If he did not fit there, they kept on trying him in various places, and finally when the right groove was found the man stayed. In that way they had reduced their labor turnover fifty per cent by endeavoring to place the man in the work he was adapted for.

When a new man came into a department, the foreman was instructed to give him some attention and teach him what his work consisted of—to do a little welfare work, a little uplift work—and make the man feel that he was a part of the organization. By doing that they made the men content. After two years of service the men received a certain bonus.

Welfare work, visiting nurses, recreation halls, etc., were necessary for the men, especially at the present time when they had a disposition to rove somewhat.

[1] Hercules Powder Co., Kenvil, N. J.

Ambrose B. Dean gave interesting details of a part-time method of vocational training successfully adopted in a textile-manufacturing city by the Board of Education, of which he is a member. Those students that had been in the classroom for three days, or a week, then went, under the school authorities, into the mills, and along with the employees there put into practice, as far as possible, the theories that had been taught in the classroom; and those who were already in the mill would then return to the schoolroom for their three-day stay or corresponding period.

In many of the mills men were discovered who were more or less advanced in years, who had never had the opportunity of scholastic education, many of whom could not read a blueprint, and many of whom did not understand a simple formula. Attempts made to get them into the regular vocational schools were not successful, owing to the sensitiveness of the older men in regard to associating with younger men in school work. This situation was successfully met by organizing a class for the employees of a given mill, and, under the direction of the school authorities, appointing a college-graduate employee of the mill as teacher of the class, the mill owner contributing the time of this teacher and furnishing the classroom.

E. B. Smith said that in the case of machinist training, those who had graduated from apprentice schools, or otherwise, he had found the labor turnover depended on one feature—selling the operator to the company. If the manager, foreman, gang boss, leader or monitor, failed to sell each operator to the producer, the result would be a large turnover.

The turnover caused the most expense in the case of the old experienced hands, who usually had a psychological reason plus a financial reason for their actions in relation to the company. The psychological reason lay in the training of the old hand and the financial reason in the pay envelope. Work going to an operator from a previous operation in a defective condition was the cause of much trouble, and that was due to the improper training of the operator performing the previous work. It all resolved down to the question of the individual operator under consideration: Was he or she trained right?

They had found that the principal way in which to hold the old operator was to let the company appreciate he or she was an old operator. Rewards and badges of merit were good, a Christmas envelope of five per cent of the yearly wages was also good. But in any case the operator must be contented and satisfied or he would leave.

Their practice was to break the operator in first and then to try to fit the round pegs in the round holes. They had found on a particular operation where ten weeks was ordinarily required, that intensive supervision brought it down to ten days. This meant that we must employ these intensive methods if we were to fit the female for the work which the male had been doing. The males were going to the front and the females were taking their places, and we must analyze step by step each operation and cut out the heavy manual part of the work where we could, in order that the female could take it up, and then we must train her and treat her so that she would be satisfied. The chief thing was to have the operator satisfied with the pay envelope, and to get that the operator must be trained right, the machine must be right, and the work coming from the machine must be right.

P. A. McKittrick said that the company with which he was connected built textile machinery, and in one of their plants

where about 1600 workers were employed they found that the labor turnover was about 120 per cent, nearly all of it in the first year. If they could hold the man a year they could hold him then as a more or less permanent employee.

During the last two years it had been necessary to make many general advances in wages, and in the last advance they adopted the plan of giving each man in their employ up to three months extra pay each month at the rate of 4 per cent of his monthly wages; from three to six months he would get 6 per cent; from six to nine months, 8 per cent; from nine to twelve months, 10 per cent; and in the case of those employed over twelve months, 12 per cent. They had put the plan into operation just at the time when the Liberty Loan was being exploited, and as a result 1300 of their men had subscribed about $65,000, using this extra pay to pay for their bonds. They were quite sure the plan would cut down their yearly turnover.

The chairman called attention to the fact that the author had said that the question had been asked: Will it be wiser to leave the broad problem of control of labor turnover entirely in the hands of employers, or should the state or labor unions have a voice in the control? and inquired if that was an intimation that the employer had had the control in his hands, or that it should be left there.

Mr. Gregg, in replying to the chairman's question, said that he did not think the employer had control now, but as time went on he would get it more and more, and he was personally inclined to think that with the development of employment exchanges, which were very probably coming in this country as they had come in England and in the Continental countries, we may see a method of control of labor turnover for specified districts. That system might be developed by the state, but probably the labor unions would have a voice in its development.

He urged that care be taken to remember that the greater part of labor turnover is not a malady in itself, but is important primarily as a symptom of dissatisfaction or discontent.

Mr. Beyer Discusses Accident Prevention in the Textile Industry

In presenting his paper, Mr. Beyer emphasized the fact that the textile plants had an abnormally high proportion of mechanical accidents, giving the reasons therefor. He then discussed fully various devices for safeguarding existing and new machinery, and presented for consideration a set of safety standards in actual use in a textile plant which specify the safety equipment for gears, sprockets, dangerous projections, pickers, cards, doublers, drawing, winding, ring spinning and twisting frames, looms, etc.

John W. Upp, in a written discussion, said that few realized the vast number of minor accidents that occurred in our workshops and factories, or had any adequate conception of the aggregate cost of such accidents until they made up their yearly reports or looked at tabulations of accidents such as were presented in Mr. Beyer's paper. As we gained in experience, we found that the majority of these accidents were preventable if we installed safety appliances and then saw that these appliances were guarded and kept in place after the first installation.

He was very much pleased to find that the author recommended those machine guards which were interlocking, and that they compelled the operators to use them. Belts, fortunately, were beginning to give way to direct drive, but there were still enough of them in use to warrant special attention being given to the guarding of machine belts, for they were even more hazardous to the woman worker than gears.

In the various factories in which he was interested they had found their safety-committee work the most profitable single undertaking with which they dealt. They gave the committee complete authority, so that they could discipline those operators who jeopardized their own interests, or those of others, when they removed guards, and they analyzed each accident report and did not dispose of it until they had indicated a means of prevention of similar accidents in the future.

George R. Wadleigh said that, in regard to the belting, particularly in the spinning room, which is equipped with what is known as the Lockwood, Greene drive, it seemed impossible in that case to run a belt guard from the floor up to a height of 6 ft. This, in his opinion, was more or less unnecessary, but at the same time it was the law in some of the states. Another requirement in several of the states was a screen around large belts. In their records of accidents going back five years, in a number of textile mills they had only one case of any one being injured by falling against a main driving belt.

The author, replying to Mr. Wadleigh, said that he had never been in sympathy with the 6- or 7-ft. height specified for the belt guard in some cases. He had asked a number of safety engineers if they had ever known of an accident in a case of a belt guard which was run to a height of 3 ft. 6 in. from the floor, and had never been able to find a record of such an accident which could have been prevented by the higher guard. A committee of engineers of the insurance companies he was connected with was working on this matter, and had called a conference to be held December 11 in New York, to which representatives from the New York, Massachusetts, Pennsylvania, New Jersey, Wisconsin and other labor departments were invited, in an effort to get uniform standards adopted in all these states which would be practicable and would not go too far, as it was now felt some of these standards did. He thought it would be of great value to the employers in the different states and quite a step forward if this could be done.

W. G. Duncan said that manufacturers had had a great deal of trouble, not only in regard to the lack of uniformity of standards between one state and another, but between the various whims of the different state inspectors. He thought also the legislatures had made a mistake in passing laws which were entirely too mandatory, and leaving to the safety department of the state or the chief engineers and inspectors no room for the exercise of any judgment whatever. His company had been very much annoyed in putting on a set of guards which were satisfactory to the state department one year, and then being told the next year that they were worse than useless, and must be replaced by something else. It seemed to him that the first step in this matter was to bring about a standardization of safety devices.

P. A. McKittrick emphasized the need for standards, stating that his company sold machinery to manufacturers in nearly every state in the Union and practically every country in the world, and that it was necessary for them to have very many sets of patterns—what was good and sufficient for one was not for another. This burden was entirely on the ma-

chinery builder, because his company had never succeeded in getting any recompense for the additional work.

D. E. Douty told of his difficulties in endeavoring to comply with the requirements of an insurance inspector in a plant of moderate size, and suggested that the standardization of such officials would be an excellent thing.

Richard B. Gregg[1] asked the author whether there were any figures which showed the distribution of accidents throughout the day and week: that was to say, were there more accidents the first thing on Monday morning than there were the first thing, say, on Thursday morning? Were there any more accidents at the end of the working period along at 11.30 or 12 o'clock, or 5.30 or 6 o'clock, than there were at other times in the day? He thought that was sometimes an element in the human factor which was overlooked, as sometimes we ascribed accidents to sheer carelessness which were really due to fatigue of the operator.

Allan D. Risteen said, in reply to a previous speaker, that all insurance companies certainly did need a standardization of inspectors, for inspection was largely a question of standardization. It was the custom of his company to have their inspectors, after they had visited a plant, indicate in their reports about how soon they thought the plant ought to be visited again, and if an inspector found it necessary to go to a plant every six or eight weeks, he did not know whether he thought it was altogether the fault of the inspector or not.

William D. Hartshorne said that in regard to the time of day accidents occurred, for some 10 or 15 years he was connected with the Arlington Mills at Lawrence, Mass., where they kept an accurate account of every accident, the hour at which it occurred, the cause of it, and every detail about it, and he would say that there was no question but what there was a material difference in the nature of the accidents which occurred at different hours of the day, and that there were many accidents which occurred on Monday morning which, taken in connection with the circumstances which surrounded them, were certainly well worthy of special consideration.

S. C. Coey said that he had made somewhat of a study of the time of day of accidents in the steel industry, and found that in the case of the Youngstown Sheet & Tube Co. the greatest number came along in the morning hours, about 10.30, and that thereafter another peak in the accidents occurred in the afternoon. The peculiar thing about this time of greatest accidents was the fact that it was at the same hour as the peak in the power curve, showing that the rate of doing work in the plant and the number of accidents had a certain definite relation. He had been connected with Celluloid Company of Newark for the last few months, and had had a curve drawn up along the same lines, which showed the same general results in that industry as in the steel industry.

Allan D. Risteen said that in making reports of accidents, where the hour was not recorded at once, there was a certain psychological factor that influenced the man who was filling out the blank not to set the hour at opening or closing time, but somewhere in between. He did not mean to say that that caused the curve to have that characteristic, but there was certainly an influence of that kind which tended to emphasize the curve and should be considered when statistics were being studied.

[1] 814 Flatiron Bldg., New York City.

Mr. Beyer, in closing, said that he desired to speak a word in behalf of the machinery manufacturer, and that was this: that the man who used the machinery was paying the money, and he was really the one who held the key to the situation. They had found that in the U. S. Steel Corporation—when they got out definite specifications for new machinery, showing what they wanted, the manufacturer gave it to them, but until they adopted that plan they had quite a variety of results. That would be taken care of by the definite standards suggested in the paper—the machinery builder would know what he had to give, and the employer would be assisted in securing the best.

The question of an overhead belt guard had been raised, and he knew of one or two cases of serious injury or death from the breaking of overhead belts. That did not happen often in any one plant, but where there were several thousand plants located in each state a number of accidents occurred every year, and he thought it was desirable to guard 12-in. belts or over—when they were fast-running belts.

The question of standardization was largely up to the insurance inspector and state inspectors in getting uniform results, but he thought the Society could exercise an excellent influence in bringing about a more general uniformity in standardization.

The question of the time of day at which accidents occurred had been pretty well discussed. He had made a number of such analyses and studied a good many others, and found that almost invariably both in this country and abroad the accident rate increased gradually until within about an hour of the end of the turn, both in the forenoon and afternoon, and then dropped off. There it seemed that the employees got their second wind and began to pick up a little and look toward the closing of the day. That was such a constant condition that he hardly thought it could be due to the makeup of the report, and he thought it did represent the psychological and physical condition of the employee. In regard to a relation between the peak of the load and the frequency of accidents, the load in the textile industry was apt to be pretty even, so that there was not the variation due to the human factor that would be found, say, in the steel industry.

Mr. Hartshorne Reads Paper on Moisture Content of Textiles

In the third paper to be presented, Mr. Hartshorne discussed at length the effect of moisture content on the weight of textile materials, and set forth certain laws governing the regain in cotton and worsted which he had developed after an extended period of investigation, together with numerous charts and tables for facilitating calculations.

Walter M. Kidder, in a written communication, commended the paper highly. He said that the author raised but did not answer one question that was of the greatest importance because of the magnitude of the cotton industry in this country, namely, whether or not it was of advantage to increase the humidity of the air in the successive processes of manufacturing. It was a matter of importance to have this determined authoritatively.

The effect upon quality which the author showed results from varying conditions of moisture constituted a powerful argument for the maintenance of uniformity in each department of the particular condition which was most advantageous. To accomplish this in practice called for intelligent application of the law that he had enunciated, but also would

require the exercise of engineering skill in many cases, for the flow of air currents within some factories extended throughout the entire structure, and differences in degree of humidity in different departments were correspondingly difficult to maintain. It was also true that it was difficult to maintain uniformity of humidity in all parts of one room under the best conditions.

Willis H. Carrier thought that Mr. Hartshorne's paper had gone into the subject with extreme thoroughness, and that it was a contribution to the subject which would be permanent, largely because of the methods he had adopted.

The subject, however, had a very much wider bearing on paper. It was very important, he thought, perhaps, even more important than, in the case of textiles, because in the subsequent treatment of paper and sizing and calendering, the moisture content had to be procured for the best results with great accuracy. The same was true of tobacco and practically all hygroscopic substances where moisture content was important in the process.

There was one product he had in mind where the installation was bad, the material was wet, and they wanted to dry it down to 10 per cent moisture. But if they had sold it on the basis of 10 per cent moisture, it would have been at a loss, so finally the moisture was reduced to 0.25 per cent, which was made possible by his knowledge of the laws enunciated by Mr. Hartshorne. That was a very important application, for that one-half or one per cent they got in the week's production, something like $100,000, meant $1000 or so.

The effects of differences in vapor pressure were very important in calculating rates of drying which occurred in various hygroscopic substances, and it would be desirable if Mr. Hartshorne would carry out his investigations at higher temperatures, temperatures beyond 100 degrees, where a great deal of the drying was done, in order that the laws could be investigated there as well as in the normal temperatures of the room.

Mr. Hartshorne, in closing, thanked the previous speaker for his comments. The question of the relation to drying, he thought, was an exceedingly important one, and he had mentioned it in the paper in several places as being affected in ways which might not be understood. That subject needed more investigation, and he would be very glad to undertake it if he had a research laboratory available.

Referring to Mr. Kidder's communication, the question to which he alluded as having been raised but not answered, Mr. Hartshorne agreed was very important, and he was of the opinion that it needed careful investigation under practically workable conditions, with complete understanding and controlled knowledge of results, to demonstrate what are the best obtainable effects both as to quality and quantity of product. It could be done, and for the benefit of the cotton industry it ought to be done authoritatively.

WORK OF THE BOILER CODE COMMITTEE

The Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York City.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval, after which it is issued to the inquirer and simultaneously published in The Journal, in order that any one interested may readily secure the latest information concerning the interpretation.

Below are given the interpretations of the Committee in Cases Nos. 177-180, inclusive, as formulated at the meeting of November 9, and approved by the Council on December 4, 1917, and the interpretations of the Committee in Cases Nos. 181-184 inclusive, as formulated at the meeting of December 6, 1917, and approved by the Council on January 18, 1918. In this report, as previously, the names of inquirers have been omitted.

Case No. 177

Inquiry: Is the type of removable dome as shown in Fig. 13 for use on h.r.t. boilers permissible under the rules of the Boiler Code, or is it necessary that this dome be attached direct to the shell with a double-riveted flange for pressures over 100 lb.?

Reply: The construction shown in Fig. 13 is considered as a steam boiler drum and not a boiler dome, and therefore does not come under Par. 194 of the Boiler Code.

Case No. 178

Inquiry: An interpretation is requested of the application of Par. 253 to the drilling of rivet holes in crowfoot braces. Is it permissible to punch holes in the shell full size where the brace is fastened thereto?

Reply: It has been proposed to revise Par. 253 to read as follows:

> 253 *Drilling of Holes.* All rivet holes and staybolt holes and holes in braces and lugs shall be drilled full size, or they may be punched not to exceed $\frac{1}{4}$ in. less than full diameter for material over $\frac{5}{16}$ in. in

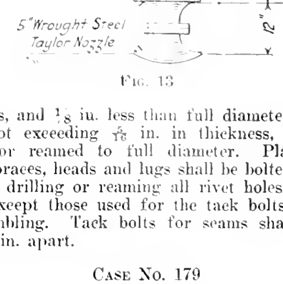

Fig. 13

> thickness, and $\frac{1}{8}$ in. less than full diameter for material not exceeding $\frac{5}{16}$ in. in thickness, and then drilled or reamed to full diameter. Plates, butt straps, braces, heads and lugs shall be bolted in position for drilling or reaming all rivet holes in boiler plates except those used for the tack bolts required in assembling. Tack bolts for seams shall be not over 12 in. apart.

Case No. 179

Inquiry: In the use of steel castings for the construction of locomotive boilers, what class shall be used under the speci-

fications for steel castings given in the A.S.M.E. Boiler Code?

Reply: It is the opinion of the Committee that unless the Code specifically distinguishes between Class A and Class B, either class is permissible.

Case No. 180

Inquiry: Is it permissible when calculating the maximum allowable pressure on a furnace of a vertical tubular boiler that is staybolted and less than 38 in. in diameter, to determine the pressure that would be allowed under Par. 239 for a plain furnace, and then add the pressure which would be allowed according to Par. 199 for the supporting value of staybolts?

Reply: It is the opinion of the Boiler Code Committee that your inquiry is answered by the reply in Case No. 57 and the reply in Case No. 113*a*.

Case No. 181

Inquiry: Is Par. 239 of the Boiler Code correct, as interpreted in Case No. 22, in its application to plain cylindrical furnaces? Under the interpretation of Case No. 22, a Lancashire type boiler with a single furnace 30 ft. long by 4 ft. diameter, built of 11/16 in. sheets, would be allowed a working pressure of only 29 lb.

Reply: There is no rule in the Code for the calculation of the pressure to be allowed on this particular construction, as Par. 239 is limited in its application to furnaces whose length is not over six diameters. If plain furnaces of these large dimensions are to be used without Adamson rings or other reinforcements, they must be stayed as specified in Par. 240.

Case No. 182
(Annulled)

Case No. 183

Inquiry: Is the rule in the Boiler Code requiring double stop valves on the steam pipes of boilers set in battery applicable to boilers of the locomotive type where no openings are made for entering them and the danger of scalding any one working inside does not exist?

Reply: It is the opinion of the Committee that Par. 303 does not make specific reference to any particular type of boiler, and therefore fully answers this inquiry.

Case No. 184

Inquiry: It is desired to use, solely for heating purposes, a h.r.t. boiler with 4 in. flange for connecting the gravity returns from the heating system. Is this allowable, or does a boiler of this construction come under the limitation of the Code as to size of blow off?

Reply: If the construction is to be solely used for low-pressure heating purposes, the rules for heating boilers apply, and no limitation in size of blow-off is required for that class of boiler (see Par. 364). If, however, this boiler were to be used for power purposes, it would be necessary to limit the blow-off size as described by Par. 308.

CORRESPONDENCE

Contributions to the Correspondence Departments of The Journal by members of The American Society of Mechanical Engineers are solicited by the Publication Committee. Contributions particularly welcomed are suggestions on Society Affairs, discussions of papers published in The Journal, or brief articles of current interest to mechanical engineers.

Scheme of Gaging for Screwed Parts

To the Editor:

The trend of machine design, as found in the bicycle, automobile and airplane, indicates an increasing demand for better screw-thread fits.

This is not only desirable for standard bolts and nuts, but

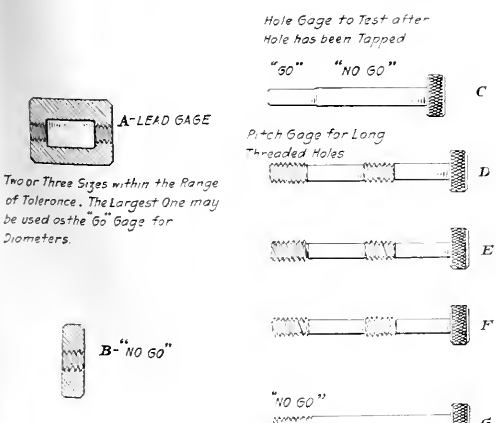

Fig. 1 System of Gages for Screw Parts

it is imperative for screw threads that enter into the design of a machine in which the greatest strength for given dimensions is required.

One of the steps in betterment of the lead of die-cut screws is set forth in a paper by the writer, entitled A Screw Die for the Turret Lathe, Trans. Am. Soc. M. E., Vol. 19, p. 77.

We know how high may be the price paid for a poor fit in an obscure place of this kind, especially in the life of the flier, but if such carelessness runs through all the work, it may actually result in turning the tide of battles and final results of the present war. The contemplation of the full significance of this and other elements of machine design keeps us continuously keyed up to the keenest appreciation of our obligations.

Much advance has been made in the production and gaging of the screw, but the nut or internal thread has not shared in this advance.

The flow of metal under stress of the so-called wrench fit makes it possible in a moderate length of contact to force a nut over a screw in which there has been a marked difference in both the form and lead of thread. Many screw-thread fits that are most satisfactory in common practice do not give an even distribution of the working stress. As a matter of fact, where there is a difference in lead, the stress within the length of the nut may be added to the working stress.

Many ways have been considered for the improvement of the internal thread, but our practice is still very unsatisfactory, especially when viewed from the needs of the airplane.

The purpose of this communication is to emphasize the need of greater care in cutting internal threads and to suggest a system of gaging that will give a more definite indication of the character of the fit. The importance of greater care in cutting internal threads is not only from the needs of more dependable product, but in keeping with modern practice it may even reduce the cost of product.

The system of inspection should give most careful scrutiny to the means and methods for producing the work. This is particularly necessary in connection with internal threads in which the length and diameter are so proportioned that it is impossible to see the condition of the thread.

We should know the pitch and lead of the tap, and we should also know the lead and other dimensions of the work produced by the tap.

The leading end of the tap may produce a larger hole than the part following, so that the whole length of the tap may not serve to control the lead. In fact, it is known that the first few threads of a tap generally determine the advance, and that there may be a very strained condition if the contact of the following threads conflicts with the tendency of the leading threads.

Experiments in which the shank of a tap has been threaded to fit a nut in order to insure the advance of the cutting end of the tap in the work, have shown that even with a short thread in the cutting part of the tap, well backed off, there is a conflict between the control of the lead screw on the shank of the tap and the natural advance of the cutting end, so that any lost motion in the lead screw or any yielding between the lead screw and the cutting end results in a similar degree of error in lead of thread produced in the nut.

In die and tap making it is found that the final hardening of the cutting edge of the die and the tap results in changes that are not uniform, and that it is desirable, in the production of work in which the greatest strength is required for a given weight, to use only those dies and taps that are known from the first to produce satisfactory results, and the product of these should be inspected not only at first but from time to time during their use to insure their maintenance of accuracy of lead. The first inspection may result in discarding 10 to 90 per cent of the taps, but this cost is very small compared with the cost entailed by the production of work that is not uniform in diameter and lead.

This, coupled with the inspection of the form of the cutting edges of the taps and dies, constitutes one part of the inspection, and it should be remembered that what is said of the inspection of the taps applies to both the roughing and finishing taps and dies, providing two are used.

If the lead of the roughing tap is not true, the use of a finishing tap may leave a thread that will seem satisfactory in any ordinary gaging method, and yet one of most undependable character.

The proposed scheme of gaging which is presented for discussion is offered with full knowledge that it may make it necessary to discard a large percentage of taps and dies that have been made for this purpose and that it will require a little more care in inspection, but notwithstanding this apparent handicap, it will not, in the writer's judgment, reduce the output of finished product but will tend to increase the dependability that is of paramount importance.

Everyone knows that interchangeability is of greatest value from the production standpoint, yet interchangeability has in some cases been sacrificed to obtain a fit that would be satisfactory according to the sense of feeling; that is, a finger fit or a wrench fit.

It is well known that a screw fit that at first is what is called a wrench fit may become a finger fit after it has been screwed in and out a few times. It is also known that if both screw and nut are of perfect form and true lead, no such great change takes place by merely screwing the two pieces together a number of times.

The system of gages, both internal and external, includes a "go" and a "no go" gage, but these are supplemented by pitch gages. If the total range of tolerance for the thread of the nut is 0.003 in. at the pitch diameter, there should be two or three gages provided for the different pitch diameters coming within the range of tolerance for the nut. The largest of these gages that will enter two or three threads must pass easily through the entire nut.

For long threads, such as found in airplane turnbuckles and the cylinder sleeve of one of the airplane engines, the pitch gages should be made as shown at *D*, *E* and *F* in Fig. 1. Turning out the middle of the gage eliminates some of the obscuring effects due to crooked holes or to particles of grit lodged midway in the fit.

The limit of tolerance of these gages should be made to conform to the special requirements of the work.

It is conceivable that in some kinds of work it may be desirable to give the nut and screw a slight difference in lead so as to equalize the stress of each thread, to compensate for any difference in extension that may exist between the screw and the nut when subject to the working stress.

The "go" and the "no go" diameter gages should be short and of perfect form. The lead gages may be a trifle flat on top of the thread to insure clearance.

James Hartness.

Springfield, Vt.

Accuracy vs. Precision, and the Gage Problem

To the Editor:

A gage is an instrument indicating physical limits, employed in measuring duplicate parts.

Manufacturing tolerances are the established limits of parts which will properly function.

It is obvious that there must be a definite amount of clearance between male and female components. The maximum clearance should be made as large as the nature of the work will permit, and the minimum clearance should be made as small as will permit of the ready assembling of the parts. Thus we will establish the maximum manufacturing tolerances which represent the rejection points. To insure uniformity of manufacture within these established tolerances, gages are made to check the rejection points. Allowances must be made to take care of inaccuracies developed in the construction, and use of, these gages provided to accept or reject the work.

Minimum male and maximum female gages, made to the extreme tolerances, soon become unserviceable by wear, as work which is beyond the established tolerance will be acceptable to such gages.

Maximum male and minimum female gages should be made as near the extreme limits of tolerance as manufacturing conditions will permit, for work passed by these gages after becoming worn will be within the established tolerances.

Extreme refinements in gage manufacture are most expensive, and are unwarranted by the functioning of ammunition components. The variation of gages within the established tolerances (operating to reduce the manufacturing tolerance of the component) is an economic question which concerns only the manufacturer. All gages within the established tolerances of the component which are acceptable to the manufacturer as master, inspection or working gages should be accepted.

These are basic principles controlling the manufacture of interchangeable parts and the standardization of gages therefor.

The gage problem is a simple problem if we leave it so. The details of its operation require constant supervision, but

this supervision is only necessary to insure that we do not leave the straight and narrow path.

Many attempts have been made in the past few years to develop a science of gages that would either automatically run itself, or that would enable inexperienced or untrained persons to control it. The writer has come in contact with several of these attempts, and has observed their rise, decline and fall, each scheme going through very similar successive phases. Schemes developed by novices without experience of actual conditions; elaborate, expensive and inefficient; appearing ideal on paper, but disregarding basic principles; developed as an end in themselves, instead of as a means to an end; finally discarded and the matter handled in the simple and direct manner that governs the other manufacturing tools.

A gage is a manufacturing tool. The purpose of a manufacturing tool is to aid production. A gage should be used as a preventive and not a cure. Gages properly used increase production and reduce scrap. If this result is not obtained there is some basic fault present.

There are two kinds of results in regard to dimensions obtained in manufacturing. For want of better terms, we will entitle them accuracy and precision. These two results are often considered as identical; in fact, if ideal conditions could be maintained they would be identical, but in actual practice these local conditions are seldom, if ever, met with.

In ordinary manufacturing practice, precision only is obtained. Precision is sufficient for a plant which manufactures only its own product. It is only when several separate factories are working independently of each other to produce a common product that a greater degree of accuracy is required.

Let us consider the true meaning of this factor that we are calling "precision." By precision we mean the relative variation that develops between similar parts. For example, we will assume that we have a part to manufacture that contains a hole which we wish to make 0.500 in. in diameter. In the manufacture of these parts we obtain a product in which the difference between the largest and smallest holes does not exceed 0.005 in. in diameter. This would mean that our limit of precision was 0.005 in. for this dimension. The size of the corresponding part which is to assemble into this hole would be developed in relation to the size of the hole obtained, allowing the necessary clearance. It would not matter if the absolute size of these parts was off 0.008 in. or more, as long as the requirements of precision are met. As time goes on, the absolute sizes often fluctuate in actual practice; but as long as the relative precision of the companion parts is maintained and the quantity of production is balanced, the results obtained are satisfactory. Whether or not this is the most economical method in the long run is an open question.

In order to maintain accuracy, all the requirements of precision must be met, and, in addition, all checking and testing instruments and other standards must be compared against a fixed standard. This results in the following situation: If a tolerance of, say, 0.004 in. is given for any dimension, if precision only is required, the whole 0.004 in. is available for a manufacturing tolerance. If accuracy, however, is required, and as it is impossible to make our testing instruments without some degree of error, all errors in our testing facilities are subtracted from the total permissible tolerance, thus actually giving us a smaller manufacturing tolerance. The more nearly accurate our checking facilities are, the greater the per cent of the tolerance remaining for manufacturing variations.

The confusing of these two factors—accuracy and precision—has been the cause of many difficulties and misunderstandings, particularly during the past three years, in the manufacture of munitions. A company would take a contract to manufacture certain articles to specified limits of accuracy. This company had manufactured their own product to similar limits of precision, or assumed that they had, and foresaw but little difficulty in meeting the requirements. But when the actual production started, and they were required to maintain the specified degree of accuracy, they discovered that there were much more severe conditions to be met than they had ever contended with before.

The establishment of manufacturing tolerances is too often based upon assumptions rather than definite records of past performances. For example, some time ago I personally made some tests at a plant covering a period of a couple of months, to determine, among other things, what their normal variation in milling cuts amounted to. This company was an old established concern, produced work of the highest quality, and had a very complete inspection system. The use of limit gages, however, was not general. In many cases only a "go" gage was provided, and all work was required to "fit" this gage. This company assumed that all work which passed this inspection did not have a total variation of over 0.001 in. They were so certain of the fact that they would not have hesitated to give sworn evidence that they could hold their milling cuts within a limit of 0.001 in. But the tabulation of several hundred measurements of the same dimension on similar pieces revealed the fact that their normal variation in milling cuts amounted to over 0.005 in. instead of only 0.001 in. Similar conditions exist in many other plants.

Another striking example in this connection is in regard to threading tools and gages. The producers of these articles will only guarantee their product to a limit of error which seems excessive in comparison with their specifications of a few years ago. As a matter of fact, these tools are practically the same as those made in the past, but the facilities for checking them have been so improved that discrepancies are now discovered which in the past had been assumed to be very much smaller. These examples could be multiplied almost indefinitely.

The answer to this whole problem is to face the facts, and base all plans upon the results of actual tests and investigations rather than upon assumptions. If the conditions are known we can take steps to meet them. As long as they are not known or understood, difficulties will constantly arise—difficulties that result in almost unending delays and extra expenses.

The following is suggested as one of many possible plans that will operate economically, simply and efficiently:

The logical first step toward producing accurate work is to provide physical standards, or master gages, to control the gages. These standards represent the rejection points: all gages within these limits are satisfactory; all gages beyond these rejection points are discarded. The design of these standards is not of great importance, except as it assists in the verification of the inspection and working gages. In the majority of cases a master of the same design and construction as the gage gives very satisfactory service. For profiles, tapers and other similar forms, a male master for a female gage is often the most efficient.

A drawing, properly dimensioned, gives those dimensions which it is essential to maintain. This automatically controls the design of the gage, indicating the points for which gages must be provided. It also thus specifies the holding points for the work, as it is a self-evident truth that the work must be located in relation to the cutting tool from those points on which a gage is applied.

The construction of the gages should be carried out under the same general principles that govern the construction of the tools. If a tool, or gage, tends to wear larger, the policy is to make it as small as is consistent with the manufacturing conditions without going beyond the rejection points. If the tool, or gage, tends to wear smaller, the reverse is true. Extreme refinements in measurement or construction only become necessary as they approach closely to the rejection points.

After the gages are completed and checked against the rejection points they may be graded according to the requirements. We will assume that there is a shop inspection and a final inspection. This would require three groups, one for the machine operators, one for the shop inspection, and one for the final inspection. Those gages which show the greatest amount of variation within the rejection points would be given to the machine operators. Those measuring closest to the rejection points would be used on the final inspection. The intermediate gages would be used for the shop inspection.

An efficient gage inspection is imperative in any case. Under this plan all gages of the same type would be inspected and regraded at the same time, and the proper distribution again made.

All persons who handle the gages should be properly instructed in their use. It should hardly be necessary to say this, but in the past much unnecessary expense has been caused by abuse of gages. The final inspectors should establish the standard method of applying the gages to the product, and all other inspectors should be instructed accordingly.

This plan would entail the minimum gage expense and insure the maximum of service from each gage. This plan includes all types of gages.

Owing to the fact that thread gages involve such a large number of factors, it might be advisable to discuss this subject in some detail.

The main function of all threads in ammunition components is to hold two pieces together, and it is advisable to use standard forms of thread wherever possible, as the various factors of these standard threads are definitely established and extensively tabulated.

A thread is cut with a tool carrying a fixed form, whether this thread is made with a tap or die, chased on a lathe or milled. It is therefore evident that a variation in the diameter of one factor will be accompanied by a corresponding variation in all other diameters cut at the same time with the same tool. Statements have been made to the effect that the pitch diameter was the most essential factor of a thread, and efforts have been made to control that diameter to closer limits than the other diameters, but the statement is fallacious, and the attempts were unsuccessful.

The pitch diameter of a screw is that diameter where the thickness of the thread and space are equal. Its only function is to locate the angular flanks of the thread. If a standard form of thread is employed, this function becomes useless, because a standard form of thread carries with it a definite relation of these flanks with the outside and root diameters. The pitch diameter of the male thread does not coincide with the pitch diameter of the female thread. The essential requirements of the threads used on ammunition components are the angle or flank of the thread in contact, the load and the amount of contact between male and female threads. In most cases the ammunition is so designed that the "set back" due to firing would hold the parts firmly in position without any threads, so that the main consideration on such threads is that they be sufficiently strong to hold the parts together during transportation and handling.

In those cases where the "set back" must be withstood by the thread, one of sufficiently coarse pitch should be used, so as to allow of liberal tolerances and still retain sufficient strength to meet all conditions.

It seems to the writer that instead of profiting by the experience in this work that has been gained by the manufacture of large quantities of similar articles for several of the foreign governments, particularly in regard to threaded parts, and of going on from where that work left off, we are starting almost at the beginning, and have still to solve again many of those problems that were well advanced. For example, on many tapped threads the British inspection consisted of the use of a "go" or minimum plug thread gage, which would insure interchangeability, and a "not go" or maximum plain plug gage which would insure a sufficient area of contact. A visual inspection of the thread would insure that the shape of the thread or width of flats at the root diameter was sufficient to give the required strength, as the factor of safety in regard to its strength was large, and any weak threads that met the requirements of these two gages would be very evident at the visual inspection.

The gage problem is about what we make it ourselves. If we attempt to create an elaborate and exacting system of gages considering the subject as an end in itself, we will but store up for ourselves future trouble and great expense. If we consider it in its true light, as a means to an end, and handle all its many details in the same manner, and following the same general principles that are employed in dealing with the questions in regard to other manufacturing tools, we will find it a simple problem. As was stated before, the whole subject is covered by the first page of this paper.

Earle Buckingham,
Captain, Ord. Dept., U. S. R.,
Gage Manager,
and
G. F. Matteson.

The Dake Steam Turbine

To the Editor:

I have read with great interest the paper on Commercial Analysis of the Small Steam Turbine Situation, by W. J. A. London, as published in The Journal for December 1917.

I note that in enumerating the various types and makes of steam turbines, the statement is made that the Bliss, Dake and Wilkinson turbines are either no longer on the market or are not seriously competitive. I wish to correct this statement, which may have arisen from the fact that the Dake turbine is no longer manufactured by the Dake American Steam Turbine Company, of Grand Rapids, Mich., this company having gone out of business.

The Dake turbines are now being manufactured by the Pyle-National Company, Chicago, Ill., and there have been built and are in successful operation 22,300 of them, aggregating some 70,000 hp. These turbines are of the single-stage impulse type made under my patents, and substantially all of them are used in connection with turbo-generator units. More than 80 per cent of the electric headlights in operation on steam locomotives today are driven by turbo-generators manufactured under the Dake patents.

Charles W. Dake.

Chicago, Ill.

Society Affairs

Engineering Survey

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

ABRIDGED LIST OF OFFICERS AND COMMITTEES[1]

OFFICERS AND COUNCIL, 1918

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D. S. Jacobus
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Terms expire December 1919

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H. de B. Parsons
John A. Stevens

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Meetings, To be appointed
Publication, To be appointed
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Library, Jesse M. Smith
House, James W. Nelson
Research, R. J. S. Pigott
Public Relations, F. H. Newell
Constitution and By-Laws, F. R. Hutton
Standardization, Henry Hess

SOCIETY REPRESENTATION

American Association Advancement of Science
American Society for Testing Materials, Joint Conference Committee
American Society for Testing Materials, Modification Briggs Standard for Pipe Threads
Classification of Technical Literature
Conference Committee on Electrical Engineering Standards
Conservation
Engineering Council, A. D. Flinn, *Secretary*
Engineering Foundation
Expert Testimony Committee
John Fritz Medal, Board of Award
Joseph A. Holmes Memorial Association
Military Engineering Committee of New York
National Defense Committee
Naval Consulting Board of the United States
Standardization of Pipe and Pipe Fittings for Fire Protection
Trustees United Engineering Society

[1]A complete list of the officers and committees of the Society will be published in the Year Book for 1918 and in the March, 1918, issue of The Journal.

SPECIAL COMMITTEES

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American Engineering Service, George J. Foran
Am. Soc. M. E. Junior Prizes
Am. Soc. M. E. Student Prizes
Boiler Code, John A. Stevens
Sub-Committee to Confer with Committee of A. S. T. M. on Matters Pertaining to Materials, Specifications, in Code
Conference Committee on American Engineering Standards
Conference Committee to Determine Cost of Electric Power, D. C. Jackson
Cooperation and Organization, Fred J. Miller
Engineering Education
Feedwater Standardization
Flanges and Pipe Fittings
Gages, H. E. Harris
Increase of Membership, A. L. Williston
Joint Committee on Standards for Graphic Presentation, Willard C. Brinton
Local Sections, D. Robert Yarnall
Machine-Screw Nuts (Joint Committee with S. A. E.), E. H. Ehrman
Machine Tools Standardization
National Defense
Patent Laws
Pipe Threads, International Standard, Edwin M. Herr
Power Tests, Geo. H. Barrus
Refrigeration, D. S. Jacobus
Steel Roller Chains, C. H. Benjamin
Student Branches, Frederick R. Hutton
Technical Nomenclature, W. D. Ennis
Tellers of Election (Annual), R. F. Jacobus
Tolerances in Screw Thread Fits, L. D. Burlingame

Counsel for the Society, Parker & Aaron

U. S. Bureau of Mines, Advisory Committee
Sub-Committee on Mining Equipment
Sub-Committee on Fuels
U. S. Chamber of Commerce, Advisory Committee
Weights and Measures, L. D. Burlingame

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Connecticut State, H. B. Sargent, C. K. Deeherd
Bridgeport, H. E. Harris, E. L. Fletcher
Hartford, B. M. W. Hanson, S. F. Jeter
Meriden, C. K. Deeherd, To be appointed
New Haven, H. B. Sargent, E. H. Lockwood
Waterbury, W. H. Bristol, M. J. Dempsey
Detroit, G. W. Bissell, S. J. Hoexter
Erie, To be appointed, M. E. Smith
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Minnesota, H. L. Brink, E. A. Wilhelm
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New York, J. H. Norris, W. Herman Greul (Acting)
Ontario, R. W. Angus, Chester B. Hamilton, Jr.
Philadelphia, L. F. Moody, J. P. Mudd
St. Louis, R. L. Radcliffe, E. H. Tenney
San Francisco, B. F. Raber, C. H. Delany
Worcester, Geo. I. Rockwood, H. P. Fairfield, pro tem.

SOCIETY AFFAIRS

A Record of the Current Activities of the Society, Its Members, Council, Committees, Sections and Student Branches; and an Account of Professional Affairs of Interest to the Membership

THE minutes of the January meeting of the Council, published elsewhere in this number, record the transactions of several items of business which will have an important bearing on the Society's activities during the coming year, and which I am glad to comment upon, particularly in reference to the committee appointments by President Main, which are a controlling factor in the management of the Society.

On the Finance Committee, Theodore Stebbins, consulting engineer of New York City, has been appointed in place of W. H. Marshall, resigned. Mr. Stebbins has previously served on the Membership Committee of the Society, and has specialized of late years in the financial features of engineering undertakings.

Mr. Robert M. Dixon, Chairman of the Finance Committee, whose term of office had just expired, was reappointed. During the past few years the Society has been more fortunate than its members realize in the sound financial administration and progressive business policies its Finance Committee has maintained. Since Mr. Dixon became Chairman of the committee in 1911, the membership of the Society has increased from 4000 to nearly 9000, and the total annual income from \$97,600 to \$207,000. In 1911 the Society owed \$81,000, but had, besides its investment in the Engineering Societies Building, \$20,000 in cash and bonds, and trust funds amounting to \$42,000. At the present time it is owing nothing, has equity in the enlarged Engineering Societies Building, and has cash and bonds amounting to \$130,000, utilized in trust funds and working capital.

During this period the Finance Committee has consistently held to the policy of allowing for the annual budget only 90 per cent of the estimated income, reserving 10 per cent to insure an annual contribution to the reserve fund to guard against contingencies. Its chairman has also advocated and stood back of the effective work of the Increase of Membership Committee whereby the membership of the Society has been more than doubled, and at the same time the average professional standing of membership has been raised. The initiation fees were formerly used to retire the certificates of indebtedness of the land fund, resulting in the cancellation of this indebtedness last July, which must be regarded as a remarkable record. At the present time 50 per cent of the initiation fees are placed in reserve and the balance is available for current expenses.

This brief statement shows the sound financial condition of the Society and the debt which its members owe to the foresight and ability of its Finance Committee and its able chairman, whom Mr. Main has so fortunately prevailed upon to continue on the committee.

Many committees of the Society have lost valued members because of their entering the service of the Government. In the case of the Committee on Meetings, John H. Barr left for that purpose, and J. W. Upp of Schenectady, who took an active part in the interesting session on the Woman Worker at the last Annual Meeting, was appointed in his place. The regular appointee to the Committee is W. G. Starkweather of Boston, Mass., whose work as Secretary of the Boston Section is widely known and appreciated.

While the requirements of the Committee on Meetings are such that frequent meetings must be held, necessitating residence within easy reach of New York, the effort has been made to secure a committee as widely representative as conditions will permit, and its members now come from the cities of Schenectady and Ithaca, New York; Elizabeth, N. J.; Boston, Mass., and one from New York City. Prof. Robt. H. Fernald, of Philadelphia, is the retiring chairman, and the last Annual Meeting and the Spring Meeting at Cincinnati, which came under his direction, have been generally regarded as the most successful and enthusiastic conventions which the Society has held.

On the Publication Committee two new appointments were required because of war conditions. These are George A. Orrok, formerly mechanical engineer for the New York Edison Company, and now consulting engineer with an office in New York, who has for many years been a student of engineering periodicals; and H. H. Esselstyn of Detroit, Mich. In the appointment of Mr. Esselstyn, there is brought to the Publication Committee one who represents the viewpoint of our members of the Middle West, to whom the Society's publications should be of increasing importance, forming as they do the main connecting link between such members and the various sections throughout the country, including New York. Mr. F. R. Low, who has been chairman for the past five years and a member for part of a previous term, because of his intimate acquaintance with publishing and his sound judgment in such matters, has been a most valued member. The regular appointee on the committee is Ralph E. Flanders, who has had publication experience on *Machinery,* and is now general manager of the Jones and Lamson Machine Company, Springfield, Vt.

On the Public Relations Committee the new appointee is J. Waldo Smith, chief engineer of the Board of Water Supply, New York City, who has been identified with important public-works construction for many years.

Of all the committees of the Society, none has more arduous duties nor requires more conscientious effort than the Membership Committee, on which W. S. Timmis is the appointee. The Society has sustained a sad loss in the death of the former chairman of the committee, L. R. Pomeroy, whose place was temporarily filled during part of the past year by James W. Nelson, with Hosea Webster as acting chairman. Mr. Timmis is a consulting engineer in New York and has specialized on printing machinery and the construction and equipment of printing plants. Incidentally he was consultant for the large plant where THE JOURNAL is now printed.

On the Library Committee, John W. Lieb, who retires, has been succeeded by W. N. Best, President of the W. N. Best Company, Inc., New York. This committee has the duty of serving on the Library Board, administering the Joint Libraries of the four Founder Societies. The annual report of the Board appears in this number.

The House Committee, which is responsible for the maintenance of the Society's headquarters and for its homelike surroundings, has as its new appointee J. D. Maguire, President

of the Maguire Rubber Company, of New York. He succeeds Fred. A. Scheffler, who has contributed generously of his time both in connection with the House Committee and in providing for the pleasure of visitors at the annual meeting.

To the Research Committee has been added one of the strongest men in the department of research in the vicinity of New York, Prof. Walter Rautenstrauch of Columbia University, who succeeds Ralph D. Mershon. It is believed by many that the Research Committee affords the greatest opportunity in the Society for useful service, through the coördination and development of research work in colleges and among the industries. At present, the Research Committee has several sub-committees engaged upon important investigations.

Prof. Frederick R. Hutton was reappointed to the Constitution and By-Laws Committee, where his intimate knowledge of the history and precedents of the Society are invaluable. Professor Hutton of this committee and Mr. Dixon of the Finance Committee are the two members of Standing Committees who received reappointments. The President in making appointments tried, so far as is possible, to distribute them among the membership at a distance from headquarters for the obvious reason of bringing members in touch with the Society.

The Standardization Committee acts as a coördinating committee to direct and unify the standardization work conducted by the several special committees of the Society. Two new members were appointed: Prof. L. S. Marks of Harvard University and Massachusetts Institute of Technology, the author and compiler of the Mechanical Engineers' Handbook and at present engaged upon expert work for the Government in connection with engines and carburetors for aeroplanes; and C. F. Hirshfeld of the research department of the Detroit Edison Company.

Of perhaps greater importance than the personnel of our present committees was the preliminary action taken at the Council meeting, at the suggestion of President Main, looking toward the adoption as a fixed policy of the Society of the plan carried out under the administrations of Dr. Jacobus and Dr. Hollis for nominating the Society's officers. This plan is entirely democratic in that the Nominating Committee is made up of representatives from the various sections or groups of sections throughout the country. The Local Sections Committee of the Society has been asked by the Council to formulate rules for incorporating this plan into the Constitution and By-Laws, thus making it a fixed policy to nominate officers through representatives who actually represent the widely distributed membership. This is a policy which has been carried out by the American Society of Civil Engineers.

CALVIN W. RICE, Secretary.

COUNCIL NOTES

A REGULAR meeting of the Council was held in the Engineering Societies Building on January 18, beginning at 11 a. m. and continuing throughout the afternoon. There were present Charles T. Main, *President; Past-Presidents* Ambrose Swasey, D. S. Jacobus, John A. Brashear, W. F. M. Goss, F. R. Hutton; Wm. H. Wiley, *Treasurer;* Robert H. Fernald, D. R. Yarnall, John Hunter, H. de B. Parsons, Fred N. Bushnell, R. M. Dixon, *Chairman Finance Committee;* Calvin W. Rice, *Secretary;* F. R. Low, *Chairman Publication Committee;* and by invitation, Dr. C. R. Mann of the Carnegie Foundation and Mr. E. J. Mehren, Editor of the *Engineering News-Record.*

Committee Appointments: The President announced the following appointments to standing and special committees: *Finance*, Theo. Stebbins, one year, R. M. Dixon, five years (reappointment); *Meetings*, J. W. Upp, one year, W. G. Starkweather, five years; *Publication*, George A. Orrok, one year, H. H. Esselstyn, three years, Ralph E. Flanders, five years; *Public Relations*, J. Waldo Smith; *Membership*, W. S. Timmis; *Library*, W. N. Best; *House*, J. D. Maguire; *Research*, Walter Rautenstrauch; *Constitution and By-Laws*, F. R. Hutton (reappointment); *Standardization*, L. S. Marks, two years, C. F. Hirshfeld, five years; *Sections*, H. B. Sargent.

Nominating Committee. Action was taken toward continuing permanently the custom inaugurated during the presidential terms of Dr. Jacobus and Dr. Hollis of appointing as a nominating committee for officers representatives selected by the various Local Sections, arranged in groups for this purpose. The following resolution was passed:

Voted: That the Sections' Committee as a special committee of the Council, with Mr. Yarnall as chairman, be requested to report to the Council suggestions of procedure whereby the Nominating Committee may be regularly chosen through the nomination by sectional groups of the Society along lines similar to those of the American Society of Civil Engineers, and in accord with the custom of the Society for two years.

Annual Meeting Resolutions. As recorded in THE JOURNAL for January, resolutions were passed at the Annual Meeting and referred to the Council: (1) A resolution at the business meeting providing for a committee to investigate opportunities for coöperation between the Government and the technical schools in the training of men for service in the War and Navy Departments. (2) A resolution introduced by Sir Charles Ross at the Machine Shop Session calling for a board to be intermediary between manufacturers and inspectors, and the Secretaries of War and the Navy, to hear complaints and give advice; (THE JOURNAL, Jan. 1918, p. 67). (3) A resolution adopted at the Gage Meeting asking for the certification of all master and reference gages, and standards of measurements, where so required, by the Bureau of Standards as the official agency for the purpose. (THE JOURNAL, Jan. 1918.)

In respect to these, (1) the Council directed the appointment of a committee; (2) a letter was read from the Secretary of War expressing appreciation of the Society's helpfulness and stating that it was planned to take up at once the suggestion of an intermediary board; (3) the Council approved and referred the resolution back to the Gage Committee to take up with the various Bureaus of the Government, and also asked the Secretary to present it to the Engineering Council.

Standardization of Bolts and Nuts. In response to a request for standardization by Mr. C. B. Auel, it was voted that the Engineering Council be requested to consider the advisability of placing under the Engineering Council all standardization committees of the four societies to deal with standards wherein two or more societies are interested.

Engineering Education. Dr. C. R. Mann, of the Carnegie Foundation, brought to the attention of the Council the proposed plan of the Federal Board of Vocational Education to divert the Engineering Colleges of the country for a period of five months from their regular work of training engineers

to the training of technicians for the war. Resolutions were passed expressing the opinion that such a step was unwise at this time.

Amendment to By-Law 16. Voted to approve the following revision of B16:

B16*a* The Council may in its discretion restore to membership any person dropped from the rolls for non-payment of dues or otherwise upon such terms and conditions as it may at the time deem best for the interests of the Society.

B16*b* The Council may in its discretion remit the dues of any member of the Society in any grade who is engaged in military or other patriotic service of the United States during the continuance of the war conditions and for a period thereafter.

B16*c* The Council shall permanently exempt from dues any member of the Society who has paid dues for thirty-five years or who shall have reached the age of seventy years after having paid dues for thirty years.

Boiler Code Interpretations. The record of Boiler Code Interpretations covering Cases 181 to 184 were approved and ordered published in The Journal. They appear elsewhere in this issue.

Membership Badges. On recommendation of the Membership Committee, a smaller size of badge was approved for those who prefer it to the larger badge now exclusively used.

Members in Military Service. It was voted that members who have honored the Society by entering the military service of the United States shall receive all privileges of their membership and have their current dues remitted upon request.

Printing of Reports. Printing was authorized of the preliminary report of the Committee on Tolerances in Screw Thread Fits; the report of the Committee on Weights and Measures; and three preliminary reports by sub-committees of the Research Committee, covering Flow Meters, Bearing Metals, and Lubrication.

Employment Work. In view of the extensive growth of the employment work of the Society, which has been conducted under the personal supervision of the Secretary, it was voted that this activity now be assigned to a committee for its direction, and it was suggested that the work be combined under the same committee with that of the Engineering Resources Committee, which now is supervising the work of supplying engineers for Government service.

Isherwood Bust. The Council accepted with deep appreciation the gift from Miss Isherwood of a pedestal for the bust of Admiral Benjamin F. Isherwood, which was presented to the Society at its Annual Meeting.

Appointments. The following committee and other appointments were authorized:

Engineering Council. Charles T. Main was appointed a member for one year in place of Arthur M. Greene, Jr., resigned.

Worcester Section. On recommendation of the Sections Committee for officers of the Worcester Section: George I. Rockwood, *Chairman;* H. P. Fairfield, *Secretary;* W. W. Bird, W. H. Damon, George N. Jeppson, F. W. Parks.

Fuel and Fuel Conservation. As a representative on the Advisory Committee on Fuels to the Bureau of Mines, O. P. Hood.

Washington Award. In response to a request from the Western Society of Engineers for representatives to serve on its Board of Washington Award for Engineering Achievement: M. E. Cooley for one year and Charles Whiting Baker for two years.

Junior Prize Committee. A. L. DeLeeuw, *Chairman;* J. A. Brooks and George B. Brand.

Student Prize Committee. George B. Haven, *Chairman;* F. R. Hutton and William Kavanaugh.

Machine Shop Practice Committee. Ralph E. Flanders, *Chairman,* for one year, and George Langen, Henry Spencer and William A. Viall for five years.

Tellers of Election. R. F. Jacobus, *Chairman;* Norman G. Reinicker, Claude Hartford.

Calvin W. Rice, *Secretary.*

THE PRESS ON THE WAR CONVENTION OF THE SOCIETY

AMERICA is just now beginning to mobilize her engineers so that the present world war may be the last great war. And in the light of this mobilization the thirty-eighth Annual Meeting of The American Society of Mechanical Engineers assumes extraordinary interest. Thus the *Iron Trade Review* strikingly characterized the Society's war convention, and it is a matter of gratification to report that the magnificent spirit of patriotism and public service that ran through its many sessions was similarly recognized in every other press notice. The *Engineering News-Record* commented upon the timely addresses that "dealt with the manifold and vital relation of the engineering profession to war-supply requirements." The *Evening Sun* of New York gave full credit to the hundreds of mechanical experts who have been sacrificing their time and money in war work and who quietly and unostentatiously have aligned themselves in a solid phalanx behind the Government.

The above press comments are only reflections of the general attitude that is now being taken toward the engineer. It is becoming more and more evident that in these days of war the engineer must come out of his "technical shell," must become a citizen of the world ready to bear the great economic and social burdens that of necessity will have to be placed upon his shoulders. The troops are fighting valiantly at the front; behind them are the great national executive organizations that direct their movements. But behind both are the engineers—the engineers in all fields—whose thoughts and skill are constantly changing the state of peace and war. Through many of the press reports there runs this undercurrent of thought: the present condition of affairs seems to indicate that the engineers have used their power only to unloosen the great destructive forces that are spreading havoc and misery broadcast. It is for them to vindicate themselves; to allow their power, their skill and the great store of knowledge at their command to run into constructive channels so that the great forces of science will be used for man and not against man, and so that the civilization of the world that has been built up so slowly and so laboriously during the long centuries of man's existence on the earth shall not perish.

The Society is well aware that just at present the need of diverting engineering into more beneficial channels should occupy the minds of all thoughtful and farsighted men, and that the mechanical-engineering field should and must be so broadened as to be able to include the great economic and industrial problems of both today and of the future.

Forbes' Magazine says of the meeting: "Human engineering is but one of the many phases of the mechanical engineer's

broadened field in an age when the direction of industry is more and more passing to the hands of 'masters of material,' represented by the industrial engineer whose business it is to provide both management and workmen with scientific industrial methods and accurate records of production." And in accord with this development of the field of mechanical engineering the Society held its session on Management and invited surgeons, Government officials, Red Cross directors, psychologists, psycopaths, social workers and others to coöperate in putting back upon the payroll of the world both the war cripple and the industrial cripple and thus make of them useful and independent members of the state instead of objects of charity. Not only must the existing labor supply be improved and rehabilitated, but a new supply must be added in such a way that our production and distribution in the future will be allowed to reach the maximum point of efficiency; and thus at another session of the convention the question of the employment of women in the skilled industries was considered from a mechanical as well as a psychological standpoint.

The conservation of time and energy, of food and fuel, is a matter of the most vital importance both at home and abroad. The press had only words of praise for the Society's recognition of this fact and for its inclusion in its keynote session a consideration of the problems of conservation that the Government with the aid of the engineer is attempting to solve today.

There was hardly an account that did not contain at least one extract from Dr. Hollis's address on Universal Service in Peace and War. The assertion of Professor Kimball that "mechanical engineering would soon include every subject in the world and that the aims of the Society ought to be therefore redefined," was another favorite point for press comment.

The fuel situation as outlined by Professor Breckenridge was the subject for much discussion and speculation, and the statistics given by Mr. Myers in his paper on Preventable Waste of Coal in the United States must have touched a vital chord in the fuel question, for they were quoted again and again.

The conservation of energy and time as treated by Mr. Gregg, Mr. Gantt and others, was heartily endorsed by the daily as well as the technical press. Special attention was directed to the fact that not only were the timely subjects of transportation, airplane building, cantonment construction given to the assembled engineers for consideration but for solution as well, and the *Iron Trade Review* predicted that "undoubtedly the convention will show fruitful results in coming months."

As was expected, the valuable contributions along strictly technical lines which ordinarily attract so much attention were relegated to a second place by the war subjects. But this is only corroboration of the fact that the country's needs during the war crisis dominated the whole convention so strongly and so potently, and that so far as the mechanical engineers of the country, as represented in our membership, are concerned, there is from now on only one task.

Junior and Student Prizes

THE rules covering the awards of Junior and Student Prizes for technical papers have been made more comprehensive this year in that a definite standard has been established by which the papers are to be judged. According to this new standard, the prizes will be awarded for the best papers adjudged from the standpoints of originality of matter, applicability (practical or theoretical), value as a contribution to mechanical-engineering literature, logical development of contents, conclusiveness, completeness and conciseness. These specifications, besides furnishing the examining committees with a definite basis upon which to rate the papers submitted, will also serve to assist competitors in the preparation of their manuscripts.

As to suggestions for topics of papers, besides the usual specific technical subjects, of which there are a large variety in every branch of the profession, papers dealing with how the engineer can be of service in these days of war are this year in order. In this latter connection papers might well be written on such topics as the following:

Laboratories for war testing, including munitions; organization for war research with special reference to munitions and fuel; industrial reconstruction plants to meet the needs of war industries; application of management systems to war plants; records of cost of operating war plants; novel methods of training and managing employees in war plants; workmanship requirements; safety devices and measures for men and women workers; new buildings for housing munitions plants; speed of production in munitions plants; maintaining efficiency of machines used in continuous production; specifications covering munitions requirements; certification of munitions gages; standards and interchangeability in munitions parts; machine-shop practice and inspection in wartime; increased terminal facilities in wartime; new responsibilities of the engineer in wartime, etc.

From the technical standpoint a paper might well be devoted to any one of the following subjects: a description of a new mechanical invention or piece of enginering apparatus; an account of some original work in the laboratory, shop or classroom; a description of a novel modification to an existing plant; an explanation of plans or methods of proposed engineering work; a summary of present practice in a given mechanical field or an argument for or against a particular mechanical apparatus, process, construction, etc.

The prizes themselves and the certificates accompanying them are both inducements to Junior Members and to members of Student Branches to enter these annual competitions. Added incentives are the opportunities furnished by the Meetings Committee and the Publication Committee of considering successful papers for presentation at the meetings of the Society and inclusion in its publications.

The rules covering the award of these prizes are given in the Year Book of the Society, the 1918 edition of which is about to be issued. The last date for submitting papers for consideration by the Committee on Awards this year is June 30. Any other information desired by those who intend to compete will be gladly furnished by the Secretary.

Activities of the A.S.C.E. During the Past Twenty-five Years

AT the December 5, 1917, meeting of the American Society of Civil Engineers, Mr. Charles Warren Hunt, secretary, presented a review of the activities of the society during the past twenty-five years. While devoted fundamentally to the work of the organization, Mr. Hunt has served for even longer than the period it covers. The paper contains sections of particular interest to our Society as a Founder Society and as a sister organization with similar objects and aims.

Mr. Hunt thus adequately sums up the functions of a national technical society:

1 To advance engineering knowledge and practice

2 To maintain the dignity and standing of the organization,

and to preserve the high character and professional qualifications of its membership

3 To keep in touch with, and take proper action on, all matters in which the relation of the profession to the public is involved, and to render service to the nation when occasion demands

4 To do whatever is possible for its members individually, and, in general, to return to them an equivalent for the dues paid.

"The latter function necessarily takes the form of providing opportunity for professional discussion, both formal and informal, which, as in the case of this society, more than 80 per cent of the membership is non-resident, must be through publications."

This latter statement by Mr. Hunt applies with equal significance to our own Society, since, like the Civil Engineers, we have a non-resident membership of 80 per cent. One modification could be applied to the statement with justification, however, and that is that 86 per cent of our membership is included in the Local Sections, an activity which has disclosed tremendous possibilities, many of which, due to the good generalship of our present Committee on Local Sections, are about to be realized. This is as it should be, for whether a society's membership is resident or non-resident, all members should have equal benefits from all the activities—meetings, publications, library, etc.

Another significant paragraph of Mr. Hunt's paper is that devoted to war activities. This applies equally to all the societies, and much of the work in this connection which Mr. Hunt describes has been done jointly by all the societies working together. One unique contribution that the Civil Engineers have made, and for which they should be granted full recognition, is the offering of their former headquarters to the United States Food Administration as a central office for its work in New York State. This offer was made unqualifiedly and was gladly accepted by the Board.

Other sections of Mr. Hunt's paper describe the removal of the Society to its new headquarters in the Engineering Societies Building and show plans of the new rooms, describe the tremendous work of transferring their library, which consisted of 89,000 accessions, of which 67,000 were not duplicated in the libraries of the Founder Societies, gives a history of the local sections, meetings, publications, special c mmittees, and other activities of the Society.

To the report is appended a classification of the library of the Civil Engineers, in which work Mr. Hunt has always evinced a keen interest and which he brought up to a remarkable degree of perfection.

SECRETARY OF COOPERATIVE ACTIVITIES

Appointment of Mr. Alfred D. Flinn to the Secretaryship of the Engineering Council, the Engineering Foundation and the United Engineering Society

A MOST significant step is the appointment of Mr. Alfred D. Flinn, Member of the American Society of Civil Engineers, to the secretaryships of the Engineering Council, the Engineering Foundation and the United Engineering Society. Such an appointment indicates that the necessity for concerted action in all matters pertaining to the engineering profession has been fully realized and that the professional solidarity that has long been the goal of engineers of vision is at the point of consummation.

To Mr. Flinn is given a great task—a task ably begun by the Engineering Council through its Committee on Public Affairs, its War Committee of Technical Societies and through its individual members. Mr. Flinn is worthy of the task; his broad executive and organizing experience and his great skill in securing the hearty coöperation of all his coworkers will stand him in good stead in his endeavor to make of the engineering profession a united profession of service to all mankind. A brief sketch of his achievements and attainments follows:

Alfred D. Flinn Underwood & Underwood

Alfred Douglas Flinn

Alfred Douglas Flinn was born in New Berlin, Union County, Pa., August 4, 1869. He was graduated from the Worcester Polytechnic Institute in June 1893 and immediately afterward went to Boston. His first engagement was with the firm of George S. Rice and George E. Evans, consulting engineers, on surveys for the so-called "alley route" for a proposed elevated railway through the heart of Boston, and on surveys for the Muddy River Parkway. In November, 1893, he obtained employment on the Boston Water Works under Dexter Brackett, engineer of the distribution department, and was engaged upon upkeep, operating and construction duties and extensive tests of fire-department apparatus until the spring of 1895, when he entered the engineering office of the Associated Factory Mutual Insurance Companies under John R. Freeman. Here he was engaged for a few months upon hydraulic experiments and factory surveys.

In July, 1895, upon receiving an offer from Dexter Brackett, Mr. Flinn became connected as transitman with the distribution department of the engineering force then being organized by Frederic P. Stearns as chief engineer of the Metropolitan Water Works for the Boston metropolitan district. He had an active part in the creation of this organization and in the surveys, investigations, designs and construction, rising

through various ranks until early in 1900, when he was made principal office assistant in the Boston office, charged with the preparation of contracts and drawings, investigations and miscellaneous office work. This system included the well-known Wachusett dam and the Wachusett and Weston aqueducts, together with large distributing reservoirs, pumping stations and pipe lines in Boston and the surrounding municipalities. During the winters of 1900-01 and 1901-02 Mr. Flinn gave a course of lectures to senior classes of the Lawrence Scientific School, Harvard University, on water supply and sewerage.

In October, 1902, Mr. Flinn was asked to become managing editor of the *Engineering Record* and removed to New York to take up these new duties. Shortly thereafter the *Engineering Record* was purchased by the McGraw Publishing Company and increased in size and scope. In August, 1904, he left the *Engineering Record* to become general engineering inspector of the Croton Aqueduct Commissioners under J. Waldo Smith, Chief Engineer, and remained for a year in that office. During the year he had charge of the completion of designs for the new Croton dam and Jerome Park reservoir, prepared designs and contracts for the Cross River reservoir and began those for the Croton Falls reservoir, all of these works being parts of the Croton water-supply system of New York City.

During the summer of 1905 the Board of Water Supply of the City of New York was created under special legislation and Mr. J. Waldo Smith was engaged as chief engineer. Mr. Flinn became the first member of Mr. Smith's staff and with him had a large share in the creation of the engineering organization which later earned an enviable reputation for its effectiveness, business-like methods and *esprit de corps*. Until August, 1914, Mr. Flinn was department engineer of headquarters department, in charge of civil-service matters, special investigations, designs, preparation of contracts and reports, inspection of materials, and requisitioning of supplies and equipment for this large organization. August 1, 1914, Mr. Flinn became deputy chief engineer and so remained until he assumed the duties of secretary for the United Engineering Society, the Engineering Foundation, and Engineering Council. The Catskill Mountain water system for providing 500 million gallons daily additional supply of water for New York City, including the Catskill aqueduct, the Ashokan and Kensico reservoirs and other important works, are so well known as to require no detailed description in this brief account of Mr. Flinn's professional career.

From an early period in his engineering work Mr. Flinn has been a frequent contributor to engineering literature, on a variety of subjects, and is one of the compilers of the Water-Works Handbook, in the preparation of which Mr. Robert Spurr Weston, of Boston, and Mr. Clinton L. Bogert, of New York, were associated. This book has been adopted by the U. S. Army Engineers.

Members' Pins and Certificates

A slight increase has been made in the prices of pins and certificates supplied to members of the Society. The new schedule of prices is:

Dark blue enamel four-leaf clover official badge, with letters in bright gold, for honorary-members, members, associates and associate-members:

Pin	$4.00
Charm	5.50
Stick-pin	4.00
Button	5.00

Crimson enamel four-leaf clover official badge, with letters in bright gold, for junior members:

Prices same as above.

Membership certificates, all grades, including engrossing $1.50

A small pin, one-quarter of the size of the present pin, can now be obtained, price $3.00, screw back. It will probably be some time before a complete stock of these pins is on hand, but orders will be placed on file and will be filled as early as possible.

AMONG THE LOCAL SECTIONS

A NEW era in the history of the Local Sections was begun at the Local Sections Conference, held on Tuesday, December 4, during the Annual Meeting of the Society. Mr. D. Robert Yarnall, Chairman of the Committee on Sections, presided and a report on the new By-Laws governing Sections was presented by Prof. L. C. Marburg, member of the Local Sections Committee. Delegates representing twenty out of the twenty-one Sections were in attendance—the largest proportion ever present at a general meeting. In addition there were representatives from four branches of the Connecticut Section, as well as visitors from centers of the country interested in the formation of sections.

The conference was divided into two parts; first, a luncheon, at which the Sections delegates had an opportunity to meet informally the members of the Council, and second, a business meeting. The latter was arranged to develop four topics of importance to all the Sections at this time: 1. The new By-Laws and the Sections. 2. Coöperation between Sections and other local societies. 3. How the Sections can secure papers. 4. The Sections and research

The first of these topics was ably presented by Prof. L. C. Marburg, member of the Committee on Local Sections, in the form of a paper which will be given in full in the next issue of The Journal. The other topics were developed in the form of informal discussion, an account of which follows.

DISCUSSION AT THE CONFERENCE

Coöperation Between Sections and Other Societies

Professor Rautenstrauch (Sections Committee): The Committee on Sections has been very much interested in the work of the different Sections in coöperating with the local engineering organizations. We find that the Sections in St. Louis, Milwaukee, Chicago and Detroit, which we visited about a month ago, are working toward a better coöperation on the part of the local engineering organizations with our national Society, and these visits have been sources of inspiration and encouragement to us, and we hope that during the coming year we may have an opportunity to visit other Sections and become acquainted with the work which is going on.

It is almost impossible to maintain a separate and distinct organization in any community without coöperating with the local sections or branches of other national organizations and local engineering organizations that are in the community. Where there is an engineers' club we find that it is inevitably the case that our Local Section, together with other local sections of the other national organizations, group about the engineers' club or engineers' society as a focal point. In Birmingham, where there is no engineers' club, the Alabama Technical Society was formed

and membership in that society is limited to those who are members of the local sections of national organizations. Thus there seems to be a demand for some centralizing element or influence that the different engineering organizations may group about, and it is only through the coöperation of the local societies in this way that I think we can grow both as Sections and as a national organization.

Mr. Engel (Chicago): We have the Western Society of Engineers in Chicago—a general engineering body, composed mainly of civil engineers, with some electrical engineers and mechanical engineers among its membership. They offered us various encouragements to meet with them. At first we had an idea that the mechanical engineers would not gain very much by an affiliation with them. The Sections Committee gave us a different viewpoint, and we are going to meet with them now, and be one with them. We have coöperated with the other engineers in the formation of a Citizens' Unit, and also in the formation of the whole of the First Illinois Regiment of Engineers.

It has been my own conception, as I have viewed the problems in Chicago, which is the second city in America—a city which in some respects is more the center of the country, and more the center of industry than New York—that the close and cordial coöperation of all of the engineering organizations in that city may ultimately bring about the erection of a second engineering headquarters, which, to many of us, would be of more value, perhaps, than the building in New York.

The first step, however, in doing big things is real coöperation between the engineers, and that has been the propaganda that the Committee on Sections has been carrying on. The engineers must combine their purely local questions with a view to promoting the general welfare of the profession as a whole, while at the same time maintaining a certain individuality in order that the technical interests of a particular profession will be taken care of. In this building we have a bringing together of all of the national engineering societies. It is a kind of affiliation, a coöperation which could easily be brought about in Chicago.

Mr. Radcliffe (St. Louis): We have been coöperating with the local sections of the national societies in St. Louis for many years. It came about very largely as the result of an agreement entered into by the local society a number of years ago to the effect that each section of a national society should present not less than two papers each year at a meeting to which members of the other local organizations in St. Louis would be invited. This has helped us to secure good papers, and we have been assured of at least six meetings a year. The organization is called the Associated Engineering Societies of St. Louis.

There is a point that it might be well to emphasize, and that is in making your arrangements for coöperating with the local sections of the various national societies, do not lose your own identity. We have avoided that this year by planning a definite program, with one monthly meeting of the Local Section of the A.S.M.E. from September to May, and we hold that meeting regardless of the two joint meetings which the A.S.M.E. is responsible for as members of the Associated Engineering Societies of St. Louis, which may be given any time of the year.

Mr. Hoexter (Detroit): We have the Detroit Engineering Society, an organization which has about six hundred members. The mechanicals, civils, architects and automotive engineers are particularly strong in the city, and the Detroit Engineering Society has taken it upon itself to provide speakers, representing the various organizations. The individual societies might ordinarily get out as many as twenty-five men to a meeting, which is rather discouraging for a speaker with a national reputation, whereas if the Detroit Engineering Society brings him to the city, we are assured of an audience which fills the hall to capacity.

Professor Fairfield (Worcester): "What has the Section done to coöperate with the profession at large?" In Worcester there are no prominent engineering societies. We are strictly an industrial city, and we have a technical school of some note. We seemed to find that the Boston Section appealed to a considerable number of us, but that as far as the industries went it did not attract them. When the members of the Society began to consider the fact that Worcester was to be given a chance to have the President of this great Society, we began to discuss the question to see if we could not have the A.S.M.E. coöperating with the industries in such a way as to interest those men who are prominent in the industries, largely in machine-tool building and similar industries. We also have a considerable alumni of the Worcester Polytechnic Institute, located in the city and near it, many of them connected with the industries, so that the Worcester Section instead of coöperating with other sections of other societies, undertook to coöperate with the industries and with the Alumni of the Worcester Polytechnic Institute, and to bring the student body also in contact with the A.S.M.E. This is a good form of coöperation to be considered in many of these smaller cities. It can be done well where a city is the central or focusing point of a number of towns.

Mr. Geier (Cincinnati): We have formed in Cincinnati a joint association of electrical and civil engineers called the Engineers' Club. We have meetings once a month and after every meeting we have refreshments, at a series of small tables seating four to six persons. In that way the men present get thoroughly acquainted with each other. We have ten meetings a year, and out of the ten meetings we undoubtedly have eight at which the papers are of such a character as to bring out an attendance of 200 members or more.

Many of the professors of the University of Cincinnati are members of the club and it seems to be an excellent thing to bring these professors into contact with the practical men who are doing the work in the field of industry, and it is having its effect on teaching in the engineering colleges. There are many places in the United States where the same conditions prevail and we ought to make a strong effort to bring into our Society the members of the different engineering colleges and schools. It is very helpful to the practical men of affairs to have the students and the professors at their meetings—it broadens their viewpoint. In Cincinnati we are getting something of that bigger outlook and vision which Mr. Marburg has so well spoken of.

Mr. Klinck (Birmingham): The Alabama Technical Association is a result of coöperation. Membership in the Alabama Technical Association can only be held by men who are members of one of the national organizations which have representatives in the city, the mechanical engineers, electrical engineers, the mining engineers, the chemical engineers and the architects. Where those societies have the ordinary membership, the men in college can come in. We are going to make the Alabama Technical Association stand for something in the state, not only along engineering lines, but as a public-service proposition.

Professor Rautenstrauch: In order to successfully carry out coöperation, there must be some definite objective as the basis upon which coöperation can be made. One can have social coöperation, coöperation in organization, coöperation in the technical papers and technical meetings, etc. Thus each section should definitely find the objective for the year on the basis of which coöperation shall be carried out. Coöperation is a rather fascinating term, but if it is allowed to stand in the air, there will be no particular element about which there can be crystallization of effort. We as engineers are organizers, and it should be a simple problem for each Section to study its local conditions and then go ahead and appoint as committees in charge of the matter those who will be able to bring about the necessary influences to get the work and the objective clearly defined.

How the Sections Can Secure Papers

Professor Richards (Sections Committee): Last July the Chairman of the Committee on Sections addressed a letter to each of the Local Chairmen. Part of the letter reads as follows:

"The Committee on Sections recognizes that the Sections emphasize the national scope of the Society, and through them membership is made of greater value to each individual.

"Next in importance to the work of the Sections is the development of The Journal and Transactions, and the Sections are expected to perform a real service in this essential. As engineers, we know that only through organization and by having certain individuals charged with a definite responsibility can an objective be accomplished.

"In a Society as large as ours, the personal element is largely developed through the point of contact between member and Local Section and it is evident that if the best publication is to be issued, it must be supported by the active interest and work of the Sections. The Journal should contain each year at least *two* technical papers of live interest from each of the Sections. Take for instance the paper by W. P. Barba on Industrial Safety and Principles of Management, presented before the Philadelphia Section, December 1915, which was considered of so much interest that it not only was published in The Journal, but was later selected for presentation at the 1916 Annual Meeting. See the yellow pages in the July 1916 Journal for other examples.

"If these facts were generally known to the individual members of Sections, we believe members would submit more papers to the Society.

"The Committee on Sections therefore suggests as a uniform practice that each Local Section make a special effort this year to contribute technical papers and data, through the establishment of the following organization:

"Appoint a committee of three, particularly qualified, to study the local field, determine what papers and data your Section is best qualified to contribute, solicit the contributions of papers from your local engineers and report to the Committee on Sections. We would call attention to the fact that these papers need not be long. In fact, brief, concise statements of valuable information often are of equal interest and value to longer papers.

"Appoint a committee of two, qualified by broadness of vision to investigate what researches may be most effectively carried out because of the particular engineering work being done in the locality. Men who are particularly fitted to organize and conduct these researches and report the findings to the Committee on Sections should be appointed."

The Committee on Sections felt that it was particularly important to have a Committee on Papers organized in each Section and that the committee be charged with the work of stimulating the members in the preparation of papers of merit. The papers should not be mere verbal discussions, but should be prepared in a somewhat formal way so that they may be discussed formally, and so that they may be presented to the Committee on Meetings as possible material for publication in the TRANSACTIONS, and for presentation at some of the meetings of the national Society.

It has often been stated that we get out of an organization just exactly what we put in it, and that is a thing we must keep constantly before us. We will get out of this Society just exactly what we put into it and one of the things that each of us should feel desirous of putting into it is a contribution, from time to time, of the things we know about and are interested in as engineers and are competent to discuss. It is an unfortunate commentary on this country that there are no technical publications, outside of the journals and transactions of the national engineering societies, which are really engineering periodicals. We have a host of trade papers, but no engineering publications like the London *Engineer*, the *Zeitschrift*, or the *Revue de Mécanique*. Very few of the national engineering periodicals will publish an article which has a differential sign or an integral sign. Outside of a publication such as our JOURNAL, there is no place where real contributions to the literature of engineering are made, except as they are presented in semi-popular form and reflect the immediate engineering of the time. In expressing the Committee's views, I am sure the national Society will agree that it is exceedingly important that the technical information which the members of the Local Sections have should see the light of day.

MR. FRENCH (New York): At the Conference Luncheon this noon, Professor A. M. Greene threw out the suggestion that in years to come the best papers would probably come to the Society for the general meetings through the Sections. As a commentary on that, I would like to call attention to the fact that at the 1917 Annual Meeting we have assigned on the general program, as a result of a review of the Sections papers for the past year made by the Publication Committee, four Sections papers. Last year we had five or six. As a general rule there are about half a dozen Section papers, selected from those published in THE JOURNAL, which are given for discussion at the Annual or Spring Meetings of the Society.

I think that clearly indicates that the bulk of the papers presented before the Sections are either quite local in character, or else, as Professor Richards has just suggested, more popular in character than would be considered as suitable for permanent record in the annual volume of TRANSACTIONS. As a matter of course that would be expected. It is desired to have the Sections' meetings of general interest and treat subjects of local interest, and I doubt very much whether many Sections meetings can be devoted to the highly technical matters that the Society would wish to put on record in the annual volume of TRANSACTIONS.

Nevertheless, I would like to impress upon all of the Sections' representatives that the strength of the publications of the Society must eventually rest with the Sections, and it is very evident why that is so. It cannot be expected that a committee of five members, the majority of whom necessarily live in the East, acting as a Committee on Meetings, can select papers for the Annual and Spring Meetings which will be entirely representative of engineering progress in this country. Engineering is too varied in its characteristics and the country is too large to make it possible for any five men to secure thoroughly representative papers. With twenty-one Sections, such as we have, representative of different parts of the country from coast to coast, and from Canada to Louisiana, we ought to be able to put on record the most important engineering events that are occurring throughout the country. It ought to be possible for the members of any Local Section to so keep in touch with the engineering progress in their vicinity that two or three papers a year could be secured dealing with the important events in their vicinity. For example, from the Pacific slope we would naturally have, as we did this last year, a paper on oil refining, or, as in a previous year, a paper on gold dredging, or, as at another time, a paper by Professor Durand on the hydroelectric developments of the Pacific slope. In New York we would expect, as we have already had, a paper on elevators for tall buildings. From the Northwest we would expect papers on coal handling, and grain handling, such as we have already had, and from New Orleans on the drainage and irrigation work carried on there.

What is desired is to have the backing of some committee for every paper that is published in THE JOURNAL, so that it is known that the paper is of some merit in the judgment of a body of our representative engineers. For example, if in Chicago there should be some engineering developments, some research engineering processes, upon which a paper could be secured which might not be considered very suitable for a joint discussion or a local meeting, but would be worthy of publication in THE JOURNAL and for publication in the TRANSACTIONS afterward, might it not be possible for the Local Committee to secure that paper, present it at a meeting where some other more popular paper was given, presenting it by title, or by giving a very brief abstract of it, and stating that it would appear in THE JOURNAL and call for discussion?

We need about two papers a year from each Section, papers of sterling merit, to keep THE JOURNAL up to the standard required for a representative mechanical-engineering journal in this country, and the problem is to work out some basis on which the Local Sections can get these papers. I believe that through the Sections Committee and the Publication Committee a method could be worked out by which the important engineering developments will come to the Society for permanent record.

A little incident came to my attention yesterday. I was talking to one of our librarians. He mentioned that the searches called for and the other work and investigations done by the library employees were more frequently for members of this Society than for any other society. We know that our members send in a large number of calls to the library for information, and I believe that it is largely due to the fact that in THE JOURNAL we have reviews of important articles in other periodicals. Apparently the effort to make THE JOURNAL representative of engineering progress through those reviews is being appreciated by the membership.

Now, cannot we make it more appreciated by having the Sections get together the material that represents the engineering development going on in the country—the machine-tool industry in Cincinnati, the hydroelectric development work on the Pacific slope, and so on throughout the country, and have the material come in backed by the committee in the particular section where the material is secured, so that when the Publication Committee receives it they know it is good matter and worthy not only to be published in THE JOURNAL, but later to be presented at the Conventions and to appear in the annual volume of TRANSACTIONS.

MR. STARKWEATHER (Boston): The Sections stand for the Society to a large percentage of the members, men who never come to New York, and never see the activities in the Engineering Building, or attend an annual convention. We in Boston are very favorably and fortunately situated, in that we draw from a large membership, and we have a variety of interests. Our Section has appointed a Research Committee and a Papers Committee. We have had three general meetings this season—one on trench warfare, one on aeroplanes, and one on shipbuilding. One of the subjects, The Building of a Modern Plant for Submarine Destroyers, would make a good paper.

MR. WHITE (Milwaukee): We have planned a meeting which we think will result in a paper of general interest, and that is on the question of forgings. We have in Milwaukee the largest forging press west of Pittsburgh. That press at the present time is running night and day, mostly on Government work, varying from guns on down. It is proposed to hold our meeting at the works where the press is located and have addresses by about six of the technical experts who have to do with the forgings. We

propose, for instance, to ask a chemical man to tell us about the billets, about the basic and open-hearth processes. Then we propose to have the superintendent of the forging plant tell us his difficulties in forging—the time of heating, the kind of ingots he wants for certain forges, etc.—and then we propose to make a visit to the forging shop and see the forging press in operation.

After this first meeting we intend to have another meeting with discussions by technical engineers as to the possibility of adapting, for instance, low-carbon forgings, high-carbon forgings, nickel steel, chrome and vanadium, etc., to the different work.

Mr. Prindle (New York): The New York Section has tried an expedient that promises very well. On our announcement postcards we have space for suggestions for papers and we also make a place on the reply postal card for suggestions. This has resulted in a wealth of suggestions which insures getting a paper that is bound to be popular.

Mr. Delany (San Francisco): There seem to be two difficulties at present in securing papers in San Francisco. One is that a great many of the best engineers are away from San Francisco on special work for the Government. Several declined for the reason that they were doing special work that is confidential at the present time. That is a difficulty which is probably met with in other Sections, and in San Francisco we would like to know if there is any way of overcoming it.

Mr. Sargent (New Haven): We recently had a meeting of the Connecticut Section under the auspices of the New Haven Branch at which Professor L. P. Breckenridge gave a paper on the Conservation of the Coal Supply. The paper will be read at the Convention under the title of The Fuel Problem. That is our first contribution. We expect to have two or three others, perhaps more, during the year, and will endeavor to have these of local interest, and technical interest, but in Connecticut—not more perhaps than other places—the mechanical engineer is a member of the manufacturing corporation, and he very soon reaches a point where he is not permitted, perhaps, to be too explicit in the matter he gives out, giving in too much detail something that concerns his particular manufacturing plant, and this is especially true at the present time as the country is at war.

For instance, we have in Waterbury perhaps the largest interests in the manufacture of brass in the country, and it would be rather difficult at the present time to have any of the engineers employed in these various brass mills deliver a paper. We are manufacturing munitions in New Haven and in Bridgeport in large quantities. We are manufacturing in New Haven and in Hartford the Lewis machine gun. It would also be very difficult to get men to give a paper on these subjects.

Mr. Langen (Cincinnati): We have had no trouble in getting papers. We get them nearly all by personal contact, going to see the member and having a talk with him and telling him what is expected. We ask him to make the paper short, and ask him to stand for all of the questions that the members care to ask. If a member has a paper which will take forty-five minutes in its presentation, there will probably be an hour or an hour and a half of discussion. The members ask all sorts of questions and the discussion usually brings out more than the paper.

The Sections and Research

Professor Rautenstrauch: The question of research is very important, because it tends to raise the plane of activity of the Local Sections of the Society. Unless we have some definite objective of this sort, we are very liable to go to a lower level of operation than we would ordinarily go if spurred on by this sort of an incentive.

The difficulty lies very largely in making clear just what sort of thing is required under the head of research. The term generally strikes a little fear in the heart, as usually associated with something rather profound, like the integral sign Professor Richards referred to a while ago. A great deal of research does not consist of that sort of thing at all, but consists of rather systematic and logical arrangement of subject matter which need not necessarily be symbolically or formidably presented.

There are in a great many Sections problems that are peculiar to that Section, and it is an attempt to bring out the particular things that are of interest in that Section that the Committee on Research is being formed. The difficulty in doing this sort of thing is generally in the definition of the problem, and very often a considerable contribution to research is made by simply defining the problem. There is no difficulty in getting men to work on a particular line of investigation if the importance of that line is pointed out. That is what makes the difference between the big physicist and the little physicist. The big physicist can define what sorts of problems are real problems, and the little physicist is a man who fiddles around with something that is perhaps very complicated, but yet at the same time doesn't contribute very much to human progress.

As a suggestion, suppose we take the work in the Milwaukee Section. Mr. White is one of the most eminent engineers we have on the design of water wheels, and he knows that there are certain problems in water-wheel design that will bear investigation, and that we are in need of data or information along particular lines which will promote the use of water-wheel design. Why should there not be, then, a clear definition of the whole field of water-wheel design for the purpose of pointing out wherein there is a lack of certain information.

Again, in the Bridgeport district, where brass work is so prominent, there is the question of the manufacture of brass parts, the question of lubricants for the cutting of brass. In many of these works a very large number of lubricating compounds are used. Let a clear definition of what are the essential characteristics of a lubricating compound be given. Let the men who are interested in that particular thing make a statement of the state of the art, giving a clear definition of what are the things we need to know about in connection with that particular subject, and when that is once defined we will find certain fields on which we have no information. We have a great many young college men who are working in this industry, and we want to attach them to the Society at this critical time in their work and get them interested in the Society. We want to get them to contribute to the Transactions and proceedings of the Society and become real live members. Let us point out to them that there is a problem worthy of their consideration, and by pointing that out and getting them organized so that they can go to work, we will get real information for the Transactions of the Society, and save the number who would ordinarily become driftwood in the organization.

It is that sort of thing we want to accomplish through the Committee on Research.

Professor Richards: At the University of Illinois we had the first engineering experiment station organized in this country, or in the world, perhaps. It has not been long since most mechanical engineers were inclined to shy away when the term "research" was used. We were inclined to look upon the term as one that had no particular concern with actual industrial processes, and was all right for the college fellows who wasted their time upon it. That attitude has changed radically within a very few years. This war, of course, will do more to bring to each of us the realization of the absolute necessity for research than would have been possible in any other way.

One of the principal difficulties in the research field is that research costs money. If in any section of the country, where there is a community of interests such as we find in many of the New England States, due to the growth of a particular industry, that industry realizes there are difficult problems which it needs to know more about, and if the men interested can get together and provide a fund and either employ a man and get him to work or perhaps make use of some of the existing research agencies, and by supporting these agencies in a financial way, getting those competent to study in a scientific way the abstract problems presented, that will be one way of doing it.

In the Engineering Experiment Station at Illinois we have been endeavoring, so far as practicable, to encourage coöperative investigations. By coöperative investigations I mean that we furnish such facilities as we may be possessed of, with the understanding that the coöperating agent will provide the funds for materials and supplies, and also provide the special apparatus which may be required to be designed and built for the particular investigations, and also supply the funds covering the cost of special investigators that may be needed to be employed on a full-time basis. We have at the present time a number of rather important investigations under way. One of the most important, perhaps, came about as a result of a piece of research work which we had already done in the coking of coal. It was found that the by-products of the processes devised were of rather unusual character. An American creosote company was given a sample of the by-products, which we had discovered was exceedingly rich in creosote, and in view of the fact that the war had cut off the supply of creosote, most of which came from Germany, they became very much interested in the process. The president of the

company has already supplied us with a fund of $10,000 for the work, and is ready to supply as much more, to carry out on a larger scale the investigations originally carried out on a more or less limited scale.

Since we are a state institution, supported by the people of the state, every coöperative arrangement of this sort is made with the understanding that the results of such investigations belong to the University of Illinois and are available to all of the people of the state.

In a great many of the states during recent years these engineering experiment stations, similar to the one that was organized at Urbana some fifteen or sixteen years ago, have been organized, but most of them are merely for the purpose of doing what we call commercial testing, as distinguished from real research, and yet it is quite possible that in the long run these agencies could be used to coöperate with the industries in that particular section, remembering in all cases that engineering research is tremendously expensive; that one can not guarantee results, and that the investigation may need to be continued for years before satisfactory and valuable results can be secured.

Mr. Geier (Cincinnati): There is no doubt considerable wasted effort now on the part of manufacturers in the same line of business trying to duplicate various laboratory tests and researches. Every concern is doing some research work and it is a waste of money for two concerns to be doing practically the same work, and duplicating the results of each other. I have been suggesting to some of the manufacturers in Cincinnati the possibility of their having an entirely private research laboratory, owned and controlled by a group of manufacturers, or possibly making it more public by attaching it to the university, and having the work done under the direction of the university authorities. No steps have been taken that are definite, but the matter is becoming more urgent as industry finds it necessary because of some of the changes in industrial conditions.

Many heads of manufacturing concerns, who are concerned primarily with the commercial side of the proposition, do not have a realization or appreciation of just how much good a research laboratory on proper lines would be to them from a financial standpoint. I believe if the Society would make an appeal, not only to its membership, but to the managements of industry throughout the country, and place before them in a very practical and persistent manner the need of the country, and the need of the individual manufacturers throughout the country, for a movement of this sort, it would be most helpful. People are listening much more carefully than they used to to suggestions of this sort. Now is the opportune time to make such suggestion, and an appeal should be made either by the committee or the incoming president to industrial managers generally to take a broad viewpoint of the matter, and see if they cannot organize in each community a real research laboratory.

Mr. Wallace (Indianapolis): If the war has taught any one a lesson it has certainly taught the wide-awake manager or manufacturer that research of the right sort on the right basis is of inestimable value. There is a great deal of research work that can be done along manufacturing lines that would not necessarily entail a great deal of expense. For instance, the question of labor is one of the greatest questions confronting the American manufacturer today, and with regard to the question of labor in this country, the subject has not been touched. We as a manufacturing organization went after that question and worked out a very comprehensive program for reducing the labor turnover in our company. We are getting results and during the last three months our labor-turnover percentage is going down in spite of the fact that the acute shortage of labor has tended to increase the difficulties of the labor situation, and especially the labor turnover.

Again, the manufacturers in a given locality, under the direction of the Local Section in that locality, could perhaps get together and work out problems of research investigation and analyze the causes for scrapping lots of material. In our factory we put that campaign on a patriotic basis. We said to our people at one of our factory meetings, that saving material is a national duty, and we want that as a slogan. If all the local sections in a given locality would get together and concentrate on that question, we would get results which would be of value to everyone.

Mr. Hamilton (Ontario): In Toronto, we are just getting started on the mechanical side of the research problem. The Manufacturers' Association and the government have been financing the matter, but up to now it has been more in connection with the chemical industries. I got notice the other day that the Research Committee of the Manufacturers' Association was ready to take up the research work in coöperation with the mechanical engineers, and especially with the users of iron and steel in the district. In the course of the next few weeks we will form some sort of a joint organization between the bodies that are interested in that problem, the local mechanical engineers and the Manufacturers' Association, and promulgate the problems of the mechanical engineers.

At the close of the meeting Professor Richards gave a timely example of how the Sections could render practical service—he urged the Sections to enter into the national movement for the conservation of fuel. The knowledge at their command would enable them to give practical and special information in their communities regarding the proper use of fuel in heating the homes and the importance of putting the boiler plants in good condition and operating them more effectively, and to bring home to everyone that conservation is a problem everyone has to face squarely.

SECTION MEETINGS

BALTIMORE

December 19. At the second meeting of the Section, Wm. W. Varney, Chairman, reported on the Annual Meeting of the Society and appealed to the members of the Section for papers bearing on the local industrial interests of Baltimore.

The Secretary, A. G. Christie, discussed the fuel situation, and outlined the efforts that are being made to educate the firemen and increase boiler efficiency. He called attention to a Baltimore conference of operating engineers and a proposed assembly of firemen, urging the hearty support of members of the Section.

Dr. D. J. MacAdams, Jr., of the Engineering Experiment Station, U. S. Naval Academy, Annapolis, presented a paper on Microstructure and the Physical Properties of Metals, in which he described the methods followed in preparing a section for metallographic inspection under the microscope. Solutions of metals were discussed and illustrated by slides. Eutectics were treated and sections of tin-lead and copper-zinc compounds shown and the effect of heat treatment was illustrated by slides. Some interesting information was developed with regard to the steels of indicator springs, tool steels and the processes of tempering.

The second paper of the evening, entitled Some Mechanical Problems of the Fertilizer Industry, was presented by Samuel P. Whiteside, Mem.Am.Soc.M.E. He said that the mechanical engineer finds that in special chemical apparatus many mechanical refinements have been overlooked. Widely used machines when applied to fertilizer factories usually develop weaknesses. For example, grab-bucket service transforms a bridge crane from a tool of occasional convenience into a steady worker, but in this new service the machine needs some training and development before it will pass the endurance test.

January 10. A meeting under the joint auspices of the Engineers' Club, the various stationary engineers' associations and the Baltimore Section, was held for the purpose of interesting the firemen of the city in the subject of fuel saving.

Mr. Charles H. Bromley, Associate Editor of *Power*, gave an address on How to Get the Most Out of Coal. A fuller account of the meeting will be published in a later issue of The Journal.

A. G. Christie,
Section Secretary.

BIRMINGHAM

December 20. The subject of conservation of fuel was discussed by F. G. Cutler, Mem.Am.Soc.M.E., and J. W. Moore, Assoc-Mem.Am.Soc.M.E., and it was believed well to formulate plans at some future date with the idea of establishing some fixed methods of procedure in the matter of coal conservation.

A letter was read from the American Uniform Boiler Law Society urging the Local Section to take steps toward securing a boiler law for the state of Alabama, and the following were appointed to investigate the advisability of having a law passed in Alabama adapting a uniform boiler code: F. G. Cutler, Chairman, H. C. Ryding and C. B. Davis.

A short talk on the Handling of the Sick and Wounded in

Actual Warfare was given by H. B. Hess, United States Medical Corps.

A talk on The Use of Graphite as a Boiler Scale Preventative was given by Samuel Stewart, Mem.Am.Soc.M.E., who related experiences at the Thomas Plant of the Republic Iron and Steel Company. Mr. Stewart brought out that after using graphite as a boiler solution, he found quite a saving of coal was accomplished, even though an increased load was put on the plant; it was absolutely necessary that the graphite be kept in suspension and the way this was accomplished was to insert an air pipe in the bottom of the tank containing the water with graphite in the solution. The graphite was kept in suspension by pumping air into this pipe, the air coming either from blowing engines or compressors. Amorphous graphite was much more satisfactory than flake graphite, and cost between 7 and 8 cents a pound; using about 0.005 lb. per horsepower per day, the entire cost of cleaning 9,000 hp. in boilers was about $14.00 per day. The best place to treat boiler feedwater was outside to keep scale from forming, but practically all boiler feedwater constituted a separate problem in itself and what was found to be good in one case would not do in another. The secret of the success of graphite was to keep it in suspension, the idea being that the small particles of graphite would combine with the small particles of scale and make them easy to remove. Graphite could not be expected to be of any benefit if the water contained acids.

At the conclusion of the meeting C. B. Davis, K. Lanrebe, Paul Wright and O. C. Thurlow were appointed a Committee to prepare a program on the conservation of fuel, in coöperation with the Alabama Technical Society.

W. L. Roueche,
Section Secretary.

BOSTON

January 22. An informal reception was tendered to the President of the Society, Mr. Charles T. Main, at the Engineers' club. Among the several addresses given was one by Mr. Balch of the Boston *Transcript* on Europe after the War. A full account of this meeting will be given later.

W. G. Starkweather,
Section Secretary.

BUFFALO

December 12. At the General Meeting of the Engineering Society of Buffalo, W. Fostergen, Manager of the Independent Bureau of Philadelphia, gave an address on Industrial Housing in which he described the work being done by large corporations in this country in furnishing proper housing for employees. Special stress was laid on the point that it is more advisable to make homes sanitary and agreeable than it is to go into great detail regarding conveniences.

December 19. Mr. H. O. Hem. Mem.Am.Soc.M.E., gave a paper before the society on The Evolution of the Scale, in which he brought out the advancement in technical development of the modern scale as compared with the crude methods of early scale manufacturers.

January 9. At the fourth general society meeting L. C. Lowenstein, Mem.Am.Soc.M.E., gave a paper on The Widening Field of the Steam Turbine as a Prime Mover, in which he called attention to the advancement made in steam-turbine work and its widening application, not only as a prime mover for generators, but also for marine propulsion and centrifugal compressors such as blast-furnace blowers.

Other meetings of the societies affiliated with the Engineering Society of Buffalo held during the month included the following:

January 16. The American Electrochemical Society Section held a meeting at which a paper on Electric Steel Castings was presented by Mr. R. F. Flintermann of the Michigan Steel Castings Company, of Detroit.

January 23. At a special meeting of the National Founders' Association moving pictures illustrating modern foundry practice were exhibited. They emphasized the rapid strides made by the more modern foundries throughout the country in the use of molding machines and other labor-saving devices.

January 30. A meeting of the American Chemical Society was held.

F. B. Hubbard,
Section Secretary.

CONNECTICUT SECTION

Meriden Branch

December 21. Chairman C. K. Decherd presented a detailed report of the Annual Meeting of the Society, in which he stated that the work of the Engineer in the War was the keynote of the entire meeting. Introducing the subject of the evening, research work, he said that research may be an endeavor to find something new for the benefit of the world, or information now lacking which is needed, or it may be an effort to make things we now have more efficient and resultant in greater good for all.

Ten-minute papers were then read by J. L. Hutchinson and Charles N. Flagg, pointing out the need for accurate data in engineering organizations and declaring that much of the data now available is either obsolete or inaccurate. In Mr. Hutchinson's paper he stated that the subjects selected for his talk were common ones and universally used. It very often is the case that data available have been worked out to prove some specific problem but when an endeavor is made to use these data on a different problem variables are found which make them practically valueless until they have been supplemented with more details.

Mr. Flagg stated that the work of the heating engineer has never been, and probably never will be, reduced to an exact science. The general practice has been to acquire as much data as possible from whatever source it may be obtained, absorb as much theory as possible, and then when a problem presents itself the task has been to fit the theory to the job, modifying it by the actual experience of the designer.

Charles N. Flagg,
Section Secretary.

DETROIT

January 25. At a joint meeting of the Section with the Detroit Engineering Society a three-part paper on the Complete Description and Test of a Modern Lake Steamer was presented. The topics included: Part I, Description of the Hull, by H. W. Miller; Part II, Description of the Machinery, by Geo. B. Turnbull, Assoc-Mem.Am.Soc.M.E., and Part III, Tests, by A. G. Mattison, Mem.Am.Soc.M.E.

S. J. Hoexter,
Section Secretary.

ERIE

December 14. At a meeting held jointly with the Engineers' Society of Northwestern Pennsylvania and the Erie Board of Commerce, a large and enthusiastic audience representing the various organizations listened with interest to an address made by Prof. Dexter S. Kimball, Mem.Am.Soc.M.E., on Industrial Management.

M. W. Sherwood,
Section Vice-Chairman.

INDIANAPOLIS

January 25. In accordance with a precedent started last year the Section held a joint meeting with the Indiana Engineering Society and the local section of the A. I. E. E. on the occasion of the annual meeting of the former society. Each organization furnished a well-known speaker, Mr. A. S. Harrell representing the A.S.M.E. Section. A detailed report of the meeting will be published in a later issue.

L. W. Wallace,
For the Secretary.

MINNESOTA

December 7. At the joint meeting of the Section with the A. I. E. E., and several other technical societies, L. D. Wildman of the Central Department, U. S. Signal Corps, delivered a lecture on the subject of War Time Work of the U. S. Signal Corps in Aviation and Electrical Communication. A most interesting account of the various branches of the service was given, including considerable detail with regard to the equipment, training and practice pertaining to each branch.

E. A. Wilhelm,
Section Secretary.

NEW YORK

January 8. The chairman of the meeting called attention to the loss of three members of the Executive Committee of the New York Section due to their participation in war activities. After discussion the following motion was unanimously adopted:

> Resolved: That the two remaining members of the New York Section Committee be instructed to appoint three members to fill the vacancies in that committee for the unexpired terms of the resigned members, such appointments to be subject to the approval of the general Sections Committee and the Council of the Society.

The Committee on Local Sections were the guests of the evening, with the following members of the committee present: D. Robert Yarnall, chairman; L. C. Marburg, Walter Rautenstrauch, H. B. Sargent. Mr. Yarnall outlined the ambitions of the committee with regard to the development of the Section activities, after which Professor Rautenstrauch presented an excellent paper on The Relation of Manufacturing to Banking and Research. Professor Rautenstrauch described the development of these relations as advanced by the Industrial Service Department of the National City Bank of New York, and the members present were much impressed by the potential growth of this relation between the engineers and banks of the country. Mr. E. A. Baker of the National City Bank was present and discussed the paper, as did Messrs. H. B. Sargent, George K. Parsons, W. H. Greul, and others.

Previous to the meeting a buffet supper was served which was thoroughly enjoyed by those who attended. The opinion was generally expressed that if the majority of members in the New York Section were cognizant of the opportunities these pre-meeting dinners afforded for acquaintanceship they would be very generally attended. Members not particularly interested in the paper of the evening would find it profitable to be present at the dinner. In future those who attend the meetings will be asked to register and records will be kept so that at the end of the year those who have participated in the meetings will be known.

The Executive Committee of the Section wishes to extend a cordial invitation to all members to attend its meetings whenever in the city. The committee is especially desirous of having out-of-town members participate in the "get-acquainted" supper held in the Engineering Societies Building at six o'clock on the meeting night. Meetings in New York are usually held on the second Tuesday. An exception to this rule will be made in February, owing to Lincoln's Birthday.

W. Herman Greul,
Section Secretary.

PHILADELPHIA

January 22. Prof. William L. Cathcart, Mem.Am.Soc.M.E., and retired from the U. S. Navy, gave an illustrated lecture on The War on Land and Sea. Through the courtesy of the British Pictorial Service, Professor Cathcart showed thirty official views of the recent fighting in Flanders and other places on the front.

On the invitation of the Section, members of the Illuminating Engineering Society attended the meeting.

John P. Mudd,
Section Secretary.

PROVIDENCE

January 15. The Development of the Submarine was the title of the paper presented by Albert Cook Church, one of the best-informed men on this subject in the country. Mr. Church is a consulting engineer and has done work for all the allied governments during the present war and his knowledge both of their types and of German types is very extensive. The lecture was illustrated by a number of slides showing the capture, salving and repair of the German mine-laying submarine UC-5; the developments of the submarine from the earlier types to the present-day super-submarines of enormous tonnage, including plans, interiors with all the maze of intricate machinery, and torpedoes, showing their actual use in warfare; and the attack and sinking of steamers, battleships and submarines. The mechanical principles involved in the design and operation were carefully explained in detail.

In addition to this general meeting several Section meetings were held during January, which included:

January 8. The Machine Shop Section meeting, at which a paper on Gages and Their Use in Quantity Production of Rifles and Munitions was given by T. Frederick McClosky.

January 9. Under the auspices of the Power Section, Mr. Frederick B. Kenney, of the Blackstone Valley Gas & Electric Company, gave a paper on Central Station vs. Isolated Plant.

January 11. The Efficiency Section held a meeting at which a paper on Some Aspects of Scientific Management was given by Albert E. Thornley, of the Narragansett Machine Company.

James A. Hall,
Correspondent.

ST. LOUIS

November 23. A report of the new Research Committee of the Section was read by Mr. Liebee, emphasizing the fact that efforts were being made to interest the manufacturers of St. Louis in the work of this committee. The speaker of the evening was Prof. C. S. Boucher, of Washington University, whose timely address on American, English and French Relations, Past and Present, was of great interest to those present. The meeting was held at the new Statler Hotel, and permission was granted by the management to those present to make an inspection of the mechanical equipment of the hotel.

December 19. At the joint meeting of the Section with the Associated Engineering Societies of St. Louis, George B. Evans, Mem.Am.Soc.M.E., presented an interesting paper on Power-Plant Installation by By-Product Coke-Oven Plants, in which he referred particularly to the power plant recently constructed in connection with the by-product coke-oven installation of the Laclede Gas Light Company at Carondelet, St. Louis. While this plant is of comparatively small size it has been laid out and constructed with all of the care and regard for best engineering practice in connection with the construction of a modern central station plant.

Opportunity was taken at this time of bringing before the Associated Engineering Societies and the Engineers' Club the matter of establishing a research laboratory in the district of St. Louis. Mr. H. R. Setz, Chairman of the Research Committee, solicited the support of all the engineering societies in the St. Louis district.

January 16. A joint meeting of the Section with the Associated Engineering Societies of St. Louis was held at the Engineers' Club under the auspices of the A.S.M.E. Section. Mr. Paul Diserens, Mem.Am.Soc.M.E., presented a paper on The Recovery of Gasoline from Casing-Head and Natural Gas.

R. L. Radcliffe,
Section Chairman.

Student Branch Meetings

POLYTECHNIC INSTITUTE OF BROOKLYN

December 1. Mr. Wunch and Mr. Fialkoff were elected at this meeting of the Branch, to serve on *The Engineer* board as representatives of the Mechanical Engineering Society. Means were discussed for increasing the attendance at the meetings, as the war has caused the loss of many members active in the affairs of the Branch, including Prof. Wm. D. Ennis. After the regular business a paper was presented by Mr. McAustin on Lubrication. Mr. McAustin told of the many problems which had to be solved in this field, especially that of the aeroplane motor. The speaker said that the lack of the proper lubrication hinders the progress of the advancement of this type of motor.

The Polytechnic Institute of Brooklyn has been very active in its coöperation with the Government in the war. Patriotic committees have been organized on smokes, correspondence, comforts, speakers, etc., whose various duties are to supply the Polytechnic men in service with comforts and keep them in touch with the Polytechnic affairs. A company of students has been organized by Professor Chittenden, and has been mustered in the 23rd Regiment; it drills at the armory every Friday.

Besides the patriotic topics given by prominent speakers at the chapel service, courses are being given at the Institute relating to military work, and which include military surveying and naval architecture. By hard and conscientious study, Polytechnic Institute is doing its bit in preparing for the huge rebuilding after the war.

Nathan N. Wolpert,
Branch Secretary.

PURDUE UNIVERSITY

November 20. Good Carburation was the paper presented at this meeting of the Branch, by Prof. O. C. Berry, of the Gas Engineering Department. Professor Berry discussed very clearly the vital principles that are necessary for good carburation, and backed each statement by actual results taken from tests, which had been tried out in the university laboratory. Many different kinds and types of carburetors, taken from an engineering standpoint, were explained and their good and bad features discussed. The different adjustments of the different carburetors were also explained and discussed and the inability of each to meet the ideal requirements. Professor Berry outlined the requirements for an ideal carburetor and the conditions they should be designed to meet under average service.

A talk was given at the December 4 meeting on the Manufacture of Munitions and Aeroplane Parts by O. W. Kastens, a senior in the School of Mechanical Engineering, on his past summer experiences. The different methods in the manufacture of munitions, and especially the methods used in making the detonators, were described very clearly, so far as the speaker was at liberty to do so. Because of the nature of the subject only very general ideas and methods could be openly discussed. The standardization and interchangeability of aeroplane parts was discussed very clearly, and a very good idea was given on what is being done towards helping the Allies with the construction of aeroplanes.

Purdue University has been very active in its coöperation with the Government in the present crisis. Approximately out of the two thousand students in the university last year, only sixteen hundred have returned this year, and many are leaving daily for service in different sections of the army and navy. Many have attended the different training camps and received commissions, while others are enlisting in the signal corps, the artillery and especially in the aviation section. About thirty professors have gone either directly into the army, into the training camps or have enlisted in the ordnance department. Purdue has shown her mettle also by raising $10,000, which was her assessed share of the Y. M. C. A. Fund, and $2000 for an ambulance equipment for the Purdue Ambulance Corps; and, in addition, she has passed the required mark of the Y. M. C. A. Fund by nearly $7000. A movement is now under way in which the juniors, and especially the seniors in engineering, may enlist in some form of service and be allowed to complete their studies, and then go directly into army service.

Claude Kegerreis,
Branch Secretary.

RENSSELAER POLYTECHNIC INSTITUTE

November 7. T. H. Thorn gave a lecture on experimental turbines at the fourth meeting of the Branch for the season. Mr. Thorn confined his talk chiefly to an experimental turbine built by the Westinghouse Company. He detailed the construction and arrangement of the turbine, gave the speed and power developed, and described particularly one that failed under test, delineating the causes of the failure as shown by the machine afterwards. The speaker explained the conditions leading up to the break and gave a few interesting facts concerning the result of the explosion.

S. F. Jeter, Mem.Am.Soc.M.E., followed with an instructive talk upon the strength of riveted joints. Mr. Jeter's talk took the form of an analysis of the boiler seam, characteristics generally overlooked, plate thickness, spacing and pitching rivets, and quick, easy methods of determining the important features of a joint from given data. The speaker illustrated the joint by slides, showing charts adaptable for finding all the necessary data concerning a joint when certain dimensions have been given.

The Institute has been very active in its coöperation with the Government at the present great crisis. There is a long list of Rensselaer men in service, many holding commissions in engineering regiments now in France. Out of the classes of 1918, 1919, 1920 and 1921, 102 men have left school to enter the service. Of the non-graduates 83 have entered the service, and 216 of the graduates are on the Roll of Honor. Aside from this total there are 16 men engaged in the civilian part of the war work. This means a grand total of 417 men on the Roll of Honor. There is an optional course of military drilling offered by the school, and the present two companies formed have a record of one hundred and sixty men.

A "smoke" fund has also been created, and this is serving a double purpose. Each man is expected to contribute ten cents or more if he wishes. Six $100 Liberty Bonds of the last issue have been set aside, and as often as the fund permits, one of them is paid for and turned over to the Troy *Record* to be used in their large Smoke Fund. The Library fund which has recently been adopted has been very successful in its purpose of supplying reading matter for the soldiers in camp. As Dr. Wier, of the American Library Association's Committee, said: "The books thus made accessible to the soldiers and sailors have a double purpose—first, they provide wholesome entertainment to the men; and second, they constantly keep before them the high ideals for which they are fighting."

December 20. At the fifth regular meeting of the Branch R. P. Kolb reported his visit to the Conference of Student Branches held at the Annual Meeting.

A paper on the Spiers Falls Power House, covering the layout and size of the plant, and diagram of the wiring, was given by C. A. Jacobson.

Due to the fact that Mr. Morretti was called into government service, G. H. Carragan was elected his successor as Vice-Chairman of the Branch.

R. A. Marriott,
Branch Secretary.

STEVENS INSTITUTE OF TECHNOLOGY

The president of the Stevens Engineering Society having been called into government service, new officers were elected at the opening of college, as follows: Raymond Mileham, president, and Paul Hiller, vice-president.

A petition was submitted by the Seniors to the Trustees of the College asking permission to eliminate holiday periods and do extra period work in order to finish the college course. The petition was granted and the Senior Class will receive regular college degrees, but will graduate earlier.

December 13. The second meeting was called for the purpose of electing a successor to G. Crosby Hiss, treasurer, who had enlisted in the U. S. Naval Reserve. Mr. Lincoln B. Aquadro was elected to carry on his work.

January 14. Mr. Paul Hiller gave a talk on the new steam automobile shown at the recent Automobile Show, and R. Mileham spoke on Automobile Differentials.

The Inspection Trip Committee reported difficulty in arranging for the regular Wednesday afternoon inspection trips to plants of interest in New Jersey due to the order of the Fuel Administrator closing the plants on that day. A trip to New York later in the year was suggested.

A committee of three was appointed to prepare a new Constitution.

Lincoln V. Aquadro,
Branch Secretary.

THROOP COLLEGE OF TECHNOLOGY

The following officers were elected to carry on the Branch work: Ralph T. Taylor, chairman, Clarence N. Ward, vice-chairman, and Retla Alter, secretary-treasurer.

The College has lost many of its faculty members and professors due to the war, and now has seven representatives on the Council of National Defense, three of whom are faculty members and four are trustees.

In the Mechanical Engineering Department most of the upperclassmen have enlisted and the majority are now lieutenants. To stop this depletion in numbers of the upper classes and to help the Government in every way possible, it was decided to graduate the Senior class on April 6 and the Junior class on September 15. The course for the Juniors will therefore be shortened, but they will be required to work through the entire summer. A course in shipbuilding similar to the one given at Lehigh University will be a required subject for the Juniors and Seniors. In this way it is hoped that a number of students after graduating will enter the shipyards to help in the construction of ships. Others will receive commissions in various branches of the service.

Throop has had compulsory military training since September 1916 under the direct supervision of a captain in the Army (always a West Point graduate) detailed by the Government and the students are consequently now fully qualified for active service.

Retla Alter,
Branch Secretary.

EIGHTH ROLL OF HONOR

ONE HUNDRED AND TWENTY-ONE additional names of members of The American Society of Mechanical Engineers who are now in the Service. This eighth list brings the total number of stars on the service flag to over 700.

ALLEN, THOMAS H., Captain, 306th Engineers, Camp Jackson, Columbia, S. C.

ANDERSON, ARRID R., Corporal, Battery F, 324th Regiment, Field Artillery, Camp Sherman, Ohio.

ASHMUN, LOUIS H., First Lieutenant Engineers, War Department, Trench Warfare Branch, United States Reserve.

BACON, JOHN LORD, Captain, Engineer Officers' Reserve Corps.

BARNUM, CHARLES L., Lieutenant, United States Naval Reserve Force.

BARRON, CHARLES R., Second Lieutenant, Officers' Reserve Corps.

BATTEN, LORING W., JR., Ensign, United States Naval Reserve Force, U. S. S. *Wyoming*.

BAYLR, GEORGE H., First Lieutenant, Ordnance Reserve Corps.

BERLINER, RICHARD W., Captain, 306th Engineers, United States Reserve.

BIXBY, WINFRED H., First Regiment Illinois Engineers, National Guard.

BLISS, EDWIN C., Lieutenant, United States Naval Reserve Force.

BOLGIANO, J. R., Second Lieutenant, Officers' Reserve Corps, Production Section, Carriage Division, Ordnance Department.

BRADY, LABAN J., Second Lieutenant, Company C, 5th U. S. Regular Engineers, Camp Skurry, Corpus Christi, Tex.

BROWN, JOHN WILSON, JR., Major Engineers, United States Reserve, Camp Lee, Petersburg, Va.

BUCKINGHAM, EARLE, Captain, Ordnance Department, Inspection Section, Gun Division, United States Reserve.

BURLING, HERBERT S., Second Lieutenant, Field Artillery, Officers' Reserve Corps.

BURROUGHS, J. H., Captain, Coast Artillery Reserve Corps, Acting Quartermaster, Coast Defenses of the Delaware.

CARSON, C. B., First Lieutenant, Officers' Reserve Corps, Carriage Division, Production Section.

CHEW, JOHN J., Ensign, United States Naval Reserve Force, Bureau of Ordnance, Navy Department, Washington, D. C.

COLE, CYRUS L., Captain, Ordnance Section, Officers' Reserve Corps.

COLVIN, JAMES A., Company E, 313th Engineers, Camp Dodge, Iowa.

COOPER, HOWARD, Signal Corps, Equipment Division, Specification Section.

CRANE, E. C., Second Lieutenant, Engineer Officers' Reserve Corps.

DICKEY, RALPH L., Lieutenant, Ordnance Department, Washington, D. C.

DIEMER, HUGO, Major, Ordnance, United States Reserve.

DODGE, ALBERT, Captain, 316th Infantry, Commanding Company J, United States Army.

DODGE, PARKER V. P., First Lieutenant, Ordnance Department, Washington, D. C.

EBEN, LEON A., Lieutenant, United States Army.

EDWARDS, H. H., Chief Machinist's Mate, Third Naval District, United States Naval Reserve Force.

FARNHAM, G. W., Second Lieutenant, Officers' Reserve Corps, United States Army, Fort Totten, L. I.

FOSTER, CHARLES C., 302nd Engineers, Company C, Camp Upton, L. I.

GFROERER, HERBERT, Second Lieutenant, Ordnance Department, Machine Gun Section, Carriage Division.

GILLAM, W. H., JR., First Lieutenant, Ordnance Department, Supply Division, United States Reserve.

GOING, CHARLES BUXTON, Major, Ordnance Officers' Reserve Corps, United States Army.

GUTHRIE, JAMES, Major, Ordnance Department, United States Reserve.

HAHN, CONRAD V., First Lieutenant, Division of American Ordnance Base Depot, France.

HALL, KEPPELE, Captain, Ordnance Department.

HALL, WINTHROP G., United States Army, Camp Devens, Mass.

HANDS, RONALD C., First Lieutenant, Ordnance Reserve Corps.

HART, HOWARD P., Ensign, United States Navy.

HAYS, JOHN C., Major Quartermaster's Department, United States Reserve.

HEILEMAN, FRANK A., First Lieutenant, Machine Gun Company, 54th Infantry.

HENDRICK, WALLACE M., First Lieutenant, 301st Engineers, United States Reserve.

HIBBARD, L. J., Lieutenant, 11th Regiment Engineers, France.

HODOUS, LOUIS W., Private, First Class, Section 542, United States Ambulance Service.

INGHAM, HOWARD M., Lieutenant (Junior Grade), United States Naval Reserve Force, Class 4.

JACKSON, J. H., Second Lieutenant, Ordnance Reserve Corps.

JACKSON, JOHN R., Captain, Ordnance Department, American Ordnance Depot in France, United States Reserve.

JACKSON, LUCIAN C., American Expeditionary Forces, France.

JACOBS, HENRY L., Camp Lee, Petersburg, Va.

KALEY, GEORGE B., First Lieutenant, Ordnance Reserve Corps.

KENT, ROBERT W., First Lieutenant, Officers' Reserve Corps, United States Army.

KINGSLEY, F., First Lieutenant, Officers' Reserve Corps.

KUGEL, H. K., First Lieutenant, Engineers' Reserve Corps, Company E, 310th Engineers, Camp Custer, Mich.

LANCASTER, W. C., Engineer Officers' Reserve Corps.

LAWRENCE, S. E., Captain, Engineer Officers' Reserve Corps.

LEWIS, F. H., Major, Ordnance Department, United States Army.

LIBBY, WILLIAM L., Lieutenant, Production Section, Gun Division, Ordnance Department, Washington, D. C.

LYNN, E. H., Captain, Coast Artillery Corps, United States Army.

LYNN, THOMAS H., Captain, Company H, Pennsylvania Reserve Militia Infantry.

MCCLELLAND, C. C., Company E, 306th Engineers, Camp Jackson, Columbia, S. C.

MCELROY, J. W., Captain, Ordnance Reserve Corps.

MCGRATH, F. P., First Pennsylvania Ambulance Company, 28th Division, Camp Hancock, Ga.

MCINTOSH, R. L., Captain, Ordnance Department, Officers' Reserve Corps.

MACLEAN, M. R., First Lieutenant, 9th Co. Infantry, Officers' Reserve Corps, Fort Niagara, N. Y.

MACLEOD, NORMAN M., First Lieutenant, Company S, United States Reserve, Camp Lee, Petersburg, Va.

MAIN, C. CURTISS, Signal Corps, United States Army.

MARSH, FRANCIS GRANT, Lieutenant, United States Navy.

MASON, EARL P., Lieutenant, United States Naval Reserve Force, Newport, R. I.

MATHER, HAROLD T., First Lieutenant, Coast Artillery Corps, Officers' Reserve Corps, Ft. Monroe, Va.

MAYNZ, T., Aviation Section, Signal Officers' Reserve Corps.

MEIXNER, B. A., First Lieutenant, Ordnance Reserve Corps.

METZ, W. R., Captain, Quartermaster Corps, United States Reserve, Fort Sam Houston, Tex.

MIDDLETON, HARVEY, Camp Funston, Kan.

MILLER, ERNEST P., JR., First Lieutenant, Ordnance Department, Officers' Reserve Corps.

MOON, H. A., Major, Rainbow Division, United States Army.

NIEMEYER, J. C. W., Captain, Quartermaster Reserve Corps, United States Army.

NORRIS, A. M., Ensign, U. S. S. *Missouri*.

PEASE, MAXFIELD, Machinist's Mate, First Class, United States Naval Reserve Force.

PHELPS, CLEON E., Second Lieutenant, Ordnance Department, United States Reserve.

PIRIE, H. L., Captain, Ordnance Department, British Expeditionary Forces, France.

POPE, HAROLD F., Captain, Quartermaster Officers' Reserve Corps.

POUND, JOSEPH H., Ordnance Department, 90th Division.

QUICK, RAY L., United States Naval Reserve Force.

RAYMOND, THOMAS E., First Lieutenant, Ordnance Department, Washington, D. C.

RIGGS, GEORGE, Sergeant, Company K, 107th Infantry.

ROGERS, JOHN I., Lieutenant (Senior Grade), United States Naval Reserve Force.

ROSS, HENRY B., First Lieutenant, Company F, 104th United States Engineers, United States Reserve.

RUBIN, HARRY E., First Lieutenant, Ordnance Reserve Corps, Machine Gun Section, Ordnance Department, Wilbur Wright Field, Fairfield, Ohio.

RUSSELL, FOSTER, First Class Private, Aviation Section, Signal Officers' Reserve Corps.

RYERSON, WILLIAM H., Captain, Class B, Engineer Officers' Reserve Corps.

SCHULTZ, WILLIAM W., Second Lieutenant, New Jersey Engineers.

SCRUGHAM, J. G., Major, Ordnance Reserve Corps, Production Section, Carriage Division, Ordnance Department.

SEARLE, DANA A., Ordnance Sergeant, Ordnance Corps, United States Army.

Sheldon, James Rhodes, Jr., First Lieutenant, 28th Company, Coast Artillery Reserve Corps, Ft. H. G. Wright, N. Y.
Shrady, C. D., Troop A, Squadron A, New York Guard.
Sibley, Mark Miller, Lieutenant (Junior Grade), United States Naval Reserve Force.
Smith, Charles W., Second Lieutenant, Signal Officers' Reserve Corps, American Expeditionary Forces, France.
Smith, Frederick C., Second Lieutenant, U. S. Reserve.
Smith, Thomas W., First Lieutenant, Engineer Officers' Reserve Corps, General Engineer Depot, Washington, D. C.
Snyder, William R., First Lieutenant, Ordnance Reserve Corps, United States Army.
Stone, M. A., Jr., Captain, Ordnance Officers' Reserve Corps.
Stovel, R., Major, American Expeditionary Forces, France.
Strahlmann, Otto E., First Lieutenant, Aviation Section, Signal Corps.
Staing, Joseph S., Captain, Ordnance Department, Gun Division, Production Section.

Taylor, Cyrus J., Chief Machinist's Mate, United States Naval Reserve Force.
Thomas, Charles W., Lieutenant (Senior Grade), United States Naval Reserve Force.
Thomas, John M., Lieutenant, Officers' Reserve Corps, Ft. Sill, Okla.
Thompson, Sanford E., Major, Officers' Reserve Corps, Office of Chief of Ordnance.
Tour, Reuben S., First Lieutenant, Ordnance Officers' Reserve Corps, Nitrate Division, Ordnance Department, Washington, D. C.
Tupper, Frederick G., Lieutenant (Junior Grade), United States Naval Reserve Force.

Van Syckel, F. T., Signal Corps, United States Reserve.
Voy, Edward L., Depot Battalion, 7th Regiment.

Werst, C. W., Lieutenant-Colonel, Russian Railway Service Corps.
Wieland, Charles F., Captain, Officers' Reserve Corps, United States Army, Manila Ordnance Depot, Manila, P. I.
Wing, Chester E., Ensign, United States Naval Reserve Force.
Woods, G. H., Captain, Quartermaster Corps, United States Army.
Woodward, H. W., Second Lieutenant, 106th Engineers, United States Reserve.
Wright, D. B., Second Lieutenant, 1st Division Staff, Engineer Officers' Reserve Corps, American Expeditionary Forces, France.
Wright, Paul D., First Lieutenant, Ordnance Department, Officers' Reserve Corps.

PERSONALS

In these columns are inserted items concerning members of the Society and their professional activities. Members are always interested in the doings of their fellow-members, and the Society welcomes notes from members and concerning members for insertion in this section. All communications of personal notes should be addressed to the Secretary, and items should be received by February 17 in order to appear in the March issue.

CHANGES OF POSITION

A. R. Carlyle, who for the past ten years has been designing marine engineer for the Union Oil Company, of California, has terminated his relations with the company and has recently been made surveyor for the American Bureau of Shipping, American Lloyds, District of Southern Cal., Los Angeles, Cal.

Carl T. Hewitt, formerly connected with the Remington Arms Union Metallic Cartridge Company, Inc., Bridgeport, Conn., has accepted the position of metallurgist and testing engineer with the Fafnir Bearing Company, of New Britain, Conn.

George S. Blankenhorn, formerly connected with the Allis-Chalmers Manufacturing Company, of Milwaukee, Wis., as engineer in the department of the chief consulting engineer, has accepted a position with the American International Shipbuilding Corporation, of Philadelphia, Pa., in the department of machinery fabrication.

E. P. Worden has resigned his position of chief engineer for Henry R. Worthington to accept the position of mechanical engineer for the Submarine Boat Corporation, New York.

Alfred L. Aicher, chief draftsman with the F. J. Stokes Machine Company, Philadelphia, Pa., has accepted a position with the Southwark Foundry and Machine Company of the same city.

James Brakes, Jr., formerly in the employ of the Kimberly-Clark Company, Neenah, Wis., as testing engineer, has accepted the position of inspector in the power department of the Western Electric Company, Hawthorne plant, Ill.

Walter H. Rastall has become assistant sales manager for The Bauer Brothers Company, Springfield, Ohio. He was formerly affiliated with the Worthington Pump and Machinery Corporation, Cincinnati, Ohio, as engineer.

Edwin A. Moore has terminated his relations with the Union Switch and Signal Company, Swissvale, Pa., as works manager, and has assumed the duties of manager of the Liberty Ordnance Company, Bridgeport, Conn.

Henry Lindenkohl, until recently engineer of construction, American Locomotive Company, Schenectady, N. Y., has been appointed engineer of construction of the Worthington Pump and Machinery Corporation, with headquarters in New York. He will have charge of the design and construction of new shops and of additions to present shops.

Frederick J. Hardman, assistant examiner, U. S. Patent Office, Washington, D. C., has become associated with the patent department of the Dayton Engineering Laboratories Company, Dayton, Ohio.

B. D. Thompson, formerly superintendent of the L. O. Gordon Manufacturing Company, of Muskegon, Mich., has resigned and taken charge of the engineering and sales department of the Charles A. Strelinger Company, Detroit, Mich.

John K. Reckendorfer, formerly assistant secretary of the American Lead Pencil Company, New York, has become associated with the Naval Aircraft Factory, Navy Yard, Philadelphia, Pa., in the capacity of assistant to manager.

Francis L. Gilman has severed his connection with the Western Electric Company, New York, as assistant chief engineer, to take charge of the manufacturing departments of the National Conduit and Cable Company, Hastings-on-the-Hudson, N. Y.

F. J. Bryant, formerly affiliated with the Huber Hand Stoker Company, Passaic, N. J., in the capacity of New Jersey manager, has become partner in the firm of the Perfection Toy Craft Company, of West Brookfield, Mass.

Ralph Earl, until recently with the Pittsburgh Filter Manufacturing Company, Pittsburgh, Pa., has become associated with Morris Knowles, Inc., of the same city.

John D. Rogers has left the employ of the Virginia Railway Company, Princeton, West Va., to accept service in Russia.

George Endicott, for two and a half years mechanical engineer at The Morgan Spring Company, Worcester, Mass., has resigned to accept a position in the sales department of the Wickwire Steel Company, of Buffalo, N. Y. He will take up his new duties January 1, and will make his headquarters in Buffalo, N. Y.

K. T. Keller, until recently master mechanic with the Cole Motor Car Company, Indianapolis, Ind., has become affiliated with the Buick Motor Company, of Flint, Mich.

L. H. Thullen, formerly in the employ of the Hall Switch and Signal Company, New York, has assumed the duties of general manager of the Grand Rapids Brass Company, Grand Rapids, Mich.

ALLEN C. STALEY has severed his connection with the General Engineering Company, of Detroit, Mich., where he held the position of experimental engineer in charge of development work on the Doble steam car, and has become associated with the Stanley Motor Carriage Company, Newton, Mass., as research engineer in the same line of work.

ANNOUNCEMENTS

PARKER H. KEMBLE has entered the Sea Service Bureau at the National headquarters of Henry Howard, director of recruiting for the United States Shipping Board at the Boston Customhouse, for the duration of the war.

GEORGE E. CROFOOT has been promoted from instructor to assistant professor of mechanical engineering in the Towne Scientific School of the University of Pennsylvania, Philadelphia, Pa.

JOHN H. DEVISSER, of Detroit, Mich., has taken up his duties as Captain in the Ordnance Department and is at present stationed at the Frankford Arsenal, Philadelphia, Pa.

CLAYTON R. BURT, assistant general manager of the Russell Motor Car Company, Ltd., Toronto, Canada, has accepted a position as general manager of the same company, at Buffalo, N. Y., where a large new factory for the manufacturing of munitions for the U. S. Navy Department is being established by the company.

MONROE R. HULL, mechanical engineer for the Sissert Mining District Company, of London and Petrograd, has recently returned from Russia and will spend several months in the United States in the interests of the Sissert Company.

FREDERICK POPE, of Moses, Pope and Messer, Inc., consulting engineers, New York, has been commissioned a Captain in the 30th Engineers, which is the Gas and Flame Division.

C. P. COLEMAN, vice-president of the Worthington Pump and Machinery Corporation, has recently been elected president of the corporation.

CHANNING TURNER has received a commission as First Lieutenant, Field Artillery, Officers Reserve Corps, and has been ordered on active duty.

L. RICHARD DRESSLER has received a commission as First Lieutenant in the Ordnance Department, Carriage Division, Officers' Reserve Corps.

L. H. BERGMAN, formerly fuel engineer for the Nicetown Plant of the Midvale Steel and Ordnance Co., has gone into consulting practice under the name of American Industrial Engineering Co., with offices in the Monadnock Building, Chicago.

FRED L. PANCOAST has received a commission as Captain in the Ordnance Department, Officers' Reserve Corps, and has been assigned to active service.

FRANK P. RHAME has been commissioned as First Lieutenant in the Ordnance Officers' Reserve Corps.

CHARLES DAY has now returned from England and will assume active management of the probation department of the Emergency Fleet Corporation.

SANFORD E. THOMPSON, of Thompson and Lichtner, consulting engineers, Boston, Mass., has accepted a commission as major in the Ordnance Department, Officers' Reserve Corps. Mr. William O. Lichtner will carry on the work of the company.

J. G. SCRUGHAM has been commissioned as Major, Ordnance Reserve Corps, and assigned for duty to the Production Section, Carriage Division, Ordnance Department, Washington, D. C.

C. L. HALLADAY, of Jackson, Mich., has become associated with the Auto Industries Committee, of Washington, D. C.

ELMER R. RITTER has entered into active service as a First Lieutenant in the United States Ordnance Reserve.

KEPPELE HALL, of the firm of Thompson and Lichtner, consulting engineers, of Boston, has accepted a commission as Captain in the Ordnance Department and is now located at Washington, D. C.

MAJOR DABNEY H. MAURY, Engineer Officers' Reserve Corps, has closed his office in Chicago for the duration of the war. For some time past he has been in Washington looking after water-supply problems in connection with cantonment construction.

W. E. MOSHER has been appointed by the Secretary of War as assistant superintendent engineer in connection with Marine Refrigeration, Army Transport Service, Quartermaster Corps, U. S. A. Piers, at Hoboken, N. J.

MAJOR-GENERAL GEORGE W. GOETHALS, acting quartermaster general, has been appointed by the Secretary of War to serve also as director of War Department transportation and storage.

NECROLOGY

WILLIAM CHARLES ADAMS

William C. Adams was born in April 1883 in North East, Erie County, Pa. He was educated in the schools there and later attended the State Normal School. He also took a course in the International Correspondence Schools.

He served his apprenticeship as machinist with the Eureka Tempered Copper Works, North East Pa., from 1902 to 1903. He then located with the Brooks Locomotive Works, Dunkirk, N. Y., as machinist. In 1904 he became associated with the Bantam Anti-Friction Co., Bantam, Conn., as draftsman, and a little later worked in the same capacity for the Coe Brass Manufacturing Co., Torrington, Conn. In 1905 he returned to the Bantam Company as superintendent. In 1908 he took charge of the sewer works of the city of Torrington.

From 1909 until 1914 Mr. Adams was employed by the Chase Rolling Mill Co. and the Chase Metal Works Co., Waterbury, Con., as draftsman and engineer, and designed, constructed and maintained their hydraulic extrusion and rolling-mill machinery. Until the completion of the new plant of the Chase Metal Works Co. Mr. Adams had charge of the machine shop, drafting room, pattern shops and hydraulic plant of the Chase Rolling Mill Co. He took charge of the same departments in the new plant.

About March 1915 Mr. Adams became associated with the Kings Norton Metal Co., Ltd., Kings Norton, Birmingham, England, as works manager. He designed and superintended the erection of buildings and plant for the extrusion of non-ferrous metals in bars and sections. As a single unit the plant is regarded by experts as the largest and finest in the British Isles.

Mr. Adams was a member of the Birmingham Association of Mechanical Engineers, the Institute of Metals, London, and was honorary treasurer of the Birmingham Metallurgical Society. He became a member of the Society in 1914. He died on July 13, 1917.

ADOLPH THEODORE BRUEGEL

A. Theodore Bruegel, secretary of the Hess-Bright Manufacturing Co., Philadelphia, died at his home in Melrose Park on November 7, 1917. Mr. Bruegel was born on January 11, 1866, in Canton, O. He was educated in the St. Louis Manual Training School and later attended Lehigh University, being graduated in 1888 with the degree of M.E. He took a post-graduate course in Cornell University and received his M.M.E. degree in 1896.

During the summers of 1883 to 1885 he worked as machinist for the Missouri Malleable Iron Works and the Lehigh Valley Railroad Co. He obtained his drafting-room experience with the Johnson Steel Co., Johnstown, Pa. From 1888 to 1892 he acted as instructor in mechanical drawing and descriptive geometry in Cogswell Polytechnic College, San Francisco. For the next five years or so he was connected with Sibley College, Cornell University, as instructor in machine design. Later he took charge of the teaching of kinematics of machinery and also junior drawing.

In 1898 Mr. Bruegel became an instructor in mechanical engineering in Pratt Institute, Brooklyn, giving his attention principally to the steam and machine-design courses. For the last ten years he was associated with the Hess-Bright Manufacturing Co., Philadelphia.

He was a member of the Engineers' Club of Philadelphia, the Society for the Promotion of Engineering Education, the American Association for the Advancement of Science, the National Geographic Society, and the Philadelphia Chamber of Commerce. He became a member of the Society in 1900.

JOSEPH PHINEAS DAVIS

Joseph P. Davis was born on April 15, 1837, at Northboro, Mass. He was graduated from Rensselaer Polytechnic Institute in 1856 with the degree of C.E. Until 1861 he acted as assistant engineer on the construction of the Brooklyn Water Works. He then went to Peru, S. A., where he remained for four years in the employ of the government as topographical engineer. Upon his return he was made commissioner of parks in Brooklyn, N. Y.

About 1867 he was appointed chief assistant engineer on the construction of the St. Louis Water Works, later becoming chief engineer on the construction of the Lowell, Mass., Water Works. In 1872 he was appointed chief engineer of the Boston Water Board, and the following year was made city engineer of Boston, which position he held till 1880.

At that time Mr. Davis accepted a position with the American Bell Telephone Co. as chief engineer, holding the same position with its successor, the American Telephone and Telegraph Co., until 1905, when he retired from active business.

Mr. Davis was the consulting engineer of the Croton Aqueduct Commission from 1884 to 1886, of the Massachusetts State Board of Health from 1886 to 1904, of the Metropolitan Sewerage Commission, Mass., in 1898. He was vice-president and general manager of the Metropolitan Telephone Co., New York, from 1880 to 1886, and was president of the Hudson River Telephone Co. from 1889 to 1895, and of the Westchester Telephone Co. from 1890 to 1903.

Mr. Davis was a member of the American Society of Civil Engineers, the American Institute of Electrical Engineers, the

A. T. Bruegel

Institution of Electrical Engineers, England, and the Boston Society of Civil Engineers. He became a member of the Society in 1880. He died on March 31, 1917.

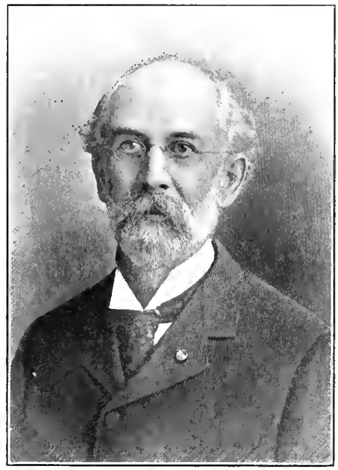
AUGUST A. HONSBERG

August A. Honsberg was born on May 18, 1841, in Boulay, Metz, France. He was educated in France, receiving his technical training in the Institution Carmentrez.

He served an apprenticeship from 1859 to 1861 with Kaut & Westmayer at St. Jean, Saarbrucken, Germany. The next two years he spent at the Ateliers des Chemins de Fer de l'Est, Montigny. He obtained his drafting experience from 1863 to 1865 in the Regimental School of Engineers, leaving there to go to l'Ecole Polytechnique, Metz. In 1866 he became superintendent of machinery at the Arsenal, Genie. He served during the Franco-Prussian War as chief of the engineering detachment, Fifth Army Corps.

About 1872 Mr. Honsberg came to the United States. His first position was with the Kings Bridge Co. Later he was associated with the Keystone Bridge Co. In 1881 he became master mechanic in charge of machinery and buildings of the Cleveland Rolling Mill Co. After ten years' service he resigned to take a position in the Cleveland city engineer's office in the bridge department, leaving this department after another ten years to enter the city water works office, to make plans for a new pumping station, engine and boiler house. For the last six years he was connected with the bridge and map department of the city of Cleveland.

Mr. Honsberg became a life member of the Society in 1901. He



Joseph Morgan, Jr.

was also a member of the Cleveland Engineers' Society. He died on October 21, 1917.

GUY EDWARD MITCHELL

Guy E. Mitchell was born on March 4, 1869, in Lowell, Mass. He attended the public schools of that city and later entered the Massachusetts Institute of Technology, from which he was graduated as a mechanical engineer in 1891.

He was employed for a number of years by the Boston and Maine Railroad and worked up from the position of chief draftsman to that of consulting engineer of that company. After leaving the Boston and Maine Railroad he was located in New York for about three years as consulting engineer. He then served in various important capacities in the building of the Berkshire trolley system. Upon the completion of that work he became associated with the Alden Sampson Co., Pittsfield, builders of large automobile trucks, and acted as general manager for a period of seven years. Later he assisted in the building of the Hampden Railroad.

In December 1914 he was appointed manager of the municipal gas and electric light plant, Westfield, Mass. He held this position at the time of his death.

He became a member of the Society in 1903. He died on October 18, 1917.

JOSEPH MORGAN, JR.

Joseph Morgan, Jr., was born on July 27, 1842, in Philadelphia. He was educated in the Central High School of that city, devoting himself to the sciences. In the fourth year of his course he entered the steam-engineering corps of the United States Navy. In 1861 he entered active service as third assistant engineer. In 1863 he was promoted to second assistant engineer. In 1866,

after the war, he resigned and entered the service of the Phenix Iron Co., Phenixville, Pa., as draftsman. In 1868 he had risen to be chief draftsman, when he resigned to take a similar position with the Edgemoor Iron Co. About 1879 Mr. Morgan became associated with the Cambria Iron Co., Johnstown, Pa., as draftsman. He was made chief engineer in 1881, and after twenty-five years' service in that capacity was relieved of his more active duties and made consulting engineer of the Cambria Steel Co.

Mr. Morgan designed and superintended the various parts of the works of that firm, including six blast furnaces, new bessemer works of the largest class, new blooming mill, open-hearth plant, rail mills and various large mills of the Gautier plant involving the expenditure of millions of dollars. He was the consulting engineer in charge of the building of the Quemahoning Dam in 1913, and later the Saltlick Dam.

In 1881 Mr. Morgan went abroad to make a study of gun and armor forgings. He visited the principal cities of England and the Continent where armor-making works were located. Later he was appointed a member of the United States Fortification Board, and wrote several valuable papers to aid in instructing the public on the subject, as well as for the information of Congress. Mr. Morgan was familiar with the art of steel making from the date of the inception of the bessemer process up to the present time.

Mr. Morgan was a member of the United States Naval Institute and the Grand Army of the Republic and also held many offices in fraternal organizations. He was vice-president of the Society from 1886 to 1888 and was chairman of the Sub-Committee on Iron and Steel for the year 1913-14. He became a life member of the Society in 1881. He died on December 9, 1917.

JOHN RIDDELL

John Riddell, mechanical superintendent of the Schenectady Works of the General Electric Company, died in Schenectady, N. Y., December 31, 1917. He was born in Ireland in 1852 and was conspicuously a self-made man. At the age of about 13 years, in Jersey City, he started as an apprentice in the jobbing machine shop of Nicholas B. Cushing, who made elevators and repaired machinery, especially marine engines. This work brought him in contact with marine circles, which resulted in his later serving two years as second engineer on trading steamers plying between the West Indies and Central America and New York.

His first association with the electrical business was with the Daft Electrical Co. where he did considerable experimental mechanical work in the railway field. In 1887 he entered the employ of the Thomson-Houston Electric Co. at Lynn, Mass. In 1888 he became foreman of the railway motor shop and was recognized as one of the leading mechanical experts at the time the General Electric Co. was formed in 1892.

Mr. Riddell moved to Schenectady in 1895, and shortly after his arrival was appointed mechanical superintendent of the company. In this important position he designed and had built special machine tools for increasing the production of the machine shops and also for carrying on the many special processes involved in the manufacture of mechanical tools. He was consulted in regard to all automatic machinery and his resourceful genius was called in when a solution was sought for different mechanical problems of a baffling nature. The records of the United States Patent Office show that 37 patents were taken out in his name.

In the sense that Mr. Riddell could obtain large outputs from machine shops with a minimum cost, he might well be termed a manufacturing economist. He was responsible for the location of machines and machine tools and his advice and opinion were sought in regard to such manufacturing problems as the routing of the materials from the time the raw materials were received until the finished product was ready for shipment.

Among the notable achievements of Mr. Riddell in the various works of the General Electric Co. is a boring mill—the largest in the world when made—which was built from his design and which has a 60-ft. swing. This was so successful for machining the large wheels for the rotors and stators of water-wheel-driven generators that he designed a 10-ft. boring mill embodying the same principles as the larg one, which is used for turbine work. These mills have operated ight and day for over ten years without the loss of a single hour.

Another one of his desigas was a bucket-cutting machine for large steam turbines which he developed in 1902. It was at this time that the General Electric Co. was building the first 5000-kw. steam turbine ever constructed, and this labor- and time-saving device became an important factor in the development of the steam-turbine industry at the time when the steam engine was preëminent in the largest power plants in the world.

Almost automatic was the field-coil-winding machine which he built and which was adopted both in Lynn and Schenectady. It was a labor saver and a time saver, and in the opinion of many persons there was no single achievement of Mr. Riddell's which advanced the electrical industry more than did this winding machine.

Mr. Riddell was a member of the Engineers' Club of New York and the Society of Engineers of Eastern New York. He became a member of the Society in 1895. During his later years he de-

John Riddell

livered several papers on engineering subjects before various associations.

He was awarded a gold medal at the Panama-Pacific International Exposition at San Francisco in 1915, as collaborator in the Exhibit of the General Electric Co. at the Exposition.

HAROLD VAN DUZEE

Harold Van Duzee was born in West Newton, Mass., on April 4, 1859. He attended the public schools of that city and later entered the engineering department of the Massachusetts Institute of Technology. He spent one year in miscellaneous drafting work for Frederick Tudor & Co. and for the Hinkley Locomotive Works, both of Boston, Mass. For two years he was associated with Col. George E. Waring of Newport, R. I., as draftsman and was his assistant on sewage and drainage work in Memphis, Tenn., where he remained for about a year. The second year of this work he had charge of the sewage disposal of the Bryn Mawr Hotel. His next position was with the Tide Water Oil Co., Bayonne, N. J. At the time of his death Mr. Van Duzee was in private practice in Philadelphia as a civil and sanitary consulting engineer.

Mr. Van Duzee did much to beautify the suburban homes of Philadelphia, working in this connection with the Olmstead Bros. of Brookline, Mass. He also collaborated with Mr. F. W. Taylor in the scientific development of sod for golf grounds.

He became a Junior member of the Society in 1885. He died on May 7, 1917.

WILLIAM FORGUE WAY

William F. Way was born on October 3, 1888, in Johnstown, N. Y. He was graduated from Rensselaer Polytechnic Institute in June 1913 with the degree of mechanical engineer. His shop experience was obtained in Hutton's Machine Shop, Seattle, Wash. Later he became associated with the Talbot Boiler Co., Seattle, as draftsman. He became a Junior member of the Society in 1916. He died on December 18, 1916.

CANDIDATES FOR MEMBERSHIP

TO BE VOTED ON AFTER MARCH 10

BELOW is the list of candidates who have filed applications since the date of the last issue of THE JOURNAL. These are classified according to the grades for which their ages qualify them, and not with regard to professional qualifications, i.e., the ages of those under the first heading place them under either Member, Associate or Associate-Member, those in the next class under Associate or Associate-Member, those in the third class under Associate-Member or Junior, and those in the fourth under Junior grade only. Applications for change of grading are also posted. Total number of new applications, 112.

The Membership Committee, and in turn the Council, urge the members to scrutinize this list with care and advise the Secretary promptly of any objections to the candidates posted. All correspondence in this regard is strictly confidential. Unless objection is made to any of the candidates by March 10, and providing satisfactory replies have been received from the required number of references, they will be balloted upon by the Council. Those elected will be notified about April 15.

NOTE. The Council desires to impress upon applicants for membership that under the present national conditions the procedure of election of members may be slower than under normal conditions.

NEW APPLICATIONS

FOR CONSIDERATION AS MEMBER, ASSOCIATE OR ASSOCIATE-MEMBER

California

PITTS, HAROLD P., Industrial Engineer, Pacific Gas & Electric Co., San Francisco

Colorado

ORR, CARLETON A., Superintendent Power Plants and Shops, Arkansas Valley Railway, Light & Power Co., Pueblo

Connecticut

AVIS, SAMUEL W., Mechanical Engineer, Hartford Special Machinery Co., Hartford

BRITTAN, FREDERICK A., Engineer, Remington Arms & Ammunition Co., Bridgeport

TOMS, ROLLIN T., Foreman Stock Tool Department, Yale & Towne Mfg. Co., Stamford

District of Columbia

BARRETT, CHARLES G., Assistant Engineer, U. S. Shipping Board, Emergency Fleet Corp.

BASCOMBE, FRANK J., Assistant Superintendent, Washington Steel & Ordnance Co.

BLACK, JOHN S., Captain Ordnance Reserve Corps, U. S. A.

MARTIN, H. T., Captain Ordnance Reserve Corps, U. S. A.

Delaware

MAGUIRE, CHARLES F., Design Engineer, E. I. du Pont de Nemours & Co., Wilmington

Illinois

CAREY, JAMES L., Architect and Engineer, Chicago

PEACH, WILLIAM M., Chief Draftsman, Pullman Mfg. Co., Pullman

STUART, WILLIAM K., Assistant Secretary, Western Steel & Fdy. Co., Chicago

Indiana

CRAVENS, GEORGE W., Chief Engineer and Works Manager, Elkhart Carriage & Motor Car Co., Elkhart

Kentucky

ANDERSON, WARWICK M., Professor of Physics, University of Louisville, Louisville

Louisiana

DOBREE, BASIL S. T., Chief Engineer, Panama Ice Co., New Orleans

Maryland

HIND, THOMAS W., Consulting Engineer, The Crown Cork & Seal Co., Baltimore

Michigan

LINK, VINCENT, Consulting Engineer, Studebaker Corp., Detroit

Minnesota

BOOTH, GEORGE, Works Managing Engineer, Pan Motor Co., Saint Cloud

REES, ELIAS, Fuel Engineer, C. L. Pillsbury Co., Minneapolis

ZIMMERMAN, FRANK R., Chief Engineer, National Iron Co., Duluth

Missouri

CANAVAN, ASA L., Southwestern Representative, W. H. Miner, Grover

TALEN, MAURITZ W., Chief Draftsman, The Ruemmeli-Dawley Mfg. Co., St. Louis

TOENSFELDT, KURT, Principal Assistant Mechanical Engineer, St. Louis Water Works, St. Louis

New Hampshire

CUMMINGS, FRED A., Resident Engineer, Nashua Mfg. Co., Nashua

New Jersey

CARLTON, JOSEPH R., Mechanical Testing, Public Service Electric Co., Newark

SCHEEL, JOHN B., Production Manager, New Jersey Brass Corp., Garfield

New York

BASTIAN, FREDERICK G., Mechanical Foreman, Lackawanna Steel Co., Lackawanna

BEEBEE, LEWIS, Mechanical Engineer, Hammond Steel Co., Inc., Syracuse

COCHRANE, LEWIS, Chief Engineer, New York *Times*, New York

GRONBECH, CHRISTIAN E. A., Superintendent and Assistant Factory Manager, C. J. Tagliabue Mfg. Co., Brooklyn

HULST, JOHN, Assistant to Vice-President, and Chief Engineer, United States Steel Corp., New York

KAY, GEORGE A., with E. W. Bliss Co., Brooklyn

KIRKHAM, CHARLES B., Chief Designing Engineer, Curtiss Aeroplane & Motor Corp., Buffalo

MORSE, EDWARD P., Jr., General Superintendent, Morse Dry Dock & Repair Co., Brooklyn

PEET, EDWIN B., Mechanical Engineer, E. W. Bliss Co., Brooklyn.

STARK, ARTHUR W., Assistant to Engineer of Construction, Consolidated Gas Co. of N. Y., New York

TAGGART, JAMES M., Consulting Engineer, Engineering Department, Interborough Rapid Transit Co., New York

WALSH, GEORGE. W., Mechanical Engineer, C. E. Knoeppel & Co., New York

Ohio

BAILY, THADDEUS F., President, The Electric Furnace Co. of America, Alliance

TUECHTER, AUGUST H., President, The Cincinnati Bickford Tool Co., Cincinnati

YANNEY, GEORGE W., Chief Draftsman, Alliance Machine Co., Alliance

Oklahoma

MEYER, BARNEY, Mechanical Superintendent, Cosden & Co., Tulsa

Oregon

DICKSON, JOHN, Superintendent Motive Power, Spokane, Portland & Seattle Rwy., Oregon Electric Rwy., and Spokane & Inland Empire Rwy., Portland

Pennsylvania

GILDERSLEEVE, FRANK M., Assistant Mechanical Engineer, Ridgway Dynamo & Engine Co., Ridgway

KAVANAUGH, RAMSEY D., Foreman of Road Tests, Pennsylvania R. R. Co., Altoona

RAPP, JESSE P., Chief Inspector, Purchasing Department, American International Shipbuilding Corp., Philadelphia

SUPPLEE, WARREN P., Chief Operating Engineer of Power Stations, The Eastern Penn. Light, Heat & Power Co., Pottsville

Rhode Island

SWASEY, CORNELIUS B., Superintendent, Allens Ave. Plant, Gorham Mfg. Co., Providence

Tennessee

ROBINSON, G. A., Mechanical Superintendent, La Follette Coal & Iron Co., La Follette

Texas

LEARMONTH, ALEXANDER C., Chief Engineer Power Plant, El Paso Electric Rwy. Co., El Paso

Virginia

DAVIS, GEORGE M., Locomotive Designer, Norfolk & Western Rwy. Co., Roanoke

HIGGINS, EDMUND S., 2nd Assistant Manager, Hopewell Works, Du Pont Powder Co., City Point

LEPS, HENRY M., Lieutenant (j.g.), U.S.F.N.R., Engineering Assistant, Office of Aide for Material, Norfolk

Wisconsin

BRINTZINGER, CHARLES H., Appraisal Engineer, American Appraisal Co., Milwaukee

Wyoming

BRENNAN, WILLIAM D., Assistant General Manager, The Union Pacific Coal Co., Cheyenne

Canada

CARPENTER, FRANK G., Superintendent Plant and Chief of Construction and Engineering, P. Burns & Co., Ltd., Calgary

Cuba
GOIRIGOLZARRI, MANUEL, Manager, Havana Marine Railways, Inc., Havana

China
HOPKINS, R. D., with the China-American Trading Co., Inc., Tientsin

Norway
BASSOE, CARL F., Engineer, Norsk Aluminum Co., Kristiania

Japan
TAKETA, HIDEJI, Mechanical Engineer, Ashio Mines of Furukawa Mining Co., Shimotsuke

South America
MACWHIRTER, GEORGE E., Operating and Constructing Engineer, Boquete Nitrate Co., Antofagasta, Chile
ANSALDO, PEDRO, Chief Engineer and General Manager, De La Compania Industrial De Electricidad, Buenos-Aires, Argentina

FOR CONSIDERATION AS ASSOCIATE OR ASSOCIATE-MEMBER

Alabama
EPHGRAVE, HERBERT, Chief Engineer, Joubert & Goslin Machinery & Fdy. Co., Birmingham

Connecticut
LANNON, JOHN D., Assistant Superintendent of Manufacturing, Remington Arms U. M. C. Co., Bridgeport

Indiana
SUTLIFF, JAMES T., Advertising Manager, The Connersville Blower Co., Connersville

Maine
ROWE, LOUIS G., Production Engineer, Eastern Mfg. Co., South Brewer

Michigan
WATSON, HARRY J., Instructor in Mechanical Engineering, University of Michigan, Ann Arbor

New Jersey
KELLEY, JOSEPH A., Designer Special Machinery, Edison Storage Battery Co., Orange

New York
AKERLY, HAROLD E., Industrial Engineer, Eastman Kodak Co., Rochester
BLOMGREN, HERBERT, Assistant Engineer, Westinghouse, Church, Kerr & Co., New York

Washington
BUCKINGHAM, JAY E. E., Assistant General Manager, Hofius Steel & Equipment Co., Seattle

Wisconsin
KOSKINEN, EINAR T., Draftsman, Nordberg Mfg. Co., Milwaukee

FOR CONSIDERATION AS ASSOCIATE-MEMBER OR JUNIOR

Illinois
CUNNINGHAM, JAMES D., President, Republic Flow Meters Co., Chicago
KELLY, ROY C., Chief Engineer, Moline Pressed Steel Co., Moline
PRATT, JABEZ H., Chemical Engineer, The Liquid Carbonic Co., Chicago

Indiana
SAUNDERS, FRED S., Charge of Planning Department, Diamond Chain Mfg. Co., Indianapolis

Massachusetts
BOSWORTH, RALPH L., Designing Engineer, Crocker-McElwain Co., Holyoke
MCKECHNIE, ALEXANDER B., Sales Engineer, The Merrill Process Co., Boston

New Jersey
SMITH, CHESTER F., Assistant Superintendent, Case & Can Department, Standard Oil Co., Bayonne
STENKEN, HARRY A., Assistant Engineer, American Sugar Refining Co., Jersey City

New York
MITCHILL, GEORGE L., Chief Inspector, Electric Bond & Share Co., New York City
UNDERHILL, JACOB, Inspector of the Contract & Inspection Department, New York Edison Co., New York City

Pennsylvania
ALLEN, EDWARD G., Marine Engineer and Supervising Draftsman, Philadelphia Navy Yard, Philadelphia
BATTLE, JOHN R., Mechanical Engineer and Philadelphia Manager, Swan & Finch Co. of New York, Philadelphia
PETERS, FRANCIS C., Mechanical Engineer, The New Jersey Zinc Co., Palmerton
TAFEL, THEODORE, Jr., Standard Sanitary Mfg. Co., Pittsburgh

FOR CONSIDERATION AS JUNIOR

California
DUNCAN, GEORGE W., Jr., Consulting Mechanical Engineer, San Francisco

Connecticut
BENSON, CARL N., Mechanical Draftsman, S. K. F. Ball Bearing Co., Hartford
STOCKMANN, ERLING B., Inspector of Ballistics, Remington Arms-U. M. C. Co., Bridgeport

District of Columbia
ANDRAE, WILLIAM C., Laboratory Assistant, Bureau of Standards
HARTMAN, CLARENCE O., Draftsman, Ord Dept., Field Carriage Div.
SEARLE, RUSSELL M., Draftsman, Gun Division, Ordnance Bureau, U. S. A.

Florida
BOEHNLEIN, CHARLES, Aeronautic Draftsman, Naval Air Station, Hull Drafting Department, Pensacola

Massachusetts
JOHNSON, HAROLD S., Erecting Engineer, Westinghouse Electric & Mfg. Co., Boston
McNALLY, EDWIN M., Cadet, U. S. Naval Reserve Flying Corps, Bureau Steam Engineering Naval Aviation Detachment, Mass. Inst. of Tech., Cambridge

Michigan
HELLER, LEWIS W., Graduate Student, University of Michigan, Ann Arbor

New Jersey
BROWN, J. LYALL, Mechanical Designer, Crocker-Wheeler Co., Ampere
TERRY, CARLYLE M., Assistant Engineer Power House, Babcock & Wilcox Co., Bayonne

New York
CROCKETT, CHARLES H., Research Engineer, Troy
BRUMBLE, WILLIAM C., Mechanical Draftsman and Engineering Assistant, New York Central Railroad, New York City
GORDON, MERRITT W., Cadet Engineer, Fulton County Gas & Electric Co., Gloversville
MARKLEY, WILLIAM F., Engineer, Western Union Telephone Co., New York City
NAUMANN, WILLIAM H., Chief Inspector U. S. Government, Artillery Ammunition, Inspection Section Ordnance Department, New York City
SPELLMAN, CHARLES B., Draftsman, Niagara, Lockport & Ontario Power Co., Lyons

Ohio
INDERBITZIN, ALEXANDER M., Mechanical Engineer, East Iron & Machine Co., Lima
SHIRLEY, HARVEY J., Machine-Tool Designer and Checker of Design, Lodge & Shipley Machine Tool Co., Cincinnati

Oklahoma
HOFFMAN, RAY T., Construction Engineer, Sapulpa Electric Co., Sapulpa

Pennsylvania
HOFFER, HOWARD A., Engineer, Special Castings Department, U. S. Cast Iron Pipe & Fdy. Co., Philadelphia
MAGOUN, JOHN W., Assistant Engineer of Tests, Steelton Plant, Bethlehem Steel Co., Steelton

Vermont
BRILL, ELLIOT M., Manager Cost Dept., Jones & Lamson Machine Co., Springfield

China
GREENWOOD, HEMAN C., Chief Instructor of Mechanical Engineering, Hunan Polytechnic Institute, Changsha

APPLICATIONS FOR CHANGE OF GRADING

PROMOTION FROM ASSOCIATE

New York
ROGERS, FRED E., Editor *Machinery*, New York

PROMOTION FROM ASSOCIATE-MEMBER

Massachusetts
GUNNING, WILLIAM A., Head Draftsman, American Optical Co., Southbridge

New York
BORIE, RENSHAW, Engineer Hoist Department, The Yale & Towne Mfg. Co., New York

PROMOTION FROM JUNIOR

Illinois
BRYEN, THOMAS T., with Williams, White & Co., Chicago (Reinstatement)

New York
FLAGG, SAMUEL B., Fuel Expert, Electric Bond & Share Co., New York
WANDEL, CARLETON, Lumber Salesman, with C. H. Pearson, New York
WEBER, H. F., with Compression Engineering Corp., New York

SUMMARY

New applications	112
Applications for change of grading:	
Promotion from Associate	1
Promotion from Associate-Member	2
Promotion from Junior	4
Total	119

EMPLOYMENT BULLETIN

THE SECRETARY considers it a special obligation and pleasant duty to make the office of the Society the medium for assisting members to secure positions, by putting them in touch with special opportunities for which their training and experience qualify them, and for helping anyone desiring engineering services. The Society acts only as a clearing house in these matters.

IN forwarding applications, stamps should be enclosed for transmittal to advertisers; applications of non-members should be accompanied by a letter of reference or introduction from a member, such reference letter to be filed with the Society.

GOVERNMENT REQUESTS

The Society has been asked to make suggestions of men for the following positions with the Government. Non-members possessing the necessary qualifications may avail themselves of these notices by enclosing with their reply a personal introduction to the Secretary. Kindly advise this office what action you have taken.

MEN competent to take over the maintenance and supply work for aero squadrons. Those qualifying must be over the draft age, but in cases of exceptional ability commissions will be issued to those in the draft age. 2574.

INSPECTION MEN FOR AERONAUTICAL ENGINES. 2575.

ENGINEERS FOR REPAIR STATION for the vessels of this Service in a port of France. Men to serve in a military or civilian capacity. Commissions in the U. S. Officers' Reserve Corps, and consideration may also be given to applicants within draft age. 2580.

INSPECTION MEN ON CARTRIDGES. Those above draft age and who show high qualifications will be commissioned. 2581.

DESIGNERS AND CONSTRUCTION ENGINEERS, mechanical and civil. 2564.

ASSISTANT GENERAL SUPERINTENDENT for woodworking and ironworking plant employing 3000 men. Age 30 to 40 years. Technical education required, with five or more years' práctical experience in handling men. Location Indiana. 2566.

TIME-STUDY MAN for small manufacturer making small stampings and brass goods. Should be conversant with modern cost accounting and able to make correct cost estimates. Location Michigan. 2567.

WORKS MANAGER. Must be familiar with the handling of help and the manufacture of small tools such as taps and dies. Young man preferred. Location Massachusetts. 2571.

JIG AND SMALL-TOOL DESIGNER, good on experimental work on steam specialties; eventually to head engineering department. Location New York City. 2572(a).

TIME-STUDY MEN. Two to four high-grade men desired. 2572(b).

MECHANICAL ENGINEER to take charge of the entire mechanical end of business, in a new position created by the growth of company in New England States. Man of more than ordinary ability. Salary $4000 to $6000 at the start. 01.

MASTER MECHANIC for large central power plant. Permanent position with chance for advancement. State age, experience, salary expected and position regarding draft. 04.

YOUNG MAN with school education at least and preferably with one or more years in college, probably not subject to draft, to enter engineering organization at nominal salary. Chance for advancement will depend upon ability of applicant. Experience along sugar-machinery lines of considerable assistance. Location New York City. 012.

GENERAL MANAGER for an old established Chicago plant manufacturing light and heavy machinery, special tools, etc. Man of 45 to 55 years of age preferred. Location Illinois. 07.

MECHANICAL DRAFTSMAN. Salary $20 to $25. Location New York. 09.

FIRST-CLASS DRAFTSMAN experienced on heavy engines and accustomed to handling work with only general supervision; also good detailers. Give full particulars in first letter. Location Ohio. 011.

POSITIONS AVAILABLE

SALES ENGINEER. Young engineer, to sell and supervise installation of steam traps and temperature regulators. Steady promotion offered. 2483.

CHIEF ENGINEER versed in refrigeration and producer-gas-engine work. Salary $2400 to $3000. Location, 50 miles from Baltimore. 2488(a).

SIX MEN to operate anthracite gas producers. Salary $21 a week, eight-hour shift. 2488(b).

TURBINE OPERATING ENGINEERS, high-class. Two or three young men with good education and some practical experience. 2492(a).

SWITCHBOARD OPERATORS who have had experience in large stations. Two or three, preferably, young men with good education to qualify for responsible positions on this line of work. 2492(b).

YOUNG TECHNICAL GRADUATE in mechanical engineering with four or five years' factory experience for position of assistant engineer. Good opportunity for advancement. 2501.

OPERATING ENGINEER for industrial plant located near Chicago. Must be a technical graduate and have had practical operating experience in power plants, and be capable of handling a power proposition involving approximately 5000 boiler hp. State age, experience in detail, and salary expected. 2445.

COLLEGE GRADUATES, ENGINEERS. Men out at least a year, for general shop engineering work with growing concern. Work leads to industrial management. State full particulars. 2478.

ELECTRICAL ENGINEER for plant in northern Ohio. Must assume (1) full charge of all electrical layout work, (2) supervise purchase of all electrical material and equipment, (3) act in an advisory capacity on all electrical equipment and installations after such have been turned over to the manufacturing departments within the plant, (4) attend to maintenance and upkeep, and (5) assume full charge and supervision of all new electrical installations. 2521.

OPERATING ENGINEERS for munitions plant. Men with practical field experience. Young technical graduates preferred. Salaries from $150 to $200, depending upon men. Positions located in Pennsylvania, Alabama, and Illinois. 2532.

FIRST-CLASS DRAFTSMAN experienced on heavy engines and accustomed to handling work with only general supervision. Give full particulars in first letter. 2533(a).

GOOD DETAILERS. Give full particulars in first letter. 2533(b).

YOUNG TECHNICAL GRADUATE, preferably a mechanical engineer who has had at least a small amount of shop experience, to act as time-study man. Salary to start $125 to $150 per month. Location Connecticut. 2534.

EXPERIENCED DESIGNER on electric baggage-truck work. Work would be the design of two- and four-wheel steer trucks, tractors and trailers. Location New York. 2535.

CHIEF DRAFTSMAN with executive and engineering ability, competent to direct work of large drafting room. Should be technically educated, have knowledge of hydraulic and mechanical engineering and be experienced in surveying and making finished plans of industrial plants. Write, stating nationality, age, education, experience in detail, present responsibilities and salary expected. Excellent opening for a capable, experienced and energetic man. Location Massachusetts. 2539.

TECHNICALLY EDUCATED MEN between 31 and 40 years of age. Three or four wanted for large engineering bureau making inspections of industrial properties. Technical education along mechanical and hydraulic lines important. Good openings for the right men. Give nationality, age, education, experience in detail, and salary expected. Location Massachusetts. 2540.

YOUNG MAN Technical graduate or man with practical shop experience who is familiar with blueprints and can readily read specifications, to develop as a sales engineer. Sufficient inducements to make the position valuable. Salary proportionate to merit and results. Location New York. 2545.

MECHANICAL ENGINEER for valuation department of chemical plant. Salary $125 to $150 per month. Location New Jersey. 2549.

MEN WITH TECHNICAL EDUCATION AND EXPERIENCE, not subject to military call, for long-established company operating steel and iron foundries and machine and forge shops, whose varied products are sold to the Government, railroads, mining and contracting industries, etc. State full particulars, kind of position preferred and salary expected. Location New Jersey. 2552.

TECHNICAL GRADUATE for fuel-economy work in connection with boiler operation, heating furnaces, and gas producers. Location Pennsylvania. 2559.

HEATING AND VENTILATING ENGINEER to supervise design, installation and work in advisory capacity in connection with maintenance in large rubber factory in northern Ohio. Salary commensurate with training, experience, and ability to handle men. Splendid opportunity for the right man. 2561.

TECHNICAL CORRESPONDENT capable of issuing orders for mechanical work. Location New York. 2562

MEN EXPERIENCED IN PLANT MAINTENANCE OR SHOP OPERATION for plant maintenance branch of the Western Electric Company. College education not necessary in all cases provided men have a fairly broad practical experience. Salaries from $1000 to $2000, depending upon qualifications of applicant. Opportunities for advancement for those who possess initiative and ability. 2563

TOOL DESIGNER who is resourceful and can follow work through to completion. Technical man with practical shop experience. Location Connecticut. 185.

ESTIMATOR for New York concern engaged as engineers and contractors for power plant, ventilation, and steam and hot water heating. 2103.

CHIEF ENGINEER to take charge of designing of railroad equipment and supplies, including motor cars, hand, push and velocipede cars, and locomotive standpipes. Technical graduate preferred, and as line is highly competitive, a man who can look at matters from a business as well as a strictly engineering point of view. Salary secondary consideration if right man can be secured. Location Middle West. 2247.

CORRESPONDENT for engineering computation department and to handle engineering correspondence, man or woman, preferably a technically educated person. Location Massachusetts. 2284.

YOUNG ENGINEER experienced in general plant construction work. Good opportunities for advancement. Preferably a man who is exempt from military duty. Location Illinois. 2286.

SUPERINTENDENT for machine shop manufacturing high grade printing machinery. Must be a good executive and thoroughly versed in modern methods of interchangeable manufacturing. Location near New York. Salary depends upon individual. Give age, nationality and complete experience. 2301

RECENT GRADUATES in mechanical engineering from schools of recognized standing desired for testing work in large steam-operated electric power plants. Applicants with experience in testing work and now located in and around New York City will be given preference. State particulars of education, experience and salary desired. 2345

ENGINEER familiar with abrasive processes as engineering sales manager with concern manufacturing metal finishing tools and equipment. Location New York State. 2346

MECHANICAL DRAFTSMAN OR YOUNG ENGINEER for drafting on refrigerating machinery and installation work. Salary depends upon man. Location New York City. 016

SALES MANAGER. Engineer experienced in estimating and selling to hold responsible position in long-established engineering and contracting business of an incorporated company, with possible opportunity to become financially interested. State age and experience. 017

INSTRUCTORS. The Department of Mechanical Engineering, University of Illinois, Urbana, Ill., needs a number of instructors in laboratory work, in machine design, and steam and gas-power engineering. Applicants should send a full statement of their educational training and practical experience with a recent photograph, addressed to Dean C. R. Richards. 018

MEN AVAILABLE

EXECUTIVE, SALES ENGINEER, now holding a responsible position as department manager in charge of design and sale of steam specialties, desires similar position with company having larger field and offering better future prospects. Age 35, married. Available on 30 days' notice. Location New York or Philadelphia preferred, but not essential. Minimum salary $4500. B-35.

WORKS MANAGER OR SUPERINTENDENT. Technical graduate, 20 years' experience from foreman to manager; successful executive with experience in modern systems of plant management. Minimum salary $5000. B-36.

EXECUTIVE PURCHASING ENGINEER with successful record in governmental, railroad and industrial service. Experienced in plant design and maintenance, in railroad valuation and in the purchase of electrical, mechanical and structural equipment and materials. At present connected with large corporation completing extraordinary program. B-37.

EXECUTIVE ENGINEER, age 40. Experienced estimator and designer of plants, particularly elevating conveying installations; also experienced in structural steel and plate work. Willing to invest capital in a plate or machine shop. Size not important but prospects must be good. B-38.

MECHANICAL ENGINEER AND PRODUCTION EXECUTIVE, age 37. Fully trained and practically experienced as tool and die maker, foreman and supervisor of engineering, manufacturing, tool and experimental departments. Well grounded in plant layouts and modern manufacture of interchangeable parts, small, medium and heavy. Knows how to handle men to get coöperation. At present employed but desires change owing to lack of opportunity for future advancement. B-39.

MECHANICAL ENGINEER. Technical graduate with eight years' experience in designing, erecting and operating power-plant and manufacturing equipment. Also experienced in specification and purchase of equipment. Desires position as mechanical superintendent or works engineer. B-40.

CHIEF ENGINEER AND RESEARCH EXPERT with 16 years' practical training in oil- and gas-engine development work. Broad experience in the fine points of both the technical and business side of engineering, with special aptitude for research work and the perfection of new ideas. Thoroughly competent to handle men, and to take charge of the development, design and supervision of construction of either marine or stationary internal-combustion engines. At present employed. Best of references. B-41.

PRODUCTION MANAGER, EFFICIENCY ENGINEER, SUPERINTENDENT OR TOOL ENGINEER. High-grade executive with 15 years' practical and technical experience in manufacturing covering every branch of the business except sales. Expert on tools and equipment, cost methods and time study. Competent to install piece work or bonus system. Until recently efficiency engineer with large automobile company: Business man looking for competent adviser on matters pertaining to manufacturing would find applicant the possessor of an attractive personality and good mixer and diplomat. Salary $3500. B-42.

MECHANICAL ENGINEER. Technical graduate with 20 years' experience in the design, construction and operation of power plants. Also familiar with building construction and the maintenance and operation of large buildings. B-43.

MECHANICAL ENGINEER. Technical graduate, age 25, with three years' experience in varied engineering work, desires position in engineering or engineering sales. Salary $1500. B-44.

PRACTICAL MAN, 42 years of age, with self-acquired technical training, desires position where initiative in labor saving, interchangeability of parts and standardization of methods are needed. Nine years' experience in machine shop, including construction and outside work, 3 years in charge of equipment installation for new plant, 8 years as designing draftsman, and 4 years' office training along industrial-engineering lines. At present employed, but desires opportunity to broaden. B-45.

MECHANICAL ENGINEER. Technical graduate with 7 years' manufacturing experience desires position as assistant-production manager. At present employed in executive position. B-46.

INDUSTRIAL ENGINEER. Technical graduate with two years' experience in time study, cost system, scheduling, planning, etc.; four years as draftsman on heavy machinery, transmission machinery, industrial-plant and power-plant equipment. At present employed but desires change where ability to produce results will be appreciated. B-47.

MECHANICAL ENGINEER. Technical graduate with 12 years' experience in the design and operation of power plants desires a permanent position with reliable concern. Cleveland preferred as location. B-48.

MECHANICAL ENGINEER with technical education and 17 years' experience in the design, construction and operation of industrial plants desires position as mechanical engineer or works manager. Competent to take charge of work from inception to operation of finished plant. Has had experience in organizing and handling work in Spanish-speaking countries and would take position away from home at present if conditions were made sufficiently attractive. B-49.

MECHANICAL ENGINEER who has specialized on drop forgings desires to make a change; reasons on request. Age 32, married. American-born of American parents, absolutely reliable and total abstainer. Desires permanent position with reliable concern. Salary $2500 to $3000. B-50.

FACTORY EXECUTIVE, graduate mechanical engineer, age 39, wishes to connect with progressive concern manufacturing interchangeable parts. Has thorough knowledge and practical experience in scientific-management methods, manufacturing and foundry methods and employment matters. For the last 7 years connected with modern progressive concern as production manager and assistant works manager. Immediately available. B-51.

OPERATING ENGINEER. Associate-member, age 40, with 15 years' experience and 9 years' successful service as chief engineer desires position as chief engineer or superintendent of power with progressive industrial, ore-mining or power company. Good executive. Experience covers steam, electric, producer gas and Diesel engines, and refrigeration. Location immaterial. At present holding responsible position. B-52.

MECHANICAL ENGINEER of 16 years' experience desires position as general superintendent or production supervisor. Has had extensive experience with modern systems of management, the setting of tasks, piece and bonus rates, routing and scheduling of work and storeroom systems. Has acted as superintendent or organization engineer in the metal-working, textile and paper industries. B-53.

ENGINEERING SURVEY

A Review of Engineering Progress and Attainment in Mechanical Engineering and Related Fields, Including a Digest of Current Technical Periodicals and Selected Titles of Engineering Articles

Corps of Engineers of the U. S. Army

THE war threw open to the Corps of Engineers a tremendous task, especially as compared with its former quite limited activities. In fact, as stated by E. J. Mehren, editor of the *Engineering News-Record*, its purchasing activities have increased 2250 per cent within three months. More than fifty engineer regiments had to be equipped, where only three had been equipped before. The organization had to be built up for handling these increased duties and all of this had to be done at top speed and in a businesslike manner.

In the General Engineer Depot purchases are being handled at present at the rate of more than $1,000,000 a day for every day in the year, with all this immense volume of business concentrated in one office. In fact, it is likely that if the war should continue, probably double that amount will be spent in the succeeding fiscal year.

The work of the General Engineer Depot is very far from being one of a routine character. In the first place, a number of specialist engineer units of a novel character have been authorized, with an equipment far more complex than that of the pioneers of prewar time. Service troops are provided for each special engineer regiment.

Even the equipment for pioneer troops, which has been standardized to a certain extent, had to be modified to fit present needs because of the advance in modern methods of warfare, while for the special regiments all of the equipment had to be selected, readopted or designed anew.

Some idea of the variety of purchasing may be gained from the standard detail supplies of the pioneer regiments alone. These cover more than 300 items and range all the way from pencils to wagons.

Quite frequently the Depot has to handle large orders in which speed is an essential element. Thus standard-gage 90-ton locomotives of a certain type were needed. An order for 300 units was placed on July 19 and on August 11 the first engine was delivered and the order called for completion by October 1.

The purchases, with the exception of some of the equipment of pioneer troops, may be roughly classified into three classes, as follows:

First, such equipment as has been standardized commercially and which without change can be used in military service.

Second, such standard commercial equipment as can by slight changes be adopted for military use.

Third, equipment not used for commercial purposes and which must be designed from the ground up.

The policy of the Depot is to buy commercial equipment whenever possible. It happens, however, that modifications become necessary for military reasons. On the other hand, in other instances, the work of the Depot has clearly disclosed a lack of a standard satisfactory even for commercial use. Thus, it was found that there is no standard rating of gasoline engines and the ratings did not mean the same thing to two different manufacturers, and, in addition, almost without exception, the graded rating was too high.

To expedite its work the practice of the Depot has been to confer with the officials of manufacturing companies from whom it is proposed to purchase, and to insist that the higher officials of the companies be in charge of these negotiations. Manufacturers have found it of advantage to bring with them their engineers and shop superintendents. Discussion with these latter frequently disclosed ways and means by which the production could be considerably increased.

The system of inspection and payment has been simplified and made as businesslike as possible. More than 1400 inspectors are either in the direct service of the Depot or are at command, much of the inspection being handled by R. W. Hunt & Co. These inspectors not only pass the material, but accept it. They deliver to the contractor a certificate of inspection which the latter sends to the General Engineer Depot with his invoice, and payment is made immediately.

In this way firms which negotiate for materials and have big labor bills are able to meet their obligations with promptness, an important factor in securing satisfactory bids.

The original article gives a chart indicating the organization of the War Departments General Engineer Depot. It also contains a list of the principal officers in charge of the various sections. The majority of these officers had extensive previous experience, many of them in commercial employment. (*Engineering News-Record,* vol. 80, no. 1, January 3, 1918, pp. 25-29)

Society of Automotive Engineers

The thirteenth meeting of the Society of Automotive Engineers was held on January 9 and 10. The first day was devoted to various committee meetings, and the second to society business, such as election of officers, etc., and professional sessions. Charles F. Kettering was elected president for the coming year.

At the professional sessions three main subjects were discussed: the Liberty airplane engine, the design of the U. S. war truck, and the question of fuel for automotive apparatus.

As regards the Liberty motor, the main paper was presented by Major J. G. Vincent, Mem.Am.Soc.M.E., one of the two men who, according to Secretary Baker's statement, were locked up in a room in the Willard Hotel and told to design the American aviation engine.

The first unit designed was an 8-cylinder engine of about 150 hp., but before that was completed it was decided to provide a 12-cylinder engine giving over 300 hp. At present only the 12-cylinder engines are being turned out and it is not believed that smaller engines will be built during the war.

In the discussion which followed, H. M. Crane called attention to the fact that an engine cannot be copied. As an instance, he cited the Mercedes engine. A number of attempts have been made to copy it, but none of these copies can be compared with the original in efficiency and usefulness.

The Liberty motor is an embodiment of the idea of a small number of parts, simplicity of parts, and compactness, all of which make for light weight and reliability.

There is no reason why the Liberty engine cannot be operated satisfactorily at low speed. It has no unusual valve timing. The exhaust valve opens 52 deg. early and the inlet closes 45 deg. late.

Fuel is fed by pressure, auxiliary tanks being provided for emergencies. The lubricating system is of the pressure type with the double-deck pump and three gears in the top deck.

Two compression ratios are used at present for the Liberty engines. In the navy engines, which have to fly at altitudes of about 5000 ft. or less, the compression ratio is 5 to 1; in the army engines for altitudes of around 10,000 ft. or higher, it is 5.4 to 1, or something under 18 per cent.

The steel cylinders are so arranged that the cooling water can be brought up close to the spark plugs. The compression pressures have not yet been carried extremely high in the Liberty engine, so that spark-plug trouble as ordinarily known in aviation engines has not been experienced.

The design of the Class B military truck engine was discussed in a paper presented by A. F. Milbraith, Mem.Am.Soc. M.E.

It was desired to develop an engine with a torque output of at least 2800 lb.-in. An average of the daily performance of engines built in the past is about 6¼ lb.-in. per cu. in. of piston displacement, which indicated a piston displacement for the engine of about 450 cu. in.

As it was desirable to keep the stroke-bore ratio as high as possible without excessive total weight or overall height, a 6-in. stroke was adopted with a bore of 4¾ in. The normal speed was set at about 1050 r.p.m., giving a piston speed of 1050 ft. per min. The speed of maximum horsepower was predetermined at about 1500 r.p.m.

The paper describes in detail the various features of design. Of particular interest are the inlet and exhaust manifolds. They are both on the right-hand side of engine. A heating chamber is cast integral with the inlet manifold near the center, where the vertical branch from the carburetor joins the horizontal section. This heating fixture is bolted directly to the exhaust manifold at a point where an opening is caused by the latter, so that the hot gases are circulated around the inlet manifold. This forms a hot spot about four of five inches long which helps vaporize the fuel and permits the use of low grades of gasoline.

From tests made it appears that a torque of 7.27 lb.-in. per cu. in. of piston displacement was obtained, while the maximum horsepower would be developed at 1550 r.p.m. (Abstracts of these two papers are made by special courtesy of the Society of Automotive Engineers from advance proofs. The full texts of the papers will appear in an early issue of the *Journal of the Society of Automotive Engineers*.)

New York Automobile Show

The Automobile Show held at Grand Central Palace, January 5 to 12, was, in many respects, one of the most remarkable exhibitions of its kind.

The latter part of the period of preparation for the show passed under conditions of great stress, with the air full of apparently authentic rumors of drastic curtailment of the passenger-car industry.

Fortunately, by the time the show opened its doors to the public the great importance of the American automobiles to the country and the prosecution of the war became clear and the position of industry reasonably assured.

The show did not exhibit any clearly war features of the automobiles and the conditions created by the events of the last year could be observed only indirectly. It is but natural, however, that they should have begun to exert their influence on the design of the cars.

There are two elements, which, if one may judge by the last show, are going to affect the industry most profoundly. The first is the growing tendency toward economy both in the size of the car and the mileage per gallon of fuel. The day of the big, heavy car has not passed, of course, because there will probably always be those who can afford to use it, or conditions where its use may be particularly necessary. But it is significant that practically all of the new cars exhibited at the show are small cars, and that at least one car has already reduced the length of the wheelbase which it employs in its standard model.

Another feature is the tendency toward the better utilization of fuel in the engine. This is achieved in various ways. In the first place there is more extensive application of devices for a better gasification of the fuel, either by the use of jacketed carburetors or by the application of the so-called hot-spot method, that is, superheating a section of the intake manifold by a flow of exhaust gas. Since this latter method has been applied even in the Liberty truck, it may now be considered as current practice.

The other way of better utilization of fuel is by better temperature control of the jacket cooling water. This, as exhibited at the show, is effected in two ways; either by means of a thermostatically controlled valve in the jacket waterline, usually at the outlet to the radiator, or by shutters located in front of the radiator and operated either manually or by means of a thermostat and lever transmission.

Finally, one car has the thermosiphon circulation with a thermostat in the waterline and manually operated shutters in front of the radiator.

Many minor refinements of design have been exhibited, such as an enclosed valve head with the valves operating in a mist of oil; a radiator attachment to condense alcohol used as a preventive of freezing, etc.

Student Units for the Army Authorized at Two Colleges

The War Department has issued the following orders:

By direction of the President and pursuant to the authority invested in him by the provisions of section 41 of the act of Congress approved June 3, 1916, and in response to the application of the Massachusetts Institute of Technology, Cambridge, Mass., the authorities of which have agreed to establish and maintain a two-years' compulsory course of military training as a minimum for its physically fit male students, which course, when entered upon by any student, shall, as regards such student, be a prerequisite for graduation, to allot a minimum of an average of three hours a week per academic year to military training and instruction during the first two academic years and to arrange for five hours per week during the remainder of such student's course, and to use their endeavors to promote and further the objects for which the training corps is organized, there is hereby established in said Massachusetts Institute of Technology, Cambridge, Mass., one Coast Artillery unit, one Signal Corps unit, of the senior division, Reserve Officers' Training Corps.

By direction of the President and pursuant to the authority vested in him by the provisions of section 41 of the act of Congress approved June 3, 1916, and in response to the application of the University of Colorado, Boulder, Colo., the authorities of which have agreed to establish and maintain a two years' compulsory course in military training as a mini-

mum for its physically fit male students, which course when entered upon by any student shall, as regards such student, be a prerequisite for graduation, to allot a minimum of an average of three hours per academic year to military training and instruction during the first two academic years and to arrange for five hours per week during the remainder of such student's course, and to use their endeavors to promote and further the objects for which the training corps is organized, there is hereby established in said University of Colorado, Boulder, Colo., an Infantry unit of the senior division, Reserve Officers' Training Corps. (*Official Bulletin*, January 10, 1918, p. 2)

The Aeronautical Situation

"I have just returned from a visit to the aircraft works in Buffalo, Detroit and Dayton. This was an official visit and so I have seen everything there is to be seen in regard our aircraft program. I can hardly express my feeling of depression. The Liberty motor is coming along splendidly, and it is going to be a great success. But we are not going to have any mechanics competent to repair it. It takes longer to train a mechanic than a pilot. Major Vincent, the man who designed the motor, told me that it would be over a year before we could hope to have mechanics even in small numbers. So far we have made one airplane suitable for use in Europe. The manufacturer assured me that his company could not be on a production program until after the first of July.

"We are having a large number of school planes made, but there are no engines for these. The man who was entrusted with the work has fallen down completely. Even if we were to have the school planes ready we do not have one-tenth the requisite number of teachers, and cannot hope to get them for six months.

"It is very hard to place one's finger on the man or committee responsible for this condition. As far as I could see, the evil is a fundamental one." (From a letter by Professor Joseph S. Ames in the *Atlantic Monthly*, vol. 121, no. 1, January 1918, Contributor's Column)

Rules for Enlistment in Aviation Section of Men of Draft Age

The Aviation Section of the Signal Corps authorizes the following statement to clear up any misunderstanding which may exist as to the enlistment of men in or under the draft age on account of the recent ruling discontinuing voluntary enlistment as a general practice:

Fliers and balloonists may enlist as heretofore upon passing the examination at the nearest aviation examining board. Their relationship to the draft and to the draft board is seen to by the examining board. They themselves are ordered into active service as soon as possible and hold the status of privates, first class, Signal Enlisted Reserve Corps, with a salary of $100 a month, 60 cents daily allowance for food, and quarters provided by the Government, until their commissions are issued or they are discharged.

Non-flying officers of draft age or below are not now being accepted for service, except a limited number of graduates of leading recognized engineering colleges or others who can qualify as expert engineers; others may, if they wish, have their names placed on file at an examining board.

Aerial observers are not now being accepted, whether of draft age or not.

Enlisted men within the draft age may now no longer volunteer at a recruiting office, but may be inducted voluntarily into service by their local board if they are physically fit, sufficiently skilled, and not required to fill the current draft quota. They will be sent to Camp Kelly, Tex., for distribution into trades, training and formation of squadrons, with ranks and salaries running from $30 a month as private to $81 a month as master signal electrician, food and quarters provided by the Government. (*Official Bulletin*, December 27, 1917, p. 16)

Flotation of Ships

The possibilities of insuring the flotation of a large ship after severe damage were discussed before the Institute of Marine Engineers by Charles V. A. Eley, who in particular dealt with the system he himself has devised.

This system combines direct pumping with central means for indicating the position and amount of the damages for operating the pumps, and for leveling the water in the ship in order to preserve a level keel. Collision mats of a special character may also be used.

In connection with these arrangements some of the ship engineers would be trained to act as "salvage engineers," who would go to their stations when the vessel was in trouble or in a danger zone in the same way as a gunner would go to his station. The station would be a small compartment, say, 12 ft. to 15 ft. long and 6 ft. or 7 ft. wide, in the most invulnerable part of the ship. On one of the longer sides, about 6 ft. above the deck, a flat sentinel model of the ship would be placed with slides to operate vertically as indicators to show at a glance if water were building up in any compartment and at what rate. Below each compartment of the model would be placed the means for starting the pumps fitted in each compartment. On the deck, close to the side of the compartment containing the model, there would be a system of levers, almost like the levers in a railway signal box, one for each compartment of the ship, and these levers would control the opening and closing of the valves for leveling the water in the ship, preferably through the double bottom where such exists. Then supposing the ship is damaged at, say, the third compartment from the stern, the indication of the model will show that the water is rising in that compartment, and the salvage engineer will start the pumps on it.

If he sees these are not sufficient to deal with the water entering the ship he will pull over the lever at the same position (No. 3) and let the water travel throughout the length of the ship, and supposing there are twenty compartments, will pull over No. 18 lever and start the pumps in No. 18 compartment. If he finds the water to be still gaining he can pull over levers Nos. 9 and 17 and start the pumps in those compartments, and so on until the water is being pumped out faster than it enters. The ship's carpenter and crew could put into position specially constructed collision mats, or make good inside of the ship, or do both, as by keeping the vessel buoyant by pumping, the inside of the damaged compartment would be opened for purposes of inspection or to make good the damage temporarily.

As a rule, the auxiliary pumps on a ship are not sufficient to deal with the water inflowing through collision or torpedo, but would require to be supplemented with a complete set of pumps capable of being started together and of utilizing the whole, or as much as might be necessary, of the forces existing in the ship for purposes of propulsion to expel water. The author thought that the involute centrifugal single-stage pump

would be the best for the work, though in certain cases the expulsion form of steam pump or even steam-jet pumps might be considered; and in the remainder of his paper he set forth various calculations as to the installation that would be required in the case of a large vessel. (Philadelphia *Public Ledger*, December 26, 1917, p. 13.)

Patent-Reform Prospects

The Patent Office Society is permitted to announce that a composite committee has been created upon request by the National Research Council to make a preliminary study among the problems of the United States Patent Office and its service to science and the useful arts. This action is understood to be in conformity with the wishes of Commissioner of Patents, J. T. Newton, and Secretary of the Interior, Franklin K. Lane.

According to the resolutions adopted by the Patent Office Society, this is the proper time for taking preliminary steps about the establishment of the institute, such as was proposed some time ago by George Sarton and others, for the history of science, a proposal which is supported also by the Washington Academy of Science.

The Patent Office corps feels that the time is at hand when the Patent Office must enter upon either a period of very rapid decline, or else upon a period of rehabilitation and expansion.

The special committee asks some very pertinent questions. For example, can all who are employed in the work of examination be in any way further encouraged and aided to become specialists in one or the other of the branches of applied science, rather than mere rule parrots and picture matchers? This, apparently, implies a desire on the part of the examiners to be placed in a position where they could investigate new applications on the basis of a full knowledge of the previous art, rather than, as is a fact to a certain extent now, be guided mostly by Patent Office indexes.

Another question is whether the rules against dilatory prosecution of applications made by Commissioner Ewing be rendered secure for the future, in order to create a diligent rather than dilatory prosecution.

Before Commissioner Ewing's time the rules were such that applications could be kept alive for many years. Thus, the famous Selden patent was kept alive for nearly twenty years, which was easy since the applicant had two years for each amendment, and, for example, Selden used to file his amendments, sometimes of a trivial nature, just a few days before the lapse of the two years. Commissioner Ewing changed all this, reduced the time for filing amendments, and gave the Patent Office means of enforcing a rapid prosecution of an application.

The Patent Office Society requests that sugestions on patent reform be forwarded at once to Dr. Wm. F. Durand, (Mem. Am.Soc.M.E.), National Research Council, Washington, D. C. It is not expected that patent reform can claim primary consideration during the continuance of the work, but it is felt that the time is ripe for, at least, a study of conditions. (*Science*, New Series, vol. 46, no. 1200, December 28, 1917, pp. 629-631)

British Electrical Power Plan to Save Coal

The big electrical power-supply scheme, formulated by the coal-conservation sub-committees of the Ministry of Reconstruction, is the latest item to be made public of the Ministry's important proposals for the future. The scheme has been issued in an interesting report by the sub-committee to the Ministry so that public opinion may have an opportunity to form itself.

How much of the scheme will be adopted remains to be seen, but Dr. Addison, in a preface, draws attention to the important issues, affecting municipalities and public bodies, raised in the report and states that the Government will explore all the sub-committee's proposals before proposing any action to Parliament.

The scheme, it is expected, would save 55,000,000 tons out of the 80,000,000 tons used in the United Kingdom for producing power.

The cost of this 80,000,000 tons at the pit head is roughly £40,000,000, and of this £27,000,000 could be saved. With the saving of by-products now wasted by burning coal in open grates and boiler furnaces, a national economy of £100,000,000 could be effected. The coal now used would if used economically, it is said, produce at least three times the present amount of power.

Increased use of electric power, it is pointed out, is the most economical way of obtaining power from coal, is the best way to increase the net output per head, with the resulting prosperity of the workers.

The committee makes proposals for getting the fullest value of by-products and for generating electricity in subsidiary plants wherever there is surplus gas or waste heat as at furnaces and coke ovens. Similarly waste coal left at pits could be used on the spot.

The committee point out that the Northeast Coast district is already served by a group of power companies from one interconnected electric system. Despite the smaller population and disadvantages for electrical supply as compared with Lancashire, which has a multiplicity of electrical undertakings, the price per unit in this district is from one-half to one-quarter the price per unit in Lancashire, while the use of electric power per head is three times as great.

The scheme in the Northeast Coast district has meant a saving of coal, reduction of smoke, greater traffic facilities through the adoption of electric traction than in any other district of similar size, the establishment of new industries in the district, and the practical elimination of the burning of coal for power, apart from the electrical power company's consumption, the railways and some collieries.

Among the advantages the committee foresees are the elimination of factory chimneys and the smoke nuisance, electrification of railways even for goods trains, electric light for the poorest classes, and so forth. The development of a technically sound system of electricity supply, the committee states, is essentially one with the problem of the industrial development of the country. (*Christian Science Monitor*, January 2, 1918, p. 1)

May Admit Women to U. of P. in Month

To offset the loss of more than 2000 students who have enlisted in various branches of the Government service, all departments of the University of Pennsylvania will be declared open to women, beginning with the second term in February, according to an unofficial statement made yesterday by a university official.

One of the reasons and perhaps the chief one for hurrying the general admission of women is the \$250,000 deficit the university faces on account of its reduced enrollment. During the Christmas holidays scores of students have gone into the

service and will not reopen their books. Many of these men would have graduated this year, but a large number are below the draft age and could have remained at school for a year or two. Prior to the holidays these students were advised that it was their duty to remain in college until they were called, but virtually all paid no heed to the admonitions. In one department alone—the Wharton School—fifty-seven students enlisted within ten days. (Philadelphia *Public Ledger*, January 3, 1918, p. 7)

Oil Experimental Station at Bartlesville, Okla.

Secretary of the Interior Lane has designated Bartlesville, Okla., as the location of the new experimental station of the Bureau of Mines for the investigation of problems relating to petroleum and natural-gas industries. The station is one of the three new experimental stations for the establishment of which the sum of $75,000 was appropriated by the last Congress. The two other stations have been located at Minneapolis, Minn., for the study of iron and manganese problems, and at Columbus, Ohio, for research connected with ceramic and clayworking industries.

The technical staff of the new experimental station will study various problems having practical commercial application to the petroleum and natural-gas industries, including questions of productions, transportation, storage and refining of petroleum and various problems connected with the technology of natural gas.

One of the greatest needs of the petroleum industry has been the coördination of scientific research with the practical side of industry, for compared with other mineral industries it has been singularly backward in this respect. The station is aimed to act as an intermediary between the facts evolved by scientific investigations and the needs of the oil industries. That is, men will be employed who will be able to gather scientific data and find out how they may be applied to the practical needs of the industry. (*Official Bulletin*, January 9, 1918, p. 10)

U. S. BUREAU OF STANDARDS

A NEW type of rope-measuring device or rope meter has been thoroughly investigated by the Bureau, using different sizes of ropes in the range of capacity of the instrument and different methods and tensions of pulling the rope through the meter. Suggestions for the improvement of the meter were made to the manufacturer in the Bureau's report.

Space Occupied per Ton of Various Commodities. In connection with the shipping of Government supplies to the front, the Bureau is now engaged in compiling data as to the cubic contents per ton of practically all such commodities. The purpose is to determine the most effective distribution of freight in relation to the available facilities. The sources from which such data are to be obtained have been ascertained and the work of collecting this information is in active progress.

Measurement of Metal Hardness. Data have been gathered by the Bureau as to the hardness numerals obtained with the "Brinell meter" and the "universal Brinell machine." The relative agreement of hardness numerals obtained from depth and diameter measurements is also being determined. The object is to ascertain the relative precision of these instruments, standardize the practice, and facilitate the general tests for hardness. The work is nearly completed.

Radium Luminous Materials. The use of self-luminous materials for the figures on the dials of measuring instruments for night use has called for the careful measurement of the relative brightness of such materials. Methods of measurements have been developed at the Bureau and a standard procedure has been formulated for routine work. The Bureau is investigating possible methods of avoiding the large loss of brightness involved in the present methods of applying luminous materials, with excellent prospect that the loss can be greatly reduced.

Standards of Gas Service. Two important problems have arisen in connection with standards for gas service. Some companies cannot maintain quality at the prevailing price without a loss. The second problem is the making of arrangements to secure the supply of toluol needed for military purposes and which can be most readily obtained from illuminating gas. The two problems have become confused and the Bureau of Standards is endeavoring to consider each separately on its merits. The War Department has been given assistance on the technical aspects of the latter subject, and an article on toluol recovery and standards of gas quality has been sent to the trade journals to secure the needed publicity. As illustrating the changed economic conditions in the gas industry, the Bureau has prepared a statement of the technical phases of the gas situation in the District of Columbia for the use and guidance of the Public Utilities Commission of the District.

Metals. New data have been obtained on light alloys and four reports have been issued by the Bureau on the several phases of its work in this field. New automatic recording apparatus has been designed for taking cooling curves and improved methods of manipulation were devised and tested out in practice. The new apparatus gives more satisfactory results, particularly at the lower temperature ranges, and the characteristics of the curves are more sharply defined.

International Aircraft Standards. The Bureau continues to take an active part in formulating the new International Aircraft Standards. During the past month 14 of these specifications were completed and published.

High-Purity Platinum. In the Bureau's investigation of platinum purity recent tests have developed the interesting fact that the highest possible purity attained hitherto only by a German firm can now be equaled by an American refiner of platinum. This will be of much interest to those concerned with the technical use of highly pure platinum, the supply of which was cut off very shortly after the beginning of the war.

Fire Resistance. Progress is being made in the Bureau's investigation of the fire-resisting properties of reinforced-concrete columns. A new column was made up to test out the simple expedient of holding the protective covering in place under fire conditions. The tiewires connecting the vertical rods with the hooping were cut and free ends allowed to project outside of the reinforcement. These are intended to service as anchorages or ties to prevent slabs of the protective covering from falling away from the column exposing the load-bearing portion to the heat as soon as the covering breaks by reason of the expansion.

Safety for the Household. The safety of the home is the subject of a new pamphlet just issued by the National Bureau of Standards. An interesting account of household hazards is given. The topics are discussed clearly in a manner which

would afford a basis for popular education in "Safety First." The dangers from electricity, gas, fire, lightning, household chemicals, and the other common causes of accident are recited, and many actual cases are described. The purpose is to aid in removing needless risk and fear, and to develop intelligent caution where the hazard cannot be entirely avoided.

The hazards of the home have increased in modern times from the service of gas and electricity and the use of such dangerous articles as matches, volatile oils, poisons, and the like. The use of energy in the home necessarily involves some risk, which intelligent planning and care will reduce to a minimum.

Caution alone is not enough, since many of the dangers are not even suspected. The nature of such unknown hazards must be made plain. The circular emphasizes the seriousness of some of the risks not generally known, gives simple cautions, and aims to guide the formation of habits of carefulness. The circular also suggests effective home equipment to minimize the risks involved, and aims to encourage public measures to provide safety for the household and community.

It is intended, not to increase fear of accident, but rather to remove the causes and the need for alarm. The sense of safety to be gained by observing these cautions would alone justify the careful study of this new circular. This circular completes the series of three popular household circulars which deal with measurements, materials, and safety. These form a valuable addition by the Bureau of Standards to the literature on household management.

The appalling loss of life from avoidable causes and injury to person and property make the pamphlet especially timely. It is believed that thousands of human lives could be saved and accidents reduced to a minimum if the precautions suggested are followed.

Leather Research. Results have been compiled covering laboratory tests and actual service tests of a special tannage of sole leather. Investigation has been conducted to study the wearing qualities of sole leather and of composition soles. The experiments comprise accelerated wearing tests on a machine provided for that purpose and actual service tests conducted by postmen and other Government employees. Similar service tests will be made on shoes worn by soldiers. A study of the water absorption of different grades of sole leather is in progress.

This Month's Abstracts

The simplest—apparently—phenomena of nature may yield results of great importance, if thoroughly and skillfully analyzed. The boiling of water in a metal cup over a gas flame is an everyday experience in practically every household, and what happens there has been supposed to be well known. As a matter of fact, however, Dr. Carl Hering's investigation reported in the section Steam Engineering shows that by changing the shape of the bottom of the cup in an appropriate way, an evaporation many times greater than that obtained from the flat bottomed cup may be secured.

In the section Coolers is described the Heenan method for cooling the jacket water from stationary gas engines in use in India. It is of the open-film type of apparently simple construction.

In the section Engineering Materials are reported several investigations on binary alloys and also two investigations on properties of steel at high temperatures. In the investigation on the thermal expansion Kotaro Honda has determined the relation between the coefficient of expansion of various steels and the contents of impurities, also the elongation curves in the various stages of transformation. The data obtained from this investigation give an insight into the causes of cracking of steel in cooling.

An investigation on the effect of the presence of a small amount of copper in medium-carbon steel by Carle R. Hayward and Arch. B. Johnston has shown that steel containing 0.860 per cent copper is, in practically every respect, superior to steel containing 0.30 per cent copper.

In this connection the article by F. H. Mason in *The Mining and Scientific Press* becomes of considerable interest, in that it discusses the direct production of steel from Sudbury ores. There one of the difficulties lay in the presence of about $1\frac{1}{4}$ per cent copper, which it was believed would make the steel hot-short. F. H. Mason shows, however, that the presence of nearly $3\frac{1}{2}$ per cent of nickel neutralizes this deleterious effect of copper.

In the section Engineering Materials is found an article on the production of pig iron from scrap steel, the so-called synthetic pig iron. It is one of the outgrowths of the abnormal war conditions in the raw material market, but an important one at the present moment.

A double-pass recuperative furnace is described in the section Furnaces.

A mathematical investigation of the flow of water in siphons is abstracted in the section Hydraulics from a paper presented before the Institution of Mining Engineers (Great Britain).

In the section Internal-Combustion Engineering, Cole Newman describes a modified-cycle Diesel engine with compound expansion, which he believes might be suitable for use on motor vehicles. In the same section will be found a discussion of the question of uniformity of multi-cylinder engines in its bearing on engines having no flywheels. The Howard cuff-valve engine is described in the same section.

In the section Lubrication will be found a description of the Michell automatic lubricating gear, the purpose of which is to lubricate during starting and stopping.

The calibration of anemometers is discussed by A. H. Anderson, Mem.Am.Soc.M.E., who claims that the short-arm method of calibrating anemometers may give quite erroneous results.

Formulæ to be used in pin measurement of spur gears are given by Reginald Trautschold in an article abstracted from *Machinery.*

In the section Mechanics, Wilhelm A. Schmidt, Mem.Am. Soc.M.E., discusses further the relation of press stroke to the life of a die, and shows that the whole question in the final count comes down to the number of strokes at the same cutting velocity of the punch within a given time. It is natural that if the same cutting velocity can be obtained with the shorter stroke that was formerly obtained with the longer stroke, the number of useful strokes per unit of time would be greater in the first case.

Tests made by the Research Department of the National Tube Company have shown that in pipe joints the round thread is superior to the Briggs thread in various regards.

In the section Munitions will be found a bibliography on the French 75-mm. cannon, the famous "soixante-quinze," prepared by the Library of the United Engineering Society.

In the section Steam Engineering is reproduced a brief mathematical investigation by Gerald Stoney on the divergence of steam nozzles, originally appearing in *Engineering.*

Heat transfer in tubes by W. Nusselt is indirectly abstracted from the *Journal of the Society of German Engineers,* while from the *Proceedings of the Royal Society* is abstracted an interesting investigation on the specific heat of water by W. R. Bousfield.

REVIEW OF ENGINEERING PERIODICALS

SUBJECTS OF THIS MONTH'S ABSTRACTS

For Articles on Subjects Relating to the War, see Aeronautics, Engineering Materials, Machine Shop, Munitions, Varia.

Aeronautics

Special Spark Plugs Needed for Airplane Engines. *Automotive Industries*, vol. 38, no. 1, Jan. 3, 1918, pp. 29-32, 4 figs. 1. Unusual Insulating Materials Seldom Withstand Heat; 2. Electrode Must Be Specially Cooled; 3. Oil Must Not Reach Insulation or Must Be Burned; 4. Plug Must Have Good Mechanical Strength.

Overhauling the Gnome Airplane Engine. *American Machinist*, vol. 48, no. 1, January 3, 1918, pp. 9-15, 16 figs.

British Aviation Engine Inspection, Lieut.-Col. R. K. Bagnall-Wild. *Automotive Industries*, vol. 38, no. 2, January 10, 1918, pp. 125-130, 2 figs., 3 charts. Part 1: Chart scheme of couple system in use; best methods of employing women in work; routine for rejection by government men; plan of using approved firms is favored; advantages of inspection to companies. Pt. 2 to follow.

Some Notes on Recent German Aeroplanes. *The Engineer*, vol. 124, no. 3233, December 14, 1917, pp. 516-518, 6 figs.

The Armament of Aeroplanes. *Engineering*, vol. 104, no. 2708, November 23, 1917, pp. 544-546, 24 figs.

Aeroplani Velocissimi. *Revista Marittima*, Anno 50, no. 9, September 1917, pp. 355-366, 2 figs., 4 charts, 2 tables. Gives formulæ and curves showing the relation of aeroplane displacement to speed, radius of action to speed, engine power to speed; also a table for various types of machines giving weight of machine, weight of power plant, output, and radius of action. An abstract of this article will be given in an early issue.

On the Maximum Flight Value of Aeroplanes, Umberto Nobile. *Aeronautics*, vol. 13, no. 216 (New Series), December 5, 1917, pp. 434-436, 2 charts.

Air Engineering

The Temperature of Evaporation, Its Practical Application to Air Conditioning and to the Drying and Conditioning of Materials, W. H. Carrier. *Journal of the American Society of Heating and Ventilating Engineers*, vol. 24, no. 2, January 1918, pp. 227-248, 6 figs.

Dust: Its Universality, Elimination and Conservation, E. R. Knowles. *Journal of the American Society of Heating and Ventilating Engineers*, vol. 24, no. 2, January 1918, pp. 285-327, 44 figs.

Air Machinery

Gasoline-Driven Air Compressor. Fig. 1 shows a section through a gasoline-driven air compressor, built by the Chicago Pneumatic Tool Company. It is of the horizontal, straight-line, single-stage, double-flywheel, enclosed-frame type. The power and air cylinders are connected in tandem.

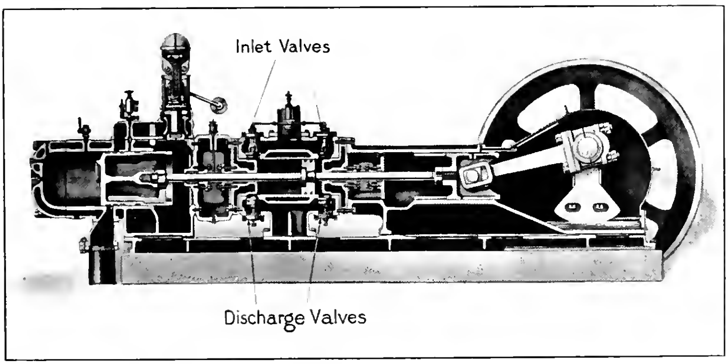


Fig. 1 Gasoline-Driven Air Compressor

The power cylinder is operated on the two-stroke cycle with low compression and high-tension electric ignition, a pressure governor regulating the amount of gasoline that is admitted to the cylinder.

The crosshead is of the single-piece box pattern without adjustable shoes, and it overtravels the guide nearly one-half its length at each end of its stroke; thus bringing the longitudinal wear on the guide on an even straight line throughout its length.

A combined speed and pressure governor is used in conjunction with the differential unloader on the gas-driven compressor. Together these automatically limit the speed of the machine, maintain a practically constant air pressure at all times, and reduce the load to a minimum when there is no demand for air. The unloader controls the air supply by permitting the opening to the air inlet valves and allowing the air in the cylinder to return to the atmosphere whenever the pressure in the receiver exceeds the predetermined amount. (*Power*, vol. 46, no. 25, December 18, 1917, p. 83, 1 fig., *d*)

Coolers

MECHANICAL WATER COOLING ON THE HEENAN PRINCIPLE. The Heenan cooler was primarily designed for use with stationary internal-combustion engines, but may be used for other purposes. It consists of cylinders built up of galvanized sheeting wound into the form of a spiral with air spaces between each convolution. The sheeting forms a large cooling surface within a small space. The cylinders are caused to revolve slowly in a covered trough containing the water to be cooled, and in revolving they take up the thin film of water which wets both sides of the sheet. A fan fixed at the end of the upper part of the cooler casing causes air to be blown through the annular spaces of the cylinder. This cools the film of water on the sheets; a considerable additional cooling effect is obtained by the partial evaporation of the water film.

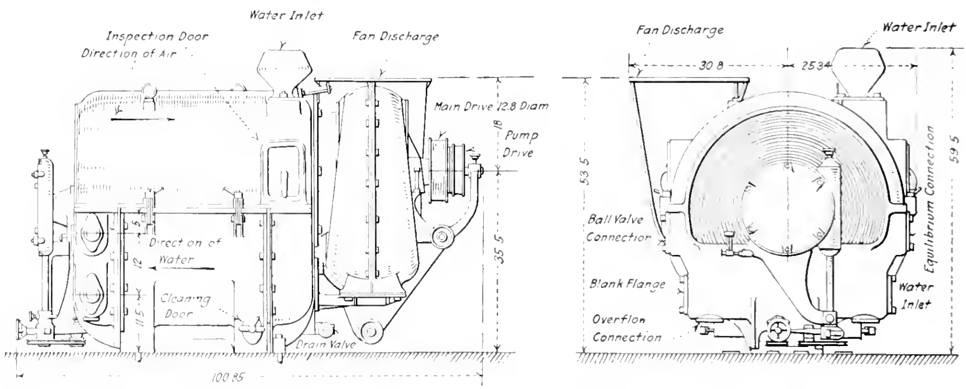


FIG. 2 HEENAN WATER COOLER FOR 200-B.HP. ENGINE WORKING UNDER TROPICAL CONDITIONS

The construction of the cooler is shown in Fig. 2. It is stated that such a cooler for a 100-b.hp. engine working in a tropical temperature requires a floor space of about 6.5 ft. by 5.5 ft. with 3.5 ft. headroom, while the natural-draft cooling tower for the same capacity would be about 7 ft. square and 15 ft. high. The power required to operate the cooler is said to amount to less than 1 per cent of the engine power for large sizes.

It is said that there are a large number of these coolers installed in India. One cooler to handle 30,000 cu. ft. of air per min. is working at the Calcutta Electric Supply Company's new power station at Cossipore in connection with the large turbo-alternator. (*Indian and Eastern Engineering*, New Series, vol. 41, no. 3, September 1917, pp. 85-86, 2 figs., *d*)

Engineering Materials

THE THERMAL EXPANSION OF DIFFERENT KINDS OF STEEL AT HIGH TEMPERATURES, Kotaro Honda. Data of an investigation on the expansion of a Swedish iron, ordinary steel, and high-speed tool steel at various high temperatures.

To measure the expansion Chevenard's method was used and the measurements were made in a vacuum to avoid the oxidation of the specimens.

In particular, the relation has been determined between the coefficient of expansion of various steels and their content of impurities, especially manganese. In the case of Swedish steel the A_1 transformation is not observable in the elongation curve at all. In the range of A_2 transformation abnormal contraction is scarcely observable, but in the range of A_3 transformation a gradual contraction by heating and a gradual elongation by cooling are noticed. But in steel with 0.14 per cent carbon the abnormal change of length begins to appear in the A_1 transformation, clearly distinguishable from that during the A_3 transformation. This abnormal change of length in the A_1 range is more conspicuous in the 0.18 per cent carbon steel, while in the steels of 0.31 per cent and 0.44 per cent carbon, the temperature of the A_3 transformation noticeably decreases and the abnormal changes of length corresponding to the two transformations, A_1 and A_3, partially overlap each other.

It is also interesting to observe that manganese, even when present in a very small quantity in steels, affects their coefficients of expansion to quite a large extent.

The various high-speed steels show elongation curves rather similar to each other. They also show the abnormal contraction in the vicinity of 850 deg., probably due to the A_3 transformation. Their coefficient of expansion increases with temperature.

The following remark is made by the writer:

Since for high-speed carbon steels the abnormal elongation or contraction due to the A_1 and A_3 transformations takes

place abruptly, it is possible that in the case when the temperature of a large specimen in the range of 700 deg. cent. is not uniform throughout the specimen, an internal strain and therefore an enormous stress will be developed during heating and cooling. During heating the inner portion is cooler than the outer portion, so that at about 700 deg. the outer portion contracts while the inner portion has not yet begun to contract, and therefore the outer portion exerts an enormous compression inward. During cooling the contrary is the case.

Besides the fact that the coefficients of expansion of steels investigated in the range of temperatures below the A_1 point increase rapidly with the temperature, it has also been found that the coefficient of expansion-temperature curves are slightly concave toward the axis of temperature, with the exception of some tungsten steels, for which the contrary is the case. (*The Science Reports of the Tohoku Imperial University*, Sandai, Japan, First Series, vol. 6, no. 4, pp. 203-212 and 6 pages of plates, *e*)

The Effect of the Presence of a Small Amount of Copper in Medium-Carbon Steel, Carle R. Hayward and Arch. B. Johnston. Data of an investigation undertaken in order to obtain additional data on the mechanical properties of medium-carbon steel containing small quantities of copper. The discussion is introduced by brief references to previous investigations, which, by the way, agree that copper increases the tensile strength, but disagree in regard to the ductility, and touch only in a slight degree upon the question of resistance to shock.

In the present investigation two types of steel were tested: one containing 0.30 per cent copper, 0.012 per cent phosphorus, and 0.860 per cent copper, and the other 0.365 per cent carbon, 0.053 per cent phosphorus and 0.030 per cent copper. As regards the difference in phosphorus, the writers expressed the belief that it is probable that the effect of phosphorus is neutralized by this slight difference in carbon.

The bars tested have been subjected to various kinds of heat treatment. The samples were submitted to tensile tests, shock tests, Brinell and scleroscopic hardness tests, and a microscopic examination. The results are presented in the form of tables and curves, and of the latter Fig. 3 is here reproduced.

These tests have shown that in regard to tensile strength high-copper steel has a decided superiority. The yield point and ultimate strength are in every case higher, while the ductility is practically the same. The hardness tests by both methods show a high-copper steel to be harder than the low-copper, while the Charpy shock tests show a high-copper steel also superior to the low-copper. In all, the tests have confirmed the previous statement made by Stead that the behavior of copper steel resembles that of nickel steel. Microscopic investigation revealed that for the same heat treatment the high-copper steel was finer grained than the low-copper. The quenched and drawn specimens of high-copper steel were also found to be slightly more martensitic. (*Bulletin of the American Institute of Mining Engineers*, no. 133, January 1918, pp. 159-167, 1 fig., *e*)

Pig Iron from Scrap Steel. This is what is known as synthetic pig iron, and is a material that has now become a commercial product.

The production of munitions on an unprecedented scale has created a vast amount of scrap steel in the shape of shavings, ends, and rejected material. This, together with the general shortage of raw materials, has made it necessary to find a convenient method of utilization.

At first glance it may appear that converting steel into pig iron is a rather illogical method of procedure. Actually, however, especially in Europe, it has been found to answer the particular purpose of producing a uniform material from a mass of scrap of varying carbon content.

The new process is now being applied commercially in the United States at the Sweetzer-Bainbridge Metal Alloy Corporation at Watervliet, New York, where two 5-ton Ludlum electric furnaces are used with the daily output of about 50 tons per day.

The process is not really new but is quite simple, although the precise procedure is not published. The process is now basic. Ordinary scrap steel of any grade is introduced into the furnace cold, is melted and, if necessary, refined. After the desired refinement is reached the slag is removed. The necessary amounts of ferrosilicon and ferromanganese are added to bring the iron to the composition desired, and then the carbon is added in the form of fine coke, which is easily absorbed by the hot metal.

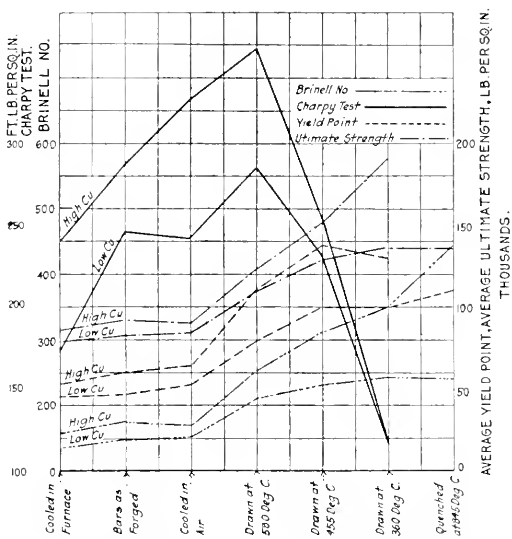


Fig. 3 Physical Properties of Copper-Bearing Medium-Carbon Steel

The regulation of the temperature and composition is quite simple, and a range from high-grade low-phosphorus iron and wash metal down to the high-phosphorus foundry and other irons is possible. The graphitic carbon content is regulated by the introduction of varying percentages of silicon. A knowledge of the composition of the scrap charged into the furnace permits to regulate quite closely the phosphorus and sulphur contents.

The pig iron is reported to be very tough and strong. As to cast iron in the form of castings, the experience of the Ludlum Steel Co. is cited. Cast-iron wobblers, for use in the company's rolling mill, which were purchased in the open market, were breaking at the rate of 10 to 12 per day. Wobblers from iron made in the electric furnace have been in use for two or three months without a case of breakage. The

company also made breaking boxes on the mill of electric cast iron. These should break easily when performing their normal function, but when made of this iron they were found to be entirely too tough, and their section had to be reduced considerably. It is believed that some explanation for these qualities may be found in the crystalline structure of the iron, as well as in its greater purity compared with cupola iron, because in the electric process, contrary to cupola practice, the sulphur decreases with each remelting. In making steel castings, the conversion loss is put at 5 per cent. The cost of production is one of the vital points. So long as low-phosphorus pig iron is selling at its present war price there can be no question as to the liberal profits obtainable. Whether in normal times such a method of making this grade or any other grade of pig iron or castings is economically possible depends on several factors. First among these are the consumption of electricity and the grade of scrap used. (*Mining and Scientific Press*, vol. 115, no. 23, December 29, 1917, pp. 936-938, 2 figs., *dp*)

Metallographische Untersuchung über das System von Tellur und Aluminum, Masumi Chikashige und Jitsuzo Nosé;

Metallographische Untersuchung über das System von Selen und Antimon, Masumi Chikashige und Masasuke Fujita;

Metallographische Untersuchung über das System von Zink und Selen, Masumi Chikashige und Rokuro Kurosawa;

Metallographische Untersuchung über das System von Cadmium und Selen, Masumi Chikashige und Riichi Hikosaka;

Metallographische Untersuchung über das System von Aluminum und Selen, Masumi Chikashige und Tsugiji Aoki. Memoirs of the College of Science, Kyoto Imperial University, vol. 2, no. 4, July 1917, pp. 227-254, 19 figs. A series of metallographic investigations on the binary alloys aluminum-selenium, zinc-selenium, cadmium-selenium, antimony-selenium and aluminum-tellurium.

Nickel-Copper Steel Direct from Sudbury Ores, F. H. Mason. *Mining and Scientific Press*, vol. 116, no. 2, January 12, 1918, pp. 57-58. Discusses methods used. The process was formerly considered impossible as the material produced would contain more than 0.75 per cent copper and therefore might be expected to be hot-short. It has been found, however, that a slightly larger per cent of copper is harmless in the presence of a sufficiently large amount of nickel in the same steel.

Tungsten and High-Speed Steel. *Engineering*, vol. 104, no. 2709, November 30, 1917, pp. 567-568. Description of processes used in the production of tungsten and especially high-speed tool steel.

Research on Refractory Materials, G. E. Foxwell. *The Iron and Coal Trades Review*, vol. 95, no. 2595, November 23, 1917, p. 578.

L'Industrie et les Grandes Applications de l'Aluminum pur et a l'État d'Alliage, Jean Escard. *Le Génie Civil*, Tome 71, no. 1843, December 8, 1917, pp. 375-378, figs. 11-14. Part 2. Discussion of the production of aluminum and aluminum alloys, chiefly with reference to France.

On the Thermal and Electrical Conductivities of Carbon Steels at High Temperatures, Kotaro Honda and Takeo Simidu. The *Science Reports* of the Tohoku Imperial University, First Series, vol. 6, no. 4, November 1917, pp. 219-233, 4 plates. Data of tests carried out to determine the thermal conductivity of carbon steels at high temperatures as well as the electric resistances. As regards thermal conductivities it was found in Swedish iron-steel and iron that conductivity decreases at first slowly and then somewhat rapidly as the temperature is increased. Above the A_2 point it slightly increases in a linear relation to the temperature, a change of conductivity by temperature being apparently quite parallel with that of magnetization. Tests were carried out for temperatures up to 900 deg. cent. and it was found that for pure iron and nickel, and probably for all pure metals, Lorenz's law is exactly satisfied. Hence, for these metals the value of thermal conductivity at high temperature may be estimated from that of ordinary temperatures provided only the electrical resistance at the high temperature is known.

Foundry

Iron Oxide—Its Effect on Molding Sand, W. R. Dean. *The Foundry*, vol. 46, no. 305, January 1918, pp. 5 and 34.

The Overweight Casting: Its Cause and Remedy, R. R. Clarke. *The Foundry*, vol. 46, no. 305, January 1918, pp. 12-16, 1 fig.

The Manufacture of Pattern Castings, Henry M. Lane. *The Iron Age*, vol. 101, no. 1, January 3, 1918, pp. 36-38, 7 figs.

Fuels

Peanut Oil as Fuel for Motorships. The large motorship *France* has successfully used peanut oil as fuel under ordinary ocean-going conditions, which confirms the former claim that Diesel-motor-driven vessels no longer need be dependent upon the supply of mineral oils.

Hitherto vegetable oils have been too expensive and insufficiently distributed to be considered as fuel for merchant ships, but the successful use of peanut oil may bring about a change in this view.

Southern Europe can obtain her supply of peanuts from northwestern Africa. In America there is also a large supply of peanuts. In fact, the Interstate Cotton Seed Crushery Association down South expects a peanut crop this season of a hundred million bushels. However, with the present price of American peanut oil at about 18 cents per lb., or \$57 per bbl., it cannot be economically used for Diesel engines in this country. (*Motorship*, vol. 3, no. 1, January 1918, p. 6)

Alcohol as a Source of Power, W. T. Rowe. *The Engineer*, vol. 124, no. 3231, November 30, 1917, pp. 471-472.

Fuel Saving Suggestions, Charles H. Bromley. *Power*, vol. 46, no. 24, December 11, 1917, pp. 786-789, 1 fig., 2 tables. The writer discusses some of the sources of appreciable loss of fuel when used under steam boilers and means for the elimination of such waste. He describes a recommended style of boiler setting for soft coal and gives complete specifications for this improved type of horizontal tubular boiler. A number of practical suggestions are included. Scraper conveyors, it is stated, are limited to about 300 ft. length. The relative advantages of bucket and bale conveyors are considered.

Blue Water Gas Used for Metal Melting in Great Britain. *American Gas Engineering Journal*, vol. 107, no. 26 (whole no. 3121), December 29, 1917, pp. 588-593.

Double-Pass Recuperative Furnaces. Description of a type of furnace successfully used in Europe.

Notwithstanding certain known advantages in the operation of recuperative furnaces, they have not yet displaced the regenerative furnace, which is mainly due to the inability of the recuperative to withstand temperatures between 1300 and 1500 deg. fahr. for any length of time without undergoing repairs. This applies mainly, however, to the recuperative furnaces of the usual type. In Europe several recuperative furnaces are in successful operation and are of a construction different from those usually employed in this country. They are constructed of hollow-brick blocks, which are built with a male flange on one end and a female flange on the other, with walls $1\frac{1}{8}$ in. thick. When several rows of blocks are placed adjacent they form flues through which the products of combustion pass. Other courses are mounted on top of and parallel to the first row of blocks. Traverse flues are formed between the upper and lower surfaces of these blocks, and it is through these flues that the secondary air is heated before mixing with gas.

The heating furnace is placed on top of the recuperator. The gas enters the lower combustion chamber of the recuperator and flows to the rear, where it mixes with preheated secondary air. This secondary air is heated by passing through ducts which are formed by the collars on the channel blocks when placed one upon the other. The temperature of the air is further increased by passing through another series of ducts, which discharge into a central chamber from which the air is directed to the combustion chamber. (*Iron Trade Review*, vol. 41, no. 24, December 13, 1917, pp. 1277-1278, 2 figs., *d*)

Hoisting and Conveying

Operation and Maintenance of Elevators—Winding-Drum Machines, R. H. Whitehead. *Power*, vol. 47, no. 2, January 8, 1918, pp. 40-43, 5 figs.

Selection of Coal and Ash Conveyors, H. E. Birch. *Power*, vol. 47, no. 3, January 15, 1918, pp. 82-86, 10 figs. The writer believes that four items control the selection of coal- and ash-handling equipment: cost of operation, maintenance, interest on the investment, and adaptability. From his point of view roller flight conveyors are considered desirable.

Hydraulics

Automatic Hydroelectric Plant. Description of a hydroelectric plant which is automatic in all its operations. The plant is so arranged that a rise of water level causes the proper number of generators to start to utilize water most economically. It belongs to the Iowa Railway & Light Co., and is located on the Cedar River.

This plant, which will have an ultimate capacity of 2000 kw., operates in parallel with an extensive transmission system. In the hydroelectric plant itself there are no instruments, all being installed in the company's steam station, which is about 0.6 mile distant. The connections are such that, while the hydroelectric station is self-controlled and automatic, it is possible for the steam-plant operators to control the action of the water wheels and generators.

One of the most spectacular features is the speed with which the station goes into service. It requires just 37 sec. from the time the first switch operates until the first generator is under full load. The system of electric controls is a double one: namely, either by float switches and contact-making ammeters in the hydroelectric plant, or by remote-control switches on the benchboard at the steam power plant.

As regards the hydraulic equipment, it is stated that the normal head at the plant is 10 ft., but the head may vary from 8 to 11 ft.

The dam is composed of nine 60-ft. spillway sections, each of which automatically rises and falls with the flowage of the river, giving an automatic flashboard effect. Four motor-driven Tainter gates are installed at the intake to the flue. Wheel pits at the power house are independent of each other, and are equipped with 20-ft. Tainter gates on the upstream side and stop logs on the downstream side. The water wheels are of the Francis single-runner type, measuring 171 in. in diameter, and are rated at 540 b.hp., 60 r.p.m. and 84 per cent efficiency under a 10-ft. head.

Fig. 4 indicates the method of using the Tainter gate and the position of busses with respect to the control cabinets.

The original article describes in detail the electric controls. An interesting feature of these controls is the safety provisions, especially important because the station is left attendantless, except for one visit every eight hours by an employee from the steam plant, and therefore must take care of its own cases of trouble if any arise. To that end the machines are protected against hot bearings by thermostats of the spiral-spring type installed on each bearing. These thermostats are set to operate at 45 deg. cent. In common with all other

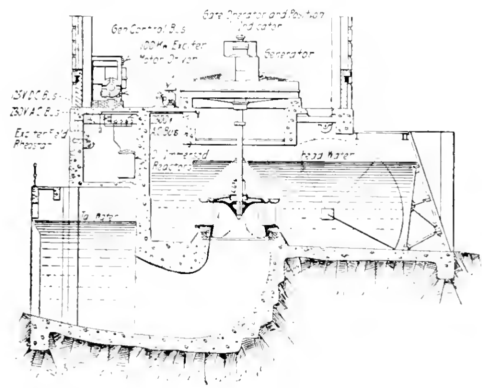


Fig. 4 Control Features of Cedar River Automatic Hydroelectric Plant

thermostatic control in the station, these bearing units operate to shut down the machine affected entirely, and keep it shut down until conditions again become normal, when the machine will start of its own accord. Thermostats are also used in connection with the control of the current-limiting reactors and the stator coils of the generators. (*Electrical World*, vol. 20, no. 22, December 1, 1917, pp. 1042 to 1045, 7 figs.; and *Power*, vol. 46, no. 24, December 11, 1917, pp. 790-793, 7 figs., *d*)

The Flow of Water in Siphons, Mark Halliday. Analysis of the flow of water in siphons. The writer considers two cases: first, that of a single siphon with one pump, and second, an amended arrangement.

In the case of the simple siphon shown diagrammatically in Fig. 5, he derives the following equation:

$$\frac{h_3}{l_2} = \frac{34 - h_1}{l}$$

where h_1 is as indicated in the diagram, l_2 is the length of the

pipe from A to C, h_2 H_2 H_1, as indicated in the diagram, and l is the length of the pipe in feet.

Unless this relationship holds, the siphon will not work continuously without a regulating valve. It will be noted that h_3 equally as much as h_2 governs the discharge. If h_2 is excessive, then v_3 tends to become larger than v_2, and cavitation in the pipes will result.

This explains the statement made so frequently that some siphons work better when the valve at the delivery end is partly closed. This must necessarily be the case, as the valve must be regulated until ($v_3 \times$ area at C) = ($v_2 \times$ area at B).

The same reasoning when applied to the Nicholson compound siphon results in the following deductions.

Fig. 6 shows the diagrammatic arrangement of the siphon; H_3, $\frac{P_3}{62.4}$, and v_3 are the static, pressure, and velocity energies per pound of water, respectively, at the air inlet N of the

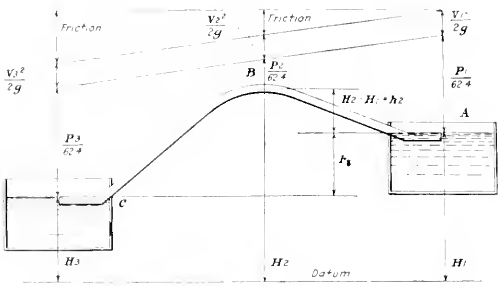


FIG. 5 SIMPLE SIPHON SHOWN DIAGRAMMATICALLY

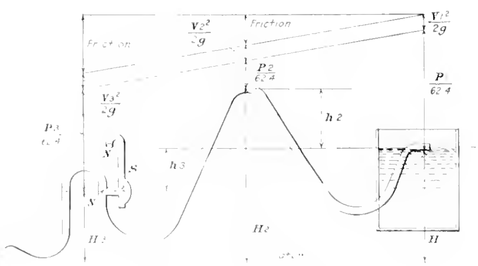


FIG. 6 AMENDED SIPHON

compound siphon. Then if the air inlet and trap N, S, N is fixed in a position according to the relationship in Equation [11], viz., such that $\frac{h}{l_2} = \frac{34 - h}{l_1}$, the compound siphon will discharge as much water as any simple siphon.

It has been assumed throughout that f, the coefficient of friction, is the same for the whole length of pipe considered; also, in order to simplify the argument, that $p_1 = 0$.

For a maximum discharge this would be so, but the analysis would hold equally well if p had a value of a few feet.

In that case the figure could be inserted to slightly modify the result in equation. (*Transactions of the Institution of Mining Engineers*, vol. 54, pt. 2, November 1917, pp. 107-112, 2 figs., *t*)

Internal-Combustion Engineering

LIGHT DIESEL ENGINE FOR MOTOR VEHICLES, Cole Newman. The writer claims that the modified-cycle Diesel engine with compound expansion would make this type applicable to motor vehicles, and further suggests the use of steam from jackets to modify cylinder pressures.

Germany is said to have just produced a Diesel aeroplane engine of the Junkers type weighing 3½ lb. per hp. It consists of double pistons in each cylinder working in opposite directions, giving a well-balanced engine practically free from vibration.

In this country it has been demonstrated that fuels heavier than kerosene cannot be successfully carburetted.

The problem is therefore how to handle the fuels. Automobile engineers hesitate to complicate the automobile engine with delicate injection apparatus, and, in fact, the amount that would be injected each time into the cylinder of an automobile engine of the Diesel type would be so small that it appears questionable whether it could be accomplished or not.

It would seem more practicable to atomize these heavy fuels and mix them with the ingoing air, after which they could be exploded by the heat of compression. An ordinary spark plug will not ignite such a mixture, or even if it were ignited a great deal of smoke and carbon deposit would result. But the compression of the charge to high pressure completely evaporates the finely atomized mist of fuel, and finally ignites it. Certain auxiliary features would be necessary for such an engine, viz., control of the point of ignition so as to prevent preignition, which might be accomplished either by varying the compression or by admitting variable amounts of water with the fuel.

The writer suggests the use of a compounded internal-combustion engine; for example, the following arrangement: a six-cylinder internal-combustion engine having four high-pressure cylinders of the four-stroke-cycle type and two low-pressure cylinders receiving exhaust from one or the other cylinder at every stroke. Assume that the four cylinders operate on the Diesel cycle by means of an atomized mixture of air with heavy fuel ignited by compression and controlled by water admission. Assume, in the first place, that the high-pressure cylinders only are water-cooled and the low-pressure cylinders properly lagged, as in the case of any steam engine. Assume that the heat of the water is utilized by permitting it to boil in the jackets. The steam from this water is admitted to the carburetor. Such as is not needed can be bypassed into the radiator. Therefore, the greater part of the heat lost to the jackets is restored to the cylinder at a lower temperature but greater heat mass. It enters the cylinder with the mixture of fuel and air, and controls the ignition point as desired. The mixture of the products of combustion with the greatly superheated steam after explosion passes through the exhaust valve to the low-pressure cylinder. The low-pressure cylinder, therefore, has not only that portion of the pressure derived from the high-pressure cylinder, but also the heat of the steam from the water jacket and of the exhaust, which is usually wasted, to turn into useful work. The cylinder also acts as a muffler, eliminating that apparatus entirely. Although a six-cylinder engine, it would give eight impulses per revolution of the crankshaft. (*Automotive Industries*, vol. 37, no. 26, December 27, 1917, pp. 1134-1135, *t*)

UNIFORMITY OF INTERNAL-COMBUSTION MOTORS WITH 6 AND 8 CYLINDERS, E. Pistolesi. (*Accad. Sci. Torino*, 52. 1, pp. 162-186, 1916-1917.) This question is of particular interest in connection with submarine motors where the use of a fly-

wheel is inconvenient. The author investigates the applicability of Wittenbauer's method to the case of multicylindered engines, and from the results obtained in specific cases he draws the following conclusions for engines of the same class as those investigated: (1) Four-stroke, six-cylinder motors with two compressors need a flywheel of moderate dimensions. The arrangement of the compressors has but small influence on the regulation. (2) Two-stroke, six-cylinder motors with their rods at an angle of 60 deg. need a small flywheel. The compressors have a preponderating influence on the regulation, and their position needs careful investigation. (3) Two-stroke, eight-cylinder motors with two compressors need no flywheel, provided all eight cylinders operate simultaneously. The compressors have a preponderating influence on the regulation, and with a suitable arrangement of these it is possible to attain a high degree of regularity. (*Science Abstracts*, Section B—Electrical Engineering, vol. 20, part 11, no. 239, November 30, 1917, p. 405, *t*)

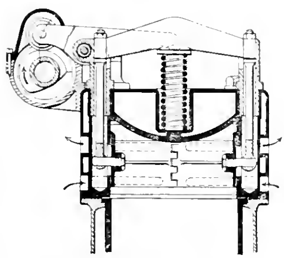


FIG. 7 ONE CYLINDER OF HOWARD CUFF-VALVE ENGINE

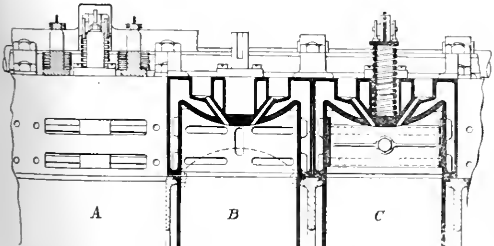


FIG. 8 THREE CYLINDERS OF HOWARD ENGINE

THE HOWARD CUFF-VALVE ENGINE. A type of engine combining to a certain extent the features of sleeve and poppet valves, which valve system is briefly described in the following paragraphs:

In a detachable cylinder head are arranged annular inlet and exhaust ports, both these rows of ports being covered and opened by the reciprocation of a broad but light ring somewhat resembling a wide piston ring. The ring is just wide enough to cover both sets of ports with sufficient overlap to prevent leakage. It is split and tongued at one point of its circumference, so as to make it elastic and to enable the compression and explosion pressures to press it tightly to the wall at the cylinder head. During these pressure periods of the cycle the valve is at rest and practically forms part of the cylinder-head wall, so that it can become only a few degrees hotter than the latter, which is water-cooled.

At the end of the explosion stroke the valve is moved downward, and immediately the exhaust port is uncovered the remaining explosion pressure is released. The valve then ceases to grip by reason of the internal pressure being released and can be moved merely to open and then to close the exhaust ports. When the valve has moved upward sufficiently to close the exhaust ports it continues this movement and immediately uncovers the inlet ports. At the correct moment it descends again and closes the inlets, remaining at rest in its mid-position during the next two strokes, held tightly to the cylinder-head wall over the ports by the internal pressures on the compression and explosion strokes.

The mechanism for operating the valve is shown in Figs. 7 and 9. The first shows the valve at the top and also the special cam and operating levers. Only one helical spring is shown, but in practice two concentric springs are used, wound in opposite directions to prevent periodicity.

In Fig. 8 is shown an outside elevation of one of the cylinders at *A*, indicating the height of the valve gear above the piston. *B* is a vertical axial section with the valve and its actuation removed to show the arrangement of the ports. The highest point reached by the piston is shown in broken lines, the top ring indicated being of the obturator type. *C* is a complete vertical section.

Fig. 9 shows the actuation of the cuff valve. This view

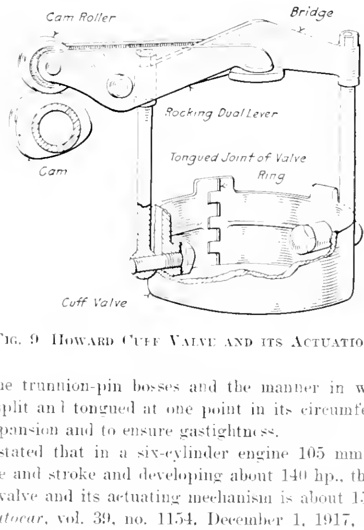


FIG. 9 HOWARD CUFF VALVE AND ITS ACTUATION

shows the trunnion-pin bosses and the manner in which the ring is split and tongued at one point in its circumference to allow expansion and to ensure gastightness.

It is stated that in a six-cylinder engine 105 mm. by 106 mm. bore and stroke and developing about 140 hp., the weight of each valve and its actuating mechanism is about 15 ounces. (*The Autocar*, vol. 39, no. 1154, December 1, 1917, pp. 540-543, 5 figs., *d*)

THE EFFICIENCY OF THE MOTOR, George Crouch. *Motor Boat*, vol. 14, no. 24, December 25, 1917, pp. 13-16. Brief consideration of the efficiency of the motor-boat engine, which the writer considers to be low in ordinary motor boats.

Lubrication

MICHELL'S AUTOMATIC LUBRICATING GEAR. Description of a new type of apparatus, the purpose of which is to lubricate bearings during starting and stopping by means of an automatic device which does not require the application of any auxiliary driving power. It was developed by Mr. Michell, the inventor of the Michell thrust and journal bearings. This

apparatus, which is really a specialized accumulator, requires no pumps for its operation, but is actuated entirely by the flow of oil which is maintained under pressure between the working surfaces of the bearing during running at normal speed.

As shown in Fig. 10, the top brass of the bearing is pivoted on a hollow stud making oil-tight contact with the brass through which a hole is drilled to its working surface at or near the point where the oil pressure is a maximum.

Assuming that the bearing is subject to a constant load of 500 lb. per sq. in. of the projected area of its brasses, oil is supplied during the normal running of the machine by the automatic action of the pivoted brass through the pipe and valves provided in the apparatus at a pressure of, say, 900 lb. per sq. in. The outer end of the hollow stud is connected by the pressure pipe to the accumulator cylinder constructed on the intensifier principle. As shown to the right in *B* and *C*,

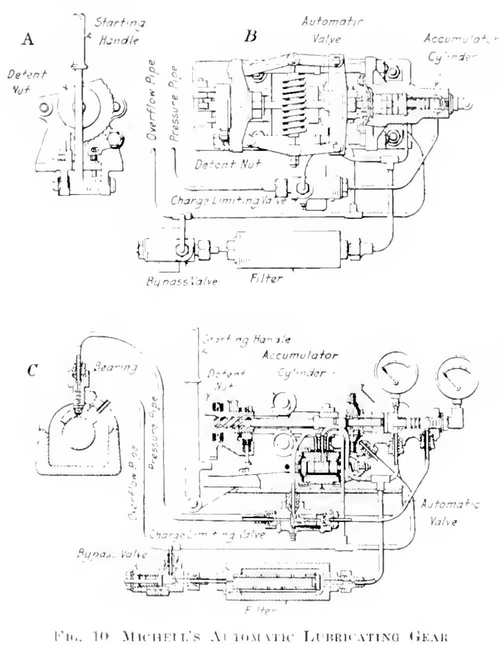


FIG. 10 MICHELL'S AUTOMATIC LUBRICATING GEAR

Fig. 10, it has a large and a small chamber in tandem, and is fitted with a stepped plunger turned to corresponding diameters. The pressure pipe delivers oil from the bearing into both chambers of the accumulator, forcing the plunger outwards and extending the loading springs, which are arranged to apply a practically constant load on the plunger of the accumulator by means of the toggle motion shown in *B*, Fig. 10.

When the outward motion of the plunger is completed it is held in that position by means of a detent nut and a pawl engaging with the nut, *A*, Fig. 10, whether the bearing continues to run or not, until the starting handle is shifted to the starting position. The accumulator is fully charged in a few minutes of normal running and the plunger remains at the outer end of its stroke during the remainder of the time that the motor is running and after it stops.

As the detent nut retains the plunger against the load imposed by the loading springs, *A*, Fig. 10, the latter imposes no pressure on the oil once the pawl is engaged, and little or no leakage takes place from the accumulator while the motor is stopped.

At starting the whole tension of the loading springs is applied to intensify the oil pressure in the small chamber of the accumulator up to, say, 2500 lb. per sq. in., oil at this pressure being discharged back through the pressure pipe to the bearing. By this means a film of oil is forced between the bearing surfaces lifting the rotor to the extent of, say, 1-1000 of an inch, and allowing it to start without solid friction on the bearing surfaces, with a comparatively very small starting current. Actual tests have shown that, whereas the coefficient of friction of the bearings on their brasses amounts to 0.18 under the usual conditions of starting, even if the starting is effected almost immediately after stopping so that the surfaces retain an appreciable amount of oil, the effective coefficient drops to less than 0.01 when the accumulator is used for starting.

In practice, one accumulator may supply all the bearings of the unit on which it is installed, and even can be made to serve several units. (*Engineering*, vol. 104, no. 2708, November 23, 1917, pp. 548-549, 7 figs., *d*)

CHARACTERISTICS OF SYSTEMS OF LUBRICATION FOR MOTORSHIPS, Thomas E. Coleman. *Motorship*, vol. 3, no. 1, January 1918, pp. 19-20, 2 figs., 2 charts. An abstract will be given in an early issue.

SIMPLE PROBLEMS IN FORCED LUBRICATION, Lord Rayleigh. *Engineering*, vol. 104, no. 2711, December 14, 1917, p. 617, 2 figs.

Machine Shop

HEAT TREATMENT AND TEMPERATURE MEASURING FOR SHELLS, J. R. VanWyck. Description of a method of heat treatment and temperature measuring that was used in the manufacture of two million 3-in. Russian shrapnel shells.

Lead-bath furnaces with room for eight shells and a preheater with room for 20 shells were used, all shells being heated and cooled in exactly the same manner. The shells in the preheater were heated from 700 to 900 deg. fahr. before being placed in the lead, pure lead being used for the bath and thermocouples being employed to take the temperature of the bath.

The article describes in detail the method of heating the bath, regulating the temperature of the lead and the signal system of colored lights employed for regulating the furnace. Base-metal thermocouples were used, these thermocouples being made right in the shop.

A very careful and systematic method of checking the working base thermocouples with the standard base-metal couples in the electric furnace was used once a week. The standard base-metal thermocouples were calibrated with the aluminum-rhodium thermocouples by removing the protecting tubes and tying together, but not touching, with asbestos tape. (*American Machinist*, vol. 47, no. 25, December 20, 1917, pp. 1087-1090, 10 figs., *d*)

MANUFACTURING OPERATIONS IN MAKING A GASOLINE MOTOR. *American Machinist*, vol. 48, no. 1, January 3, 1918, pp. 1-4, 15 figs. In this article are shown jigs and fixtures for machining the parts of a gasoline motor. The operations for machining the cylinder are taken in sequence and speeds, feeds and operating time are given. An interesting jig for drilling

the intake manifold, which is provided with a toggle equalizing mechanism for centering and holding the part, is worth noting.

Boring and Reaming Tools for 220- and 270-mm. French Shells, James Forrest. *American Machinist,* vol. 48, no. 2, January 10, 1918, pp. 70-72, 5 figs. The French type of shell is difficult to machine internally on account of its closed flat bottom and the overhang of the boring bar required. The contour of these shells is shown, and it will be seen that the inside surface is a combination of straight bore, taper bore, radius, and flat surface. How this surface is machined, with a description of the tools involved, is set forth in the article. As the operations and tools are the same for both shells, with allowances for different dimensions, the article treats of the 270-mm. shell but applies equally to both.

Use of Diamond Tools in the Shop, Frank A. Stanley. *American Machinist,* vol. 48, no. 2, January 10, 1918, pp. 49-51, 18 figs. A description of a variety of purposes to which diamonds may be put, such as turning, boring and reaming appliances for brass, iron and steel, hard rubber and compositions. Details of speeds, feeds and output are given.

Operating Characteristic of Motor-Driven Planers, C. E. Clewell. *Electrical World,* vol. 71, no. 2, January 12, 1918, pp. 87-90, 5 figs. Contains an analysis of the duty cycle of the planer and a discussion of the requirements of the driving equipment. The non-reversing motor is described and compared with the reversing equipment. Special emphasis is placed upon the method of control which is required. Incidental items, like the reduced flywheel effect due to the absence of pulleys with the reversing motor, the advantages of dynamic braking, remote control and the automatic action of the master switch in connection with the controller are also treated at some length. Economic advantages are set forth which may result directly from a careful study of cutting speeds of the return strokes, increasing the ratio of the latter to the former, eliminating the time losses from belt slip at the points of reversal, and the like.

Metal Frames and Fittings for Airplanes, Fred H. Colvin, Am.Soc.M.E. The writer describes the production of parts, which, in the earlier stages of aircraft engineering, used to be made of wood, but are now being made of metal. This applies in particular to tail-skid and rudder parts and details of control apparatus, especially the vertical stabilizer. The article is interesting, but not suitable for more detailed abstracting. (*American Machinist,* vol. 47, no. 25, December 20, 1917, pp. 1075-1077, 9 figs., *d*)

Spur Gearing Produced by the Rotary-Cutter Process, Henry E. Eberhardt. A historical article showing the development of this method of spur-gear manufacture and telling of the writer's connection with it.

The writer strongly defends the use of gears cut with disk cutters, but points out that other methods have also their legitimate field of application. (Paper read before the American Gear Manufacturers' Association at Chicago, September 1917, abstracted through *Machinery,* vol. 24, no. 5, January 1918, pp. 404-405, *h*)

Pickling with Nitre Cake. *The Iron Trade Review,* vol. 62, no. 2, January 10, 1918, p. 153.

Tool Steel Gears for Industrial Service, E. S. Sawtelle. *The American Drop Forger,* vol. 3, no. 12, December 1917, pp. 397-400.

Errors in Measuring Thread Pitch Diameters with Wires, J. Harland Billings. *American Machinist,* vol. 47, no. 25, December 20, 1917, pp. 1077-1078.

Modern Drilling Practice, Edward K. Hammond. *Machinery,* vol. 24, no. 5, January 1918, pp. 381-393, 21 figs.

Thread Milling, Franklin D. Jones. *Machinery,* vol. 24, no. 5, January 1918, pp. 413-428, 35 figs.

Measuring Apparatus

Calibration of Anemometers, A. H. Anderson, Mem.Am. Soc.M.E. The writer claims that the method of calibrating anemometers by swinging in a short radius is quite erroneous, and describes another method believed to be more reliable.

Fig. 11 shows the anemometer mounted at the end of an arm 23½ ft. long. One end of the arm is centered on the post of a heavy iron tripod; the other end is supported by a rubber-tired wheel 10 in. in diameter. The trigger is operated by two cords, *A* and *B,* which are loosely supported by two rings near the center of rotation. The operator stands near the tripod, and by means of the cords the counting mechanism of the anemometer is engaged or disengaged while the arm is in rotation.

Such a test as this may be conducted in a large room with

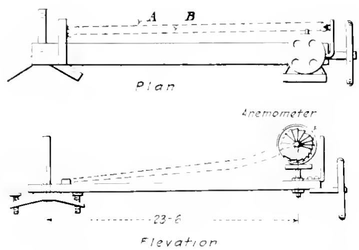


Fig. 11 Method of Calibrating Anemometers

a very smooth floor, and it is also necessary that the air in the room be undisturbed by drafts.

The arm may be rotated at practically any desired speed. At speeds greater than 1000 ft. per min., the rotation of the long arm becomes too rapid for convenient manipulation. The anemometer is then dismounted from the arm and the calibration continued by means of the pitot tube, a blast of air being provided from a centrifugal fan through a round pipe 24 in. in diameter.

This blast of air can be varied by changing the speed of the fan, and beginning with an air velocity of 1000 ft. per min. the reading of the anemometer is noted for the period of a minute and the indication of the differential gage is read. Similar runs are made at suitable intervals up to 4000 ft. per min.

In the original article the data obtained in the test are given in the form of tables; in addition two curves are given showing the relation betwen the true velocities and the velocities indicated by the anemometer. In Fig. 12 the points in the test made with the long arm are indicated by small circles, those obtained by pitot tubes by small triangles, and those obtained by the short arm by small squares. It appears that the short arm might give indications which are lower than with the long arm for equal peripheral velocities. (*The Heating and Ventilating Magazine,* vol. 14, no. 12, December 1917, pp. 15-17, 5 figs., *ep*)

An Instrument for Accurate and Rapid Density Measurements on Board Ship, A. L. Thuras. *Journal of the Washington Academy of Sciences*, vol. 7, no. 21, December 19, 1917, pp. 605-612, 2 figs.

A Simple Power Friction Test, W. F. Schaphorst. *The Gas Age*, vol. 40, no. 12, December 15, 1917, p. 563.

Pin Measurement of Spur Gears, Reginald Trautschold. Pin measurement of spur gears has been developed for determining the pitch diameter of a gear. This system consists simply in measuring the distance between suitably proportioned pairs of pins that bear on the profile pitch lines of pairs of adjacent teeth. In gears with an even number of teeth the pins are inserted between pairs of diametrically opposite tooth spaces. In gears with an odd number of teeth, in which the tooth is diametrically opposite a tooth space, the second pin

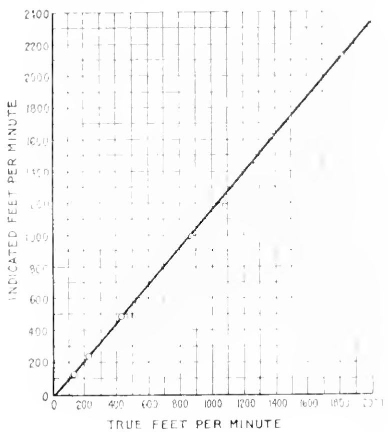


Fig. 12 True vs. Indicated Velocities by Anemometer

has to be placed in a tooth space most nearly opposite the first pin.

The writer describes the method of making pin measurements of gears with even and odd numbers of teeth, and also the method of finding the size of pin, and gives the following formulæ used in pin measurements:

$D = \frac{N}{P}$ .....[1] $R = \frac{D}{2}$ .....[2] $P_1 = \frac{3.1416}{P}$ ..[3]

$\beta = \frac{90}{N}$ ....[4] $\beta = \frac{45(P_1 + L)}{1.5708D}$ ....[5]

$Y = R \sin \beta$ ....[6] $Y_1 = R \sin \beta_1$ ....[7]

$B = R \cos \beta$ ....[8] $S = \sqrt{(0.25X^2 - Y^2)}$ ...[9]

$S_1 = \sqrt{(0.25X^2 - Y_1^2)}$.[10] $U = B + S$ ....[11]

$O = U \sin 2\beta$ ....[12] $H = O \cot 2\beta$ ....[13]

$W_1 = 2U$ for gears with even number of teeth...........[14]

$W = \sqrt{[O^2 + (H + U)^2]}$ for gears with odd number of teeth[15]

$W = W_1 + X$ ....[16] $X = 2R \sin \beta \sec a$ .....[17]

$X > 2Y$ but not $> 2Y \sec a$ ....[18]

Notation for Formulæ

Pitch diameter.. D
Pitch radius.. R
Number of teeth.. N
Diametral pitch.. P
Circular pitch.. P_1
Pressure angle.. a
Half angle subtended by tooth space.................... β
Half chordal width of tooth space..................... Y
Chordal ordinate.. B
Pin center amplitude.................................... S
Offset of pin center (for gears with an odd number of teeth) .... O
Pin center gear ordinate (for gears with an odd number of teeth).. H
Diameter of pin.. X
Pin center spacing.................................... W_1
Pin center radius.................................... U
Width over pins.. W
Backlash L
Half angle subtended by tooth space plus backlash....... β_1
Half chordal width of tooth space with backlash......... Y_1
Pin center amplitude with backlash..................... S_1

Strictly, a different size of pin ought to be used for measuring each gear that differs in the number of teeth or in pitch. It is obvious how inconvenient this would be. However, as the writer shows, the same size of pin may be employed for measuring a number of gears of the same pitch but differing considerably in the number of teeth. Within the range of the smallest and the largest gears of the same pitch cut in any particular shop, several diameters of pins may be required, but in all cases the diameter of the pin must fall within certain limits: namely, it must be greater than the standard diameter for the particular gear. Further, for any pin of suitable diameter the amplitude of the pin center, or the distance it lies above the chordal plane of the tooth space, is equal to the square root of the square of half the pin diameter minus the square of half the chordal width of the tooth space.

It is usually estimated that the widths of the teeth and the tooth spaces are equal, but in frequent cases a certain backlash is equivalent to increasing the arc of the pitch circle confined within the tooth space, which makes the pin sink farther down between the teeth. Nevertheless the contact points between the pin and the respective tooth profiles remain on the pitch circle, for the diameter of the pin must remain greater than the increased chordal width of the tooth space.

The original article contains a table giving the pin diameters of gears of 1 diametral pitch, having from 12 to 100 teeth with 14.5- and 20-deg. pressure angles, as well as the diameter of the gears when measured over the pins. (*Machinery*, vol. 24, no. 5, January 1918, pp. 406-409, 5 figs., *tp*)

Mechanics

Relation of Press Stroke to the Life of a Die, Wilhelm A. Schmidt, Mem.Am.Soc.M.E. In an article abstracted in The Journal for November 1917, E. F. Creager discussed the relation of the life of a punch and die with the increase in the length of stroke. The present article further discusses this subject and the writer offers an explanation of the cause of the increase in the life of a die when the press stroke is shortened.

The writer of the present article agrees with the statement of Mr. Creager, namely, that the stroke does not affect the life of the die if the presses are run at the same speed, but defines more fully what is meant by "speed" in this instance. If θ be the angle between the radius of the crank in a punch press and the line of motion of the arm, then the difference

in the cutting speeds between presses of $1\frac{1}{4}$-in. stroke and $\frac{5}{8}$-in. stroke will become less as this angle approaches zero. Consequently, in cutting very thin metals the velocity in either case will be nearly the same at the instant the metal is struck by the punch, but always slightly in favor of or less in the press having the shorter stroke, as velocities are absolutely equal only when angle $\theta = 0$ deg. or 180 deg., at which times the velocities are also zero. The writer believes that the difficulties in the velocities of stroke readily account for the increased life of the punch and die in the shorter-stroke press running at the same number of revolutions per minute of the crankshaft as that of a press with a longer stroke.

In a case wherein the press is constantly used for stamping metal 0.030 in. thick, is equipped with a roll feed and has a stroke of $1\frac{1}{4}$ in., the cutting velocity of the punch is 2.966 in. per sec. Assuming that this speed is such as will give a reasonable life to the punch and die, the same protection per life of the punch and die should be obtained in a shorter period of time by using a press with a $\frac{5}{8}$-in. stroke and increasing the revolutions per minute of the crankshaft until the cutting velocity of the punch is the same, namely, 2.966 in. per sec. The protection per press will naturally be greater, however, in the second case. (*American Machinist*, vol. 47, no. 26, December 27, 1917, pp. 1131-1132, 2 figs., *tp*)

TORSIONAL RESISTANCE OF ROLLED JOISTS, A. Föppl. (*Zeits. Vereines Deutsch. Ing.*, 61, pp. 694-695, Aug. 18, 1917.) A rod twisted by application of a couple M applied at its ends is deformed (withiu elastic limit) uniformly and in proportion to M. The twist δ in unit length $= M/JG$; where $G =$ modulus of shear $= 850{,}000$ kg.cm.^{2} for rolled iron, and J is a factor varying with the form of the section, and of the same dimensions (cm.^{4}) as the amount of inertia of the section. Both analytical and experimental methods are needed to solve the problem of determining the torsional resistance of sections used in practice. The author evolves a formula which he considers will be verified by experimental investigation. Almost all the formulæ hitherto available concerning the torsion of rods are based ultimately on St. Venant's researches. Some of St. Venant's formulæ are empirical formulæ intended to give at least approximate solutions for the torsional resistance of any section. These latter formulæ are less reliable. The older of St. Venant's approximate formulæ for rolled joists is $J = 4J_xJ_y/J_p$; where J_x and J_y are the moments of inertia referred to the two principal axes. This formula needs a correction factor which has only been worked out for the simplest cases. The later and more accurate formula is $J = F^4/40J_p$; where $F =$ sectional area. This formula is reasonably accurate for the old standard pattern of I-beam, but fails complete for modern broad-flanged I-beams.

The author's formula is derived from Bredt's (1896) and Prandtl's (1904) works. Most rolled joists may be considered as built up from narrow rectangles, with curves where one rectangle runs into another, these conditions being, however, of no importance as regards torsional resistance. Such sections approximate closely to the limiting case in which the narrow side of each rectangle is indefinitely small compared with the longer dimension, and in that case the torsional resistance of the whole section equals the sum of resistance of the individual rectangles. For a narrow rectangle, measuring l along its greater and d along its less dimension, $J = d^3l/3$. For a rolled joist section, built up from such rectangles, $J = \frac{1}{3}\Sigma d^3l$. This formula is not strictly true, because it is based on the unrealized assumption of infinitely thin rectangles. It is, however, a good approximation, capable of correction by factors determined by experiment. A simple formula for the maximum shear stress ($S_{\max.}$) set up in the section by the couple M, is $S_{\max.} = 3\,Md_{\max.}/d^3l$, where $d_{\max.}$ represents the smaller dimension of the thickest rectangle in the section. (*Science Abstracts*, Section A—Physics, vol. 20, pt. 11, no. 239, November 30, 1917, p. 507, *t*)

TYPE OF THREAD AS AFFECTING PIPE JOINTS. Data of experiments conducted by the research department of the National Tube Company. The purpose of this investigation was to develop a pipe joint having greater resistance to impact and vibration than the present joints. The investigation was chiefly conducted on 1-in. signal pipe, with some vibratory tests made on $1\frac{1}{4}$-in. extra heavy pipe and some internal-pressure tests on $2\frac{1}{2}$-in. steam pipe.

Table 1 gives a summary of the tensile-strength, drop and bending tests. Another table in the original article also gives data of vibratory tests. The different joints tested were: First, the regular Briggs thread on pipes and regular Briggs-thread steam coupling; second, round-bottom, sharp-top thread on pipe and regular Briggs-thread steam coupling; third, round-bottom, round-top 55-deg. thread on pipe and regular Briggs-thread coupling; and fourth, round-bottom, round-top 60-deg. thread on pipe and regular Briggs-thread coupling.

The air-pressure and water-pressure tests indicate that equally good joints can be made with mixed threads as with the Briggs thread alone, and, on the whole, the tests indicate that the different types of thread may be used together without any difficulty on the smaller-size pipe and with slight difficulty on the larger-size pipe. But when the thread galls there is some tendency to produce a leaky joint.

TABLE 1—TENSILE TESTS, DROP TEST AND BENDING TESTS ON THREADED PIPE

COMPARISONS OF UNANNEALED STEEL AND ANNEALED STEEL WITH ROUND AND SHARP THREADS AND WROUGHT IRON WITH SHARP THREADS. EACH SERIES OF STEEL PIPE TESTS WERE CUT FROM THE SAME 1-IN. STANDARD-WEIGHT PIPE

Series No.	Material	Kind of Thread	No. of Tests	Average tensile strength of joints, lb.	Drop test with 26-lb. weight Average number of blows at height of		Results: pieces broken in drop tests	Bending Tests	
					2 ft. 6 in.	4 ft.		Angle of bend, deg., average	Pieces broken
1	Black steel pipe as finished, with Briggs thread	Briggs	6	19,250	6.17	0.33	6	39 7	6
2	Black steel pipe annealed, with Briggs thread	Briggs	6	18,850	6.17	0.67	6	80 0	5
3	Black steel pipe as finished, with round thread	Round	6	21,325	7.5	6 7	1	103 5	0
4	Black steel pipe annealed, with round thread	Round	6	21,850	7.5	5	2	109 5	0
5	Black wrought iron as finished, with Briggs thread	Briggs	6	15,730	3 8	0	6	19 0	6

The following conclusions are drawn from the tests: (1) The round thread is superior to the Briggs thread in tensile strength of joint, in impact resistance, in the amount that threaded pipe may be bent, and in resistance of the joint to vibration. (2) Annealed joints are more resistant to shock, bending and vibration than the unannealed, and equally strong in tensile strength. (3) Steel joints are superior in every way to wrought-iron. (*The American Drop Forger*, vol. 3, no. 12, December 12, 1917, pp. 408-409, 1 fig., *e*)

Koniska Kugghjul, K. G. Karlson. *Teknisk Tidskrift-Veckoupplagan*, 47 Arg., Häft 47, November 24, 1917, pp. 493-496, 15 figs. Description of a new type of bevel gears produced by the Swedish Ball Bearing Works, makers of the S. K. F. ball bearings. An abstract of the article will be given in an early issue.

The Use of Soap Films in Solving Torsion Problems, A. A. Griffith and G. I. Taylor. *Engineering*, vol. 104, no. 2712, December 21, 1917, pp. 652-655, 2 figs., 5 tables. To be continued.

General Theory of Plane Motion Rotation and Translation, Francis W. Roys. *The Journal of the Worcester Polytechnic Institute*, vol. 21, no. 1, November 1917, pp. 24-31, 2 figs.

Long Columns Carrying Distributed Loads, Arthur Morley. *Engineering*, vol. 104, no. 2709, November 30, 1917, pp. 565-567, 2 figs. Abstract of a paper on the mathematical investigation of the mechanical problems of transmission lines by Koga Kato in the *Journal of the Society of Mechanical Engineers of Tokyo, Japan*. Deals with the cases of struts carrying concentrated end loads and also loads distributed along the length and considers various types of end conditions.

The Whirling of Shafts, H. A. Webb. *Engineering*, vol. 104, no. 2706, November 9, 1917, pp. 483-485, figs. 3-7 Serial article.

Worm Gearing, Francis J. Bostock. *Engineering*, vol. 104, no. 2706, November 9, 1917, pp. 503-506, figs. 7-14. (concluded).

Motor-Car Engineering

Steam Motorcycle. Description of a steam-driven motorcycle with a multitubular boiler. This boiler is 9 in. in diameter by 12 in. high, having 120 half-inch copper tubes and carrying a working pressure of 500 lb. A seamless steel tube is used for its construction and screwed-in ends electrically welded. The burner is simple type with pilot arranged for kerosene.

The engine is of the single-cylinder, double-acting type, 2-in. bore and $2\frac{1}{2}$-in. stroke, direct-coupled to the back tailshaft, having a reduction gear of 6.521. The horizontal tank, divided into two parts, contains fuel and water, the fuel being fed under pressure to the burner. The boiler feed is pumped through two water heaters: first through an exhaust-steam heater and then through a coil placed in the firebox. Superheated steam is used with the superheater again in the firebox. The exhaust is condensed as much as possible by a surface condenser, the hot water being returned to the boiler and the uncondensed steam escaping.

So far the machine has not proved satisfactory because of excessive weight, trouble in the burner in a high wind, small water-carrying capacity, and the wastefulness of the single-expansion engine working on steam at the above high pressure.

The writer adds that the rise in steam pressure and a sudden stop did not make one feel at all at ease in the saddle. (*The Motor Cycle*, abstracted through *The Autocar*, vol. 39, no. 1157, December 22, 1917, p. 629, 1 fig., *d*)

British Six-Ton Steam Truck. Description of a six-ton steam truck built by Atkinson & Co. of Preston, Lancashire, England, of interest especially because, while running on rubber tires, it uses coke as a fuel.

The steam generator is of the vertical water-tube type with tubes slightly inclined from the horizontal plane. The working pressure is 230 lb. per sq. in. In the combustion chamber is a double continuous coil of tubing forming a superheater through which the steam passes on its way to the engine. The generator is fired from the bottom by means of a chute. The driver merely removes the lid off the chute by his foot and allows a certain amount of coke to drop from the adjacent bunker into the firebox. It is claimed that with this arrangement the level of the fuel is within strict limits, leaving ample combustion space and giving a high thermal efficiency.

The special feature of the engine is the valves, shown in Fig. 13. These valves are large steel balls, of which there are four operated direct from camshafts by tappets. There are two camshafts; the steam inlets are placed above and the exhaust ports below. The exhaust camshaft is driven from the engine crankshaft by a shaft and beveled gearing, and from this through the beveled gearing and a vertical shaft the inlet

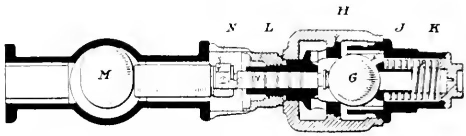


Fig. 13 Valve Mechanism of Atkinson Steam Truck Engine

camshaft is operated. All this mechanism is located in a casing and runs in oil, while a small oil pump on the exhaust-valve camshaft forces oil to all the cams through tubing.

The driving axle is of the solid type, one road wheel being rigidly mounted on the shaft and the other on a sleeve which surrounds the shaft and is carefully lubricated.

The vehicle is equipped with a steam brake which operates on a large drum bolted to the main driving sprocket on the rear axle. When steam is admitted to the rear end of the brake cylinder the piston and rod are forced inwards and the brake band is tightened round the drum by a lever. The brake is released by exhausting the steam from the cylinder. (*The Engineer*, vol. 124, no. 3232, December 7, 1917, pp. 494-496, 11 figs., *d*)

The Testing Department of the Fiat Company. *The Engineer*, vol. 124, no. 3232, December 7, 1917, p. 504.

The Automatic Axle Jack. *The Autocar*, vol. 39, no. 1157, December 22, 1917, pp. 621-622, 3 figs.

Munitions

Heat Treatment and Temperature Measuring for Shells, J. R. VanWyck. See Section: Machine Shop.

The French 75-mm. Cannon. In the following list it is to be noted that entries marked * refer to publications which are not in the Library of the Engineering Societies and have not been examined.

1898.—New Field Artillery, 1898. (*Jour. U. S. Artillery*, v. 10, p. 267, et seq.) Based on an article in *Revue de Cavalerie*. Gives reasons leading to the adoption of the 75-mm. cannon, together with some data on dimensions, projectile, etc.

1898.—75-Mm. Rapid Fire Field Material, 1898. (*Revue Militaire Suisse* for Feb.)*

1900.—Modern Field Artillery, The Schneider-Canet Systems, 1900. (*Engineering*, vol. 69.) I, pp. 540-542; description of the 75-mm. gun, illustrations, diagrams. II, pp. 573-577; continues description, etc., of 75-mm. gun, giving data on eight different types, 16 figs. III, pp. 609-611, and IV, pp. 643,646; further descriptions of 75-mm. gun types and illustrations of carriages, limber, brakes, etc. V, pp. 671-672; further description of 75-mm. gun types and illustrations.

1900.—New French Field Gun, 1900. (*Artilleri-Tidsskrift*, Jan. and Feb.)*

1900.—Schneider-Canet Quick-Firing Guns and Howitzers for Field Service, 1901. (*Engineering*, vol. 72. I, pp. 72-75; II, pp. 107-110; III, pp. 210-211; IV, pp. 246-249.) Description of the 75-mm. and other guns, together with tests carried out by Schneider & Cie. at the Harfleur long-range proving ground.

1901.—Schneider-Canet Rapid Fire Field Material, 1901. (*Revue Militaire Suisse* for May.)*

1902.—Field and Position Artillery Material from Schneider & Cie., and Experimental Firing with Same at Harfleur, March, 1901, 1902. (*Artilleri-Tidsskrift*, May, June, Sept., Oct.)*

1902.—Curey and Pesseaud, Capts., Artillerie à l'Exposition Universelle de 1900. Paris, 1902-7, 335 pp., 183 figs., 22 plates. Frs. 6.50.*

1902.—Notes on Rapid-Fire Field Artillery, 1902. (*Jour. U. S. Artillery*, vol. 17, pp. 23 et seq.; translated from the French.) Pp. 38-41 give general information on the 75-mm. gun, as far as published.

1902.—Junken, Chas. A., French Field Artillery, 1902. (*Jour. U. S. Artillery*, vol. 18, pp. 21-32; transl. from *Militär Wochenblatt*, Jan. 1 and 8, 1902.) Description of the 75-mm. gun substituting the 90-mm. gun, including general type and construction as far as known, limber, service, battery, methods of fire.

1902.—French 75-Mm. Gun, Illustrated, 1902. (*Revue Militaire Suisse* for Jan.)*

1902.—Mitteilungen über Gegenst. d. Art & Gen.-Wesens, March, 1902.*

1903.—Hero, Capt. A., Jr., French Rapid-Fire Field Artillery, 1903. (*Jour. U. S. Artillery*, vol. 19.) I, pp. 35 et seq.: diagrams and description of the 75-mm. gun (pp. 37-46), including breech mechanism, carriage, recoil brake, tire brake, shields. II, pp. 164-185; description and diagrams of "laying apparatus and instruments used in preparation for and execution of fire," including collimator, level, graduated plates, methods of pointing, preparation for fire, formation of batteries, etc. III, pp. 47-60; methods of firing, execution of fire, rules for firing, battery organization, etc.

1903.—French Field Artillery Material—75-Mm, 1903. (*Revue d'Artillerie* for October.)*

1905.—Adoption of the 75-Mm. R. F. Gun for Horse Batteries, France, 1905. (*Belgique Militaire* for Dec. 24.)*

1906.—Notes on the 75-Mm. Gun and Regulations Therefor, 1906. (*Revue de Cavalerie* for Aug. and Sept.)*

1907.—Modern French Field Guns, 1907. (*Engineering*, vol. 84, pp. 775-778.) Detailed description and diagrams of the Schneider-Canet 75-mm. field guns, pattern "P D," including dimensions, weights, pressures.

1907.—Olivier, Lieut. L., Material de Montagne Demontable de 75 a Tir Rapids, Systeme Schneider-Danglis. (1907-1912), 40 pp., 15 figs., Frs. 1.25.*

1907.—Range Table of French 75-Mm. Gun, 1907. (*Artilleristische Monatschrift* for Sept.)*

1907.—Brems- und Vorholvorrichtung des 75-Mm. Feldgeschützes M. 97, 1907. (*Mitteilungen über Gegenstände des Art & Gen.-Wesens*, vol. 38, p. 1046.) A description of the brake, etc., of the 75-mm. gun, based on an article in the *Deutsches Offizierblatt*, etc.

1908.—Wirkung der Sehrapnells der 75-Mm. Kanone M 97, 1908. (*Mitteilungen über Gegenst. des Art & Gen.-Wesens*, vol. 39, pp. 168-169.) A quotation from Aubrat's Exercises de Service en Campagne, giving results of trials of the 75-mm. shrapnel for comparative effect.

1911.—Ordnance, 1911. (Article in Encyc Brit., 11th ed., vol. 20, pp. 189-235.) Table 9, p. 211, and Table 21, p. 214, give data on 75-mm. guns (France); see also ill. plate 3 and descriptive notes on p. 221.

1911.—75-Mm. Halbautomatische Kanonen in Mittelpivotlafette der firma Schneider & Cie., 1911. (*Mitteilungen über Gegen. des Art & Gen.-Wesens*, vol. 42, pp. 764-768, with plates and figs.) Detailed description and diagrams, characteristics, dimensions, breech, limber, munition, etc.; also addition of shield, p. 340.

1913.—*Revue d'Artillerie*, December 1913.

1913.—Moliere, Capt. H., Notes sur le Canon de 75 et Son Règlement, à l'Usage des Officiers de Toutes Armes. 4th ed., paper, Paris, 1913, Berger-Levrault, 136 pp., 65 illustrations, Frs. 2.*

1914.—Artilleries de Campagne Française et Allemande, Le Canon Français de le Canon Allemand de 77, 1914. (*Génie Civil*, vol. 65, pp. 385-394.) Description, illustration and comparison of the two guns, the French 75 especially complete, and partly based on Commandant Buat's l'Artillerie de Campagne, Son Histoire, Son État Actuel. (Abstract in *Jour. Franklin Inst.*, 1917, vol. 183, pp. 374-375.)

1914.—*Revue d'Artillerie*, July 25, 1914.*

1914.—Règles à Observer pour le Tir du Canon de 75 par-dessus les Troupes Amies, 1914. (*Génie Civil*, vol. 65, pp. 334.) From an article by Com. A. P. Jamet in *Revue d'Artillerie*, July 25.

1915.—Dalman, Antonio Ferrer, El Cañon Krupp y el Schneider de 75-mm., 1915. Barcelona, Feliu y Susanna, 39 pp. Pp. 29-35 describe the French 75-mm., 11 figs.; a chapter on the construction of guns is included on pp. 37-39.

1915.—"Soixante Quinze," 1915. (*The Engineer*, vol. 119, pp. 77-78.) Based on an article in Génie Civil, giving descriptions of breech, block, recoil cylinder (as far as published), wheel brake, elevating gear, ammunition wagon, fuse setter, time and percussion fuse, ballistic data, etc.

1915.—75-Mm. Automobile Battery in France, 1915. (*Kriegstechnische Zeitschrift* for May-June.)*

1915.—Range Table of the French 75-Mm. Gun, 1915. (*Artilleristische Monatsehrift* for Oct. 14.)*

1915.—Specifications for High Explosive Shells, 1915. N. Y. Industrial Press, 44 pp., chap. 5, pp. 38-44, gives specifications for the French 75-mm. high-explosive shell.

1915.—French 75-Mm. and 105 Mm. Field Guns, 1915. (*Engineering*, vol. 100, p. 535, and pp. 559-561.) Gives dimensions, ballistic data, and a general description of these two sizes of guns.

THE INSPECTION OF SCREW GAGES FOR MUNITIONS OF WAR, J. H. Bingham Powell. *American Machinist*, vol. 47, no. 25,

December 20, 1917, pp. 1065-1073, 5 figs. See abstract in The Journal for January 1918, pp. 108-109.

Les Modèles Actualles de Torpilles Automobiles. *Le Génie Civil,* tome 71, no. 1843, December 8, 1918, pp. 365-371, 21 figs. Description of modern types of automatic torpedoes.

Power Plants

Methods of Drying Out Flooded Power Plant Equipment, Norman L. Rea. *Power,* vol. 47, no. 2, January 8, 1918, pp. 46-48, 4 figs. Discusses various schemes that may be employed for drying out electrical equipment after a power plant has been flooded, and points out the advantages and disadvantages of the various methods.

Presses

Electric Baling Presses. *Engineering,* vol. 104, no. 2710, December 7, 1917, pp. 600-602, 9 figs.

Hydraulic Forging Presses. *The Iron Age,* vol. 100, no. 25, December 20, 1917, pp. 1480, 1522-1524.

Pumps

Duty Trials on Two 24-Million Gallon Pumping Units. *Power House,* vol. 10, no. 11, November 1917, pp. 313-316, 3 figs.

Air Pumps and Condensers. *Engineering,* vol. 104, no. 2712, December 21, 1917, pp. 664-665, 1 fig.

Some Notes on Air-Lift Pumping, A. W. Purchas. *The Journal of the Institution of Mechanical Engineers,* no. 8, December 1917, pp. 613-650, 11 figs., 4 tables. An extensive discussion of air-lift-pump design and operation. An abstract will be given in an early issue of The Journal.

Railroad Engineering

The Tank Car, E. S. Way. *Railway Review,* vol. 61, no. 26, December 29, 1917, pp. 801-803.

Mechanical Problems in the Design of Electric Locomotives, W. K. McAfee. *The Electric Journal,* vol. 15, no. 1, January 1918, pp. 16-19, 8 figs.

The Transportation of Perishable Commodities, Dr. M. E. Pennington. *Railway Age,* vol. 64, no. 2, January 11, 1918, pp. 119-124, 10 charts.

New Four-Cylinder Express Locomotive. *The Railway Gazette,* vol. 27, no. 25, December 21, 1917, pp. 681-683, 4 figs. Description of a new 4-6-0 express locomotive recently completed at the works of the Great Central Railway, England. The cylinders use highly superheated steam on the single-expansion principle. The number of superheater elements has been increased from the usual 24 units to 28 units. The addition of another row of superheater units makes a considerable difference in the maintenance of steam temperature in long boilers, especially when the engine is working under high-duty conditions.

The "Ruston" Oil Locomotive. *Engineering,* vol. 104, no. 2709, November 30, 1917, pp. 569-571, 7 figs.

The Development of Inclined Planes for Locomotive Axleboxes. *The Railway Gazette,* vol. 27, no. 23, December 7, 1917, pp. 623-624, 6 figs.

New York Central 4-8-2 Type Locomotives. *Railway Age Gazette,* vol. 63, no. 26, December 28, 1917, pp. 1167-1170, 4 figs., 1 chart, 1 table.

Screw-Spike and Tie-Plate Test, W. C. Cushing. *Bulletin of the American Railway Engineering Association,* vol. 19, no. 200, October 1917, pp. 3-255, illustrations and charts.

Refrigeration

Multi-Stage Compression Plant of Central Cold Storage Co. *Power,* vol. 47, no. 3, January 15, 1918, pp. 74-78, 6 figs. This modern two-unit ammonia plant of 500 tons refrigerating capacity employs the new D. I. Davis system of multi-stage compression with cooling of vapor between stages. It is expected to save in power 25 per cent over the standard simple compressor and to develop one ton of refrigeration on less than 25 lb. of steam per hour.

Steam Engineering

The Divergence of Steam Nozzles, Gerald Stoney. As in most of the textbooks on steam turbines the theory of the divergence of steam nozzles is not fully given, the following method of calculation may be of interest.

In textbooks on steam turbines it is shown that in expanding adiabatically from a pressure p_1 to a pressure p_0 the velocity of the steam is

$$C_0^2 = 2gH_1 \frac{\gamma}{\gamma - 1}\left(1 - z^{\frac{\gamma-1}{\gamma}}\right)$$

where

$$z = \frac{p_0}{p_1} \text{ and } H_1 = 144\, p_1 V_1$$

At the throat

$$z_t = \left(\frac{2}{\gamma+1}\right)^{\frac{\gamma}{\gamma-1}}, \text{ where } z_t = \frac{p_t}{p_1}.$$

so that at the throat

$$C_t^2 = 2gH_1 \frac{\gamma}{\gamma+1} \ldots\ldots\ldots\ldots\ldots\ldots [1]$$

If A_t is the area of the nozzle at the throat, and A_0 that of the exit, the equation for continuity gives

$$\frac{A_0}{A_t} = \frac{C_t\ V_0}{C_0\ V_t} \ldots\ldots\ldots\ldots\ldots\ldots [2]$$

where V_t and V_0 are the volumes of the steam at the throat and exit of the nozzle, respectively.

As

$$p_0 V_0^{\gamma} = p_t V_t^{\gamma}$$

and as

$$p_t = p_1 z_t = p_1 \left(\frac{2}{\gamma+1}\right)^{\frac{\gamma}{\gamma-1}} \ldots\ldots\ldots\ldots [3]$$

we have

$$\frac{V_0}{V_t} = \left(\frac{p_t}{p_0}\right)^{\frac{1}{\gamma}} = \left(\frac{2}{\gamma+1}\right)^{\frac{1}{\gamma-1}} z^{-\frac{1}{\gamma}} \ldots\ldots\ldots [4]$$

Putting Equations [1], [2] and [4] into [5],

$$\frac{A_0^2}{A_t^2} = \frac{\gamma-1}{\gamma+1}\left(\frac{2}{\gamma+1}\right)^{\frac{2}{\gamma-1}} \frac{1}{z^{\frac{2}{\gamma}}\left(1 - z^{\frac{\gamma+1}{\gamma}}\right)}$$

$$= \frac{\gamma-1}{2}\left(\frac{2}{\gamma+1}\right)^{\frac{\gamma+1}{\gamma-1}} \frac{1}{z^{\frac{2}{\gamma}} - z^{\frac{\gamma+1}{\gamma}}} \ldots\ldots\ldots [5]$$

an equation for the flare of the nozzle.

As z is fractional, a more convenient form for calculation is obtained by writing $X = \frac{1}{z} = \frac{p_1}{p_0}$, X being the expansion by pressure; and then [5] becomes:

$$\frac{A_0^2}{A_t^2} = \frac{\gamma-1}{2}\left(\frac{2}{\gamma+1}\right)^{\frac{\gamma+1}{\gamma-1}} \frac{X^{\frac{\gamma+1}{\gamma}}}{X^{\frac{\gamma-1}{\gamma}}-1}$$

As the ratio of the specific heats, or γ, may be considered as practically constant in these equations for the adiabatic expansion of steam, it will be seen that the flare depends only upon the amount of expansion by pressure in the nozzle; that is, that it is the same for a nozzle expanding from 200 lb. per sq. in. to 20 lb. as from 10 lb. to 1 lb. Since, however, the value of γ for saturated steam is less than for superheated steam, the flare is slightly less in the latter case.

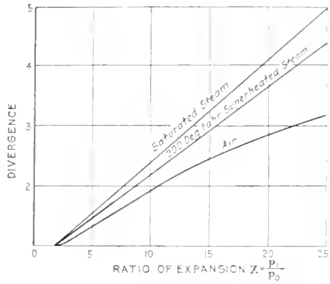


Fig. 14 Theoretical Divergence of Steam Nozzles

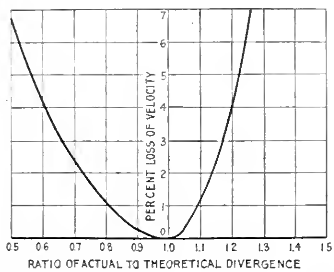


Fig. 15 Ratio of Actual to Theoretical Divergence

For the critical expansion $z = \left(\frac{2}{\gamma+1}\right)^{\frac{\gamma}{\gamma-1}}$, the value of A_0/A_t is unity; and for the ordinary values of γ, which are from 1.135 for saturated steam to 1.3 for superheated steam, the relation between the flare and the ratio of expansion in the nozzle is approximately a straight line, except for large degrees of expansion.

It may be mentioned that in the common case, where the steam is at first superheated and then becomes wet as it expands, the average value of γ is between the value for superheated steam, namely, 1.3, and that for saturated steam, 1.135.

Fig. 14 shows the relation between the flare and the amount of expansion for saturated and superheated steam, and also for air. In this diagram "divergence" is to be understood as the ratio of area at any section of the nozzle to the throat area. In practice nozzles are generally given rather less flare, since it is much more important to have too little flare than too much flare.

That this is so is well shown by the curves given by Mr. W. J. Goudie from an analysis of data published by Dr. Steinmetz. A combination of these curves is given in Fig. 15. Generally friction in a nozzle slightly increases the flare, but in practice that is negligible. Mr. H. M. Martin has pointed out to the author that

$$\frac{\lambda}{\lambda-1} = \frac{1}{\eta_1}\,\frac{\gamma}{\gamma-1}$$

where λ is, for frictional flow, the apparent value of the index in pV^{λ} = constant, and η_1 is the efficiency. For many purposes this formula is more conveniently written as

$$1-\frac{1}{\lambda} = \eta_1\left(1-\frac{1}{\gamma}\right)$$

As in practice, the efficiency is always above 90 per cent, it is easily seen that the losses in the nozzle have little effect on the flare. (*Engineering*, vol. 104, no. 2710, December 7, 1917, p. 597, *t*)

New Method of Increasing the Evaporation in Boilers, Carl Hering. Data of tests on the boiling of water made mainly in open metal cups over a gas flame.

The writer claims to have discovered a new thermal principle in the boiling of water.

He states that when a flame impinges upon the outside surface of any water-boiling vessel which is constantly maintained at a far lower temperature than the flame by the water on the other side of the metal wall, a thin film of gas forms on the flame side of the surface and offers an enormously high resistance to the passage of heat through it. If the temperature of the flame is taken at about 1300 deg. cent. and that of the water is about 100 deg. cent., there is a fall of temperature of about 1200 deg. cent. (2160 deg. fahr.) through this film, which appears to be only about 0.005 in. thick. This means an extremely high thermal resistance.

Present researches indicate that first there is a point at which it is no longer of advantage to further increase this artificial resistance, and next that this point seems to be reached when the temperature of the surface is about midway between that of the flame and that of the water; hence, for water boiling this would be about 725 deg. cent., which means a dull-red heat.

A practical way to introduce this artificial resistance is by means of lugs on the flame side of the surface, which have such a length and diameter that the heat flow through them will maintain their hot ends at about a dull-red heat.

The same thermal resistance may be produced by a long, thick lug or by a shorter but thinner one, provided the ratio of the length to the cross-section is the same, but the quantity of heat flowing through each lug will, of course, diminish with its cross-section.

Several factors are also involved in the determination of the best spacing of the lugs. Theoretically, the best condition would appear to be a very thick bottom, or very thick-walled boiler tubes, that is, one lug of the diameter of the bottom surface of the vessel; but it will be found that this thickness would have to be several feet, making this form of resistance entirely impracticable. The other extreme would be to have innumerable very thin, short lugs close together, which is also impracticable for obvious reasons.

Coming down to practical constructions, it was found that by spacing the same-sized lugs further apart, the greater freedom of the circulation of the hot gases between them increased the flow of heat through each lug, but as there were then fewer lugs per square inch of surface, the total heat flow into the vessel, as a whole, was reduced.

It was further found that the lateral surfaces of the lugs are of particular importance. The lugs may be made slightly conical, so that their bases cover practically the whole surface, while the thinner ends are more apart, to permit the further circulation of the hot gases.

Two interesting series of tests were made with lugs of various dimensions. The data of the tests are shown in Fig. 16. The results of the first series of tests are shown in *A*. In this series the lugs were of the same diameter but of different lengths, the relative flow of heat through a lug being approximately indicated by the heavy vertical lines above them. It is significant that the flow of heat through lug 3 was greater than through lug 4, although 4 is very much longer than 3.

The next series of tests with lugs of the same length but of different diameters is diagrammatically represented in the same manner in *B*. There again we see that there are certain ranges of dimensions of lug diameter which give the best results. Thus, 5 and 6 have approximately the same rate of flow, but the rates of flow between 4 and 5 are obviously different.

In the cup without lugs the heat flow corresponded to the evaporation of about 17 lb. per sq. ft. per hour. But the rate of flow through the lugs themselves was found to be as high

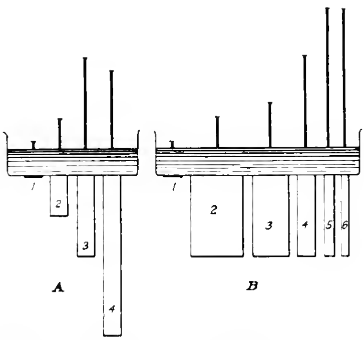


Fig. 16 Comparison of Heat Transmission Through Plates with and without Lugs

as 467 lb. per sq. ft. per hour, or about 27 times as high as in the cup without lugs. The spheroidal state which limits this rate was not yet reached.

The present investigation opens up important possibilities, but, as the writer states, requires further research for the determination of various factors which affect the efficiency of the lugs. (*Power*, vol. 47, no. 1, January 1, 1918, pp. 10-13, 3 figs., *eA*)

Determining Boiler Efficiency by CO_2 Analyses and Flue Temperatures, Haylett O'Neill. *Power*, vol. 47, no. 2, January 8, 1918, pp. 52-55, 12 figs., 2 tables. Gives several charts with the aid of which the boiler efficiency may be closely approximated when the CO_2 and flue temperatures are known. The purpose of the article is to enable the engineer to obtain valuable operating data for practical use by means of simple and cheap instruments.

The Logan, West Virginia, Power Plant. *Power*, vol. 46, no. 25, December 18, 1917, pp. 818-822, 8 figs. This power station, with a capacity of 2000 boiler hp., has with an addition of boiler equipment supplanted 14,000 boiler hp. at surrounding coal mines. A total load of 21,000 kw-hr. was carried shortly after the starting up of the plant by one 500-hp. boiler for 24 hours, the day load averaging 1500 kw-hr. This one 500-hp. boiler did the work of 4100 hp. of isolated mine boilers as formerly operated.

Conversion of Single-Expansion to Compound Engines on French Railways. *The Engineer*, vol. 124, no. 3233, December 14, 1917, pp. 511-512, 4 figs.

Standard Propelling Engines for British Standard Ships. *Engineering*, vol. 104, no. 2709, November 30, 1917, p. 569.

Thermodynamics

Heat Transfer in Tubes, W. Nusselt. (*Zeits. Vereines Deutsch. Ing.*, 61, pp. 685-689, Aug. 18, 1917.) The author gives the following formula for the mean coefficient of heat transference a_m in a tube of length L:

$$(a_m d/\lambda_m) = 0.03622 (d/L)^{0.054} (dw\gamma_m c_{pm}/\lambda_m)^{0.786} \ldots\ldots\ldots [1]$$

Here d = tube diameter, λ = thermal conductivity of the gas or superheated steam, w = velocity of flow, γ = weight of unit volume of gas, c_{pm} = true specific heat of the gas at constant pressure. If T_w and T_o are the absolute temperatures of the tube wall and gas respectively, $\lambda_m = [1/(T_w - T_o)] \int_{T_o}^{T_w} \lambda dT$, $c_{pm} = [1/(T_w - T_o)] \int_{T_o}^{T_w} c_p dT$, and $\gamma_m = [\gamma_o T_o/(T_w - T_o)] \log_e(T_w/T_o)$. In these formulae, γ_o = weight of unit volume of gas at T_o. If T_w and T_o be nearly the same, λ_m, c_{pm}, and γ_m can then be taken to be the values of λ, c_p and γ at $\frac{1}{2}(T_w + T_o)$. Equation [1] is true only for velocities of flow exceeding Reynolds's critical velocity. Denoting $(dw_m c_{pm}/\lambda_m)$ by A, Equation [1] is true for $A > 1000$ if $p = 1$ atmos., and for $A > 7000$ if $p = 16$ atmos. The formula applies to other sections of flow as well as to plain tubes. If F = cross-sectional area of an annular passage and S that part of the circumference through which heat enters or escapes, the value of d to be used in Equation [1] is $4F/S$. If heat flows through the whole of the outer circumference while the inner tube serves merely as a throttle, $d = (d_1^2 - d_2^2)/d_1$. Equation [1] is applicable either to the heating or the cooling of a gas; the heat-transfer coefficient remains the same if the gas and tube temperatures be interchanged. The three fractions composing Equation [1] are dimensionless, i.e., the constants of the formula are the same whatever the system of units employed; only one system must be used in each fraction, but it need not be the same in all three fractions. The formula applies accurately only when the temperature of gas changes little along the tube; variation in a along the tube may then be calculated easily. In the first half of the tube a is about 8.6 per cent greater than in the second half. The temperature of gas at the end of the tube is $T_2 = T_w + (T_1 - T_w)e - d_m F/W$; but if $(T_1 - T)$ be considerable, as in boiler tubes, the only way at present is to consider such short sections that the temperature fall in each case is small.

To eliminate the tedium of evaluating Equation [1] for individual cases, the author gives tables and charts which also show how a varies with the factors on which it is dependent. The data and curves presented relate to air and steam, these being the gases of greatest technical importance. The formulæ, tables, and curves are for: (1) Thermal conductivity as a function of temperature. (2) Heat-transfer coefficients for various

tubes and gas temperatures. The coefficient decreases at constant tube temperature with increasing air temperature; also, with increasing tube temperature, at constant air temperature. (3) Influence of air velocity and pressure, tube diameter and length. Finally there is a chart for the graphical determination of a for air in any case within wide limits. Experience shows that a for boiler-flue gases or the exhaust from combustion engines differs only 1 or 2 per cent from the values for air at equal pressure.

The velocity of gas flowing through a tube with which it exchanges heat varies along the tube inversely with the absolute temperature of the gas. The product $w\gamma$ is independent of tube length. A fundamental distinction is that whereas a decreases with rising air temperature when the air velocity and tube temperature are constant, a increases with temperature when the mass of air passing a given section in unit time is constant. Due to two conflicting factors, the heat-transfer coefficient for air which is warmed as it flows through a tube passes through a minimum value. (*Science Abstracts*, Section B—Electrical Engineering, vol. 20, part 11, no. 239, November 30, 1917, pp. 402-403, *t*)

Specific Heat of Water, W. R. Bousfield. The writer, in a paper before the Royal Society in 1911, gave figures for specific heats of water at temperatures from 0 to 80 deg. cent. Since then, other investigators, in particular Callendar, by using other methods, have secured data somewhat different from those obtained by the writer, who accepts the superior accuracy of the results of Callendar's new method in the range above 55 deg. cent.

In the range from 0 to 55 deg. the new method has not been applied and the difficulties which it was specially designed to meet at higher temperatures hardly exist in the lower range; since in that range the vapor pressure of water is so small that an accurate correction for evaporation may be easily made.

The corrected figures obtained by the writer were found to be closely in line with those of other observers and indicate that the mean specific heat from 13 deg. to 26 deg. is almost exactly equal to that from 26 to 39 deg., which gives the minimum value in the neighborhood of 25 deg.

The writer points out and discusses the salient differences in this lower range of temperature between his investigations and those of Callendar, but he points out that the course of his curve from 0 to 40 deg., with its minimum at about 25 deg. is in general agreement with the curves of Luedin, Rowland, and Bartoli and Stracciati, while the course of the Callendar and Barnes curve, with its minimum at about 38 deg., differs from all.

The results of a paper which will appear in the *Philosophical Transactions* dealing with the specific heat of certain solutions confirm the writer's position of the minimum very substantially. This paper deals with the determination of the mean capacity of a Dewar vessel in which a novel method of regulating the electric current was adopted. There the position of the minimum was such as to confirm the view of the author, a further confirmation of the same having resulted by a consideration of the actual values of the specific heats of potassium-chloride and sodium-chloride solutions. In this last instance it was found that the temperature-specific-heat curves for saturated solutions indicate a nearly straight-line law from 0 to 39 deg. between specific heat and temperature, a fact which can hardly be a mere coincidence.

The writer points out that until the course of the specific-heat curve from zero to 40 deg. can be considered as definitely settled, there must remain a doubt as to the value of the 20-deg. calorie, amounting to one part per thousand. The reasons for adopting as the standard calorie the mean specific heat over the interval which, undoubtedly, included the minimum point and which is easily reproducible, were stated in a former communication by the writer. The interval from 13 deg. to 55 deg. satisfies all the particular conditions and there remains the difference of over 1/10 of one per cent between the writer's value for the interval and that which results from Callendar's latest figures. (*Proceedings of the Royal Society*, Series A, vol. 93, no. A 655, October 9, 1917, pp. 587-591, *et*)

Varia

On the Solutions of Partial Differential Equations of First Order at the Singular Points, Toshizo Matsumoto. *Memoirs of the College of Science, Kyoto Imperial University*, vol. 2, no. 5, August 1917, pp. 255-292.

Physics of the Air, W. J. Humphreys. *Journal of The Franklin Institute*, vol. 185, no. 1, January 1918, pp. 83-117, fig. 47, 6 charts. Serial article (chap. 10).

Mechanical Differentiation, Armin Elmendorf. *Journal of The Franklin Institute*, vol. 185, no. 1, January 1918, pp. 119-130, 9 figs.

Discoveries and Inventions. *The Engineer*, vol. 124, no. 3233, December 14, 1917, pp. 514-515.

High-Temperature Drying, Burt S. Harrison. *Journal of the American Society of Heating and Ventilating Engineers*, vol. 24, no. 2, January 1918, pp. 213-226.

Automatic Control of High Temperatures, R. P. Brown. *The Iron Age*, vol. 100, no. 25, December 20, 1917, pp. 1478-1479.

Charts

Charts Showing Losses in Steam Boiler Furnaces, Haylett O'Neill. *Power*, vol. 47, no. 2, January 8, 1918, pp.52-55.

Charts Showing the Steam-Carrying Capacity of Pipes Under Conditions Given—Superheated Steam, W. H. Thies. *Power*, vol. 46, no. 25, December 18, 1917, p. 826.

Charts Showing the Steam-Carrying Capacity of Pipes Under Conditions Given—Saturated Steam, W. H. Thies. *Power*, vol. 46, no. 25, December 18, 1917, p. 825.

Friction Loss in Brick Chimneys. *The Heating and Ventilating Magazine*, vol. 14, no. 12, December 1917, p. 63.

Charts for Computing Dimensions and Properties of Helical Springs, Donald H. Reeves. *Machinery*, vol. 24, no. 5, January 1918, pp. 432-433.

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Survey.

LIBRARY NOTES AND BOOK REVIEWS

ARTICLES of interest from the Library of the four Founder Societies, selected list of accessions during the month, and reviews of books of special importance prepared by members of the A.S.M.E. and others particularly qualified.

Annual Report of Library Board

THE Library Board administering the Libraries of the American Society of Civil Engineers, The American Society of Mechanical Engineers, the American Institute of Electrical Engineers and the American Institute of Mining Engineers, maintained as the Joint Library of the United Engineering Society, has just issued its annual report for 1917.

The Board for 1917 consisted of:

Edward D. Adams	John W. Lieb
Harrison W. Craver	W. M. McFarland
J. V. Davis	Harold Pender
Alfred D. Flinn	Calvin W. Rice
George A. Harwood	Lewis D. Rights
Alex. C. Humphreys	Samuel Sheldon
A. M. Hunt	W. I. Slichter
Charles Warren Hunt	Jesse M. Smith
F. L. Hutchinson	E. Gybbon Spilsbury
J. H. Janeway	George C. Stone
Bradley Stoughton	

Mr. George C. Stone was added to the Board on November 23, 1917, as representative of the American Institute of Mining Engineers, to take the place of Mr. E. F. Roeber, whose death occurred on October 17, 1917.

The number of visitors to the Library for the year was 11,371, an average of 40 daily. The service given to both visitors and non-visitors was in the form of 551 searches and 59 translations. The photostat installed in 1916 has proved its value unequivocally; the number of orders was 791, calling for 7853 prints.

Accessions to the Library during the year amounted to 2337 pieces, and the collection totaled, on December 31, 1917, 132,778 volumes and pamphlets.

Arrangements were made during the year for the publication of brief descriptive reviews of new books in the publications of the Founder Societies. The leading publishers of technical books in America have furnished review copies for this purpose, thus enabling the Library to present to both engineers and manufacturers a timely and comprehensive list of nearly all important technical books.

The Library has been the recipient of some very valuable gifts, chief among them being the presentation by the American Society of Civil Engineers of the book stacks used in their building. These have been removed to the Engineering Society Building and have been erected on the fourteenth floor, where they provide the additional room which is so badly needed at the present time. Another valuable gift consisted of 505 volumes relating to electricity, presented to the American Institute of Electrical Engineers by Theodore N. Vail.

Cataloguing has progressed along two lines: one dealing with new accessions, the other with material already in the catalogue. As stated in the 1916 report, the catalogue lacks consistency and needs fundamental and thoroughgoing revision. With a view to this, possible methods of revision have been studied carefully and the process to be followed during the coming year has been selected, so that the work can be begun as soon as the stack room is completed.

There have been some changes in the Library Staff, chief among them being the resignation of Mr. William P. Cutter as Librarian. Mr. Cutter rendered faithful, skilled service during a period of six years, during which the Library has increased in size and usefulness and has acquired a leading position among libraries of engineering. As his successor, the United Engineering Society engaged, in accordance with the recommendation of the Board, Harrison W. Craver, Librarian of the Carnegie Library of Pittsburgh.

The components of a good library are an adequate collection of books and periodicals, a good system of cataloguing, convenient and rapid means of bringing books to readers and an efficient, willing staff.

Considering the Library of the United Engineering Society in these respects, it can first be said that the book collection is, within its limits, probably the best in this country, if not in the world. Widening the scope of the Library by including more adequately some branches of engineering, such as chemical engineering, should be considered.

The present catalogue needs reconstruction, as has already been indicated. This will receive the first attention during 1918 and every activity not immediately essential will be subordinated to it, with the hope that substantial progress can be made.

Certain rearrangements of the reading-room furniture are desirable. The staff is satisfactory and is sufficiently large for the present normal work of the Library.

HARRISON W. CRAVER.

BOOK NOTES

Everyman's Chemistry. The Chemist's Point of View and His Recent Work Told for the Layman. By Ellwood Hendrick. Harper & Bros., New York, 1917. Cloth, 5x8 in., 374 pp. $2.

An extremely readable account of recent progress in the science underlying the dye, the high explosive, potash, nitrogen—written for the purpose of enabling the general reader to obtain something like an adequate conception of the principles of its organic and inorganic branches, and of the important relations they bear to modern life and industry and war.

The Essentials of Descriptive Geometry. By F. G. Higbee, M. E., Professor and Head of Department of Descriptive Geometry and Drawing, The State University of Iowa. John Wiley & Sons, Inc., New York, 1917. Second Edition. Cloth, 6x9 in., 218 pp., 170 illustrations. $1.80.

In preparing his text the author has aimed to include only those portions of descriptive geometry which possess industrial utility. The subject is discussed from the point of view of the draftsman, and of the three hundred odd problems given a large proportion are of an eminently practical nature. In the present edition a chapter on tangent planes and lines has been added.

Principles of Natural Philosophy. By F. J. B. Cordeiro. Spon & Chamberlain, New York, 1917. Cloth, 5¼x8 in., 113 pp., 24 figs. $2.50 net.

A compact, closely reasoned study of force, energy and motion, so interwoven, however, with the frequent speculations of the author that he has selected the Newtonian title used as being more appropriate than mechanics, dynamics or physics. The methods of the calculus are used throughout.

Library Accessions

American Concrete Institute. Proceedings 13th annual convention. Vol. XIII. Purchase.

Analysis of British Wartime Reports on Hours of Work as Related to Output and Fatigue. No. 2, Nov. 1917. National Industrial Conference Board. *Boston, 1917.* Gift of National Industrial Conference Board.

Appropriation Acts of Pennsylvania, 1917. *Harrisburg, 1917.* Purchase.

Apuntes sobre las mejoras materiales aplicables a la America Latina. By L. R. Pezuela. *Lima, 1869.* Purchase.

Ascertainment of Machinery Values and Losses. By John Hankin. Read before the Insurance Society of New York. *New York, 1916.* Gift of Insurance Society of New York.

Le Béton Armé a la Portée de Tous. By Léopold Malphettes. *Paris, 1917.* Purchase.

Birds of the Anamha Islands. (U. S. National Museum, Bull. 98.) *Washington, 1917.* Purchase.

Board of Civil Engineers. Proceedings and Report, to consider the subject of the construction of a rail and highway bridge across the Missouri River at St. Louis. *St. Louis, 1867.* Purchase.

Chemistry of Colloids, The. Part 1, Kolloidchemie by Richard Zsigmondy. Trans. by Ellwood B. Spear. Part II, Industrial Colloidal Chemistry by Ellwood B. Spear. A chapter on Colloidal Chemistry and Sanitation by John Foote Norton. John Wiley & Sons, Inc., *New York, 1917.* Cloth, 9 x 6 in., 288 pp., 38 illus., $3. Gift of the publisher.

Chemistry of Dyestuffs. By M. Fort and L. L. Lloyd. *Cambridge, 1917.* Purchase.

Chicago, Ill., Public Efficiency Bureau. The City Manager Plan for Chicago. *Chicago, 1917.* Gift of Public Efficiency Bureau.

Cretaceous Theropodous Dinosaur Gorgosaurus. (Canada. Dept. of Mines. Memoir 100). *Ottawa, 1917.* Purchase.

Description of the Recently Discovered Petroleum Region in California, with a Report on the Same. By Professor Silliman. *New York, 1864.* Purchase.

Digest of the Game, Fish and Forestry Laws of Pennsylvania, 1917. *Harrisburg, 1917.* Purchase.

Dimensions and Weights of Gun Implements. *Washington, 1874.* Purchase.

Discourse of the Romane Foot, and Denarius; from Whence, as from Two Principles, the Measures and Weights, Used by the Ancients. By John Greaves. *London, 1647.* Purchase.

Distribution of Bird Life in Colombia; a Contribution to a Biological Survey of South America. (American Museum of Natural History, Bull. vol. 36, 1917). *New York, 1917.* Purchase.

Electrical New York as Seen by Vernon Howe Bailey. *New York, 1916.* Gift of New York Edison Co.

Electric Vehicle Hand-Book, The. By H. C. Cushing, Jr., and Frank W. Smith. 5th ed. H. C. Cushing, Jr., *New York,* (copyright *1917*). Flexible cloth, 7 x 4 in., 388 pp., 172 illus., $2. Gift of the authors.

Exporters' Directory of Japan, The. Imperial Commercial Museum of the Department of State for Agriculture and Commerce. *Tokyo, 1917.* Flexible cloth, 9 x 6 in., 26 pp. $2.50.

Ferro-Carril Central Trasandino. Informe del Ingeniero en Jefe. D. Ernesto Malinowski. Seccion del Callao y Lima a la Oroya y Presupuesto de la Obra. *Lima, 1869.* Purchase.

Ferro-Carril de Arequipa. Documentos relativos a esta empresa. *Lima, 1869.* Purchase.

Flotation. By T. A. Rickard and O. C. Ralston. Mining & Scientific Press. *San Francisco, 1917.* Cloth, 9 x 6 in., 416 pp., 131 illus., $3. Gift of the publisher.

Galvanic Batteries and Electrical Machines, as used in torpedo operations. Parts I and III. By J. P. Merrell. *Newport, R. I., 1874, 1875.* Purchase.

General Electric Company's Medical Service and Hospital. *Schenectady, n. d.* Gift of C. M. Ripley.

Geology of Massachusetts and Rhode Island. (U. S. Geological Survey. Bulletin 597). *Washington, 1917.* Purchase.

Graphics. By H. W. Spangler. John Wiley & Sons, Inc., *New York, 1917.* Cloth, 9 x 6 in., 95 pp., 88 illus., $1.25. Gift of the publisher.

Greenhouses. By W. J. Wright. Their Construction and Equipment. Orange Judd Company, *New York, 1917.* Kegan Paul, Trench, Trübner & Co., Ltd., *London, 1917.* Cloth, 8 x 5 in., 269 pp., 131 illus., $1.60. Gift of the publisher.

Gunnery Notes. *U. S. Navy, 1871.* Purchase.

Gunpowder as an Element in the Problem of Modern Ordnance. (Naval Ordnance Paper, No. 1). *Washington.* Purchase.

Handbook for Cane-Sugar Manufacturers and Their Chemists, A. By Guilford L. Spencer. 6th ed., enl. John Wiley & Sons, Inc., *New York, 1917.* Leather, 7 x 4 in., 561 pp., 97 illus., $3.50. Gift of the publisher.

Hand-Made Paper and Its Water Marks: a bibliography. By Dard Hunter. Marlborough-on-Hudson. *New York, 1916.* Gift of Technical Association of the Pulp and Paper Industry.

Harbor and Port Terminal Facilities and Works. By H. McL. Harding. *Washington, 1917.* Gift of author.

Health of the Worker. Dangers to health in the factory and shop and how to avoid them. By C. E. A. Winslow. Metropolitan Insurance Company. *New York, 1918.* Gift of Metropolitan Insurance Company.

Hydraulic Mining Débris in the Sierra Nevada. (U. S. Geological Survey. Professional paper 105). *Washington, 1917.* Purchase.

An Introduction to Theoretical and Applied Colloid Chemistry. By Dr. Wolfgang Ostwald. The World of Neglected Dimensions. Authorized translation from the German by Dr. Martin H. Fischer. John Wiley & Sons, Inc., *New York, 1917.* Cloth, 9 x 6 in., 232 pp., 45 illus., 1 port., $2.50. Gift of the publisher.

Iron Ore Occurrences in Canada. Vol. I, with maps. (Canada, Department of Mines, no. 217.) *Ottawa, 1917.* Purchase.

Laws of Pennsylvania, 1917. *Harrisburg, 1917.* Purchase.

Lecture on the Late Improvements in Steam Navigation and the Arts of Naval Warfare, with a Brief Notice of Ericsson's Caloric Engine. By J. O. Sargent. *New York, 1844.* Purchase.

Magnalite Piston Design. Ed. 2. By Jos. Leopold. *New York, 1917.* Gift of Walker M. Levett Co.

Mineral Industries of the United States. Coal products: an object lesson in resource administration. (U. S. National Museum. Bull. 102, pt. 1). *Washington, 1917.* Purchase.

Mineral Industries of the United States. Sulphur—An example of industrial independence. (U. S. National Museum, Bull. 102, pt. 3). *Washington, 1917.* Purchase.

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GIFT OF THE SOCIETY FOR ELECTRICAL DEVELOPMENT.

AIMS AND ACHIEVEMENTS. A brief summary of what the Society is accomplishing for its members and for the entire electrical industry.

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A $3,000,000,000 INDUSTRY PULLS TOGETHER, being an official record of America's electrical week. Dec. 2-9, 1916.

GIFT OF ALFRED D. FLINN.

The Library has received a complete file of the contracts and drawings issued by the Board of Water Supply of the City of New York, in which the canvasses of bids have been inserted, adding greatly to the reference value of the set. The gift was obtained through the kindness of Mr. Alfred D. Flinn, Deputy Chief Engineer of the Board of Water Supply.

GIFT OF ILLUMINATING ENGINEERING SOCIETY.

The Illuminating Engineering Society has presented to the Library some eighty volumes relating to the gas industry, among which are many of decided interest. These had been presented to them by Dr. William Paul Gerhard, but the Society, believing that the convenience of all would be best served by collecting all engineering material together, has secured Dr. Gerhard's consent to this disposition of his gift.

GIFT OF NATIONAL LIME MANUFACTURERS' ASSOCIATION—HYDRATED LIME BUREAU.

BULLETIN A-5. Modern Methods in Concrete Construction.

—— A-6. Promoting the flow of concrete in pipes and forms.

—— F-3. Watertight concrete.

—— J. Ideal mortar for brick masonry. Mortar no. 5.

PAMPHLET E. Standard specifications for hydrated lime plastering.

—— K. Improving concrete roads—the effect of hydrated lime.

TREATISE ON INTERIOR PLASTERING FOR THE USE OF ARCHITECTS, OWNERS, CONTRACTORS. *1915.* By Lawrence Hitchcock.

TESTS AND USES OF HYDRATED LIME. By R. C. Haff.

GIFT OF EDWARD WEGMANN.

Mr. Edward Wegmann has presented to the Library a bound set of the contract specifications issued by the Aqueduct Commissioners of New York City from 1885-1901, covering the contracts in connection with the Croton Aqueduct. The estimates and bids for the construction of the various parts of the work have been inserted in this set, adding much to its value for reference.

THE NEW BY-LAWS GOVERNING SECTIONS OF THE A.S.M.E.: WHAT THEY PERMIT AND ENCOURAGE

By LOUIS C. MARBURG, NEW YORK, N. Y.

Member, Committee on Local Sections

THE task has been assigned to me to speak on the new Local Sections By-Laws[1] of The American Society of Mechanical Engineers. I will say something regarding their history and will try to point out a few paragraphs that appear of interest in connection with the routine operation of the Local Sections. I will consider mainly, however, those characteristics of the new by-laws which seem to show a new spirit and which recognize modern tendencies in the engineering profession and elsewhere; and will also devote some consideration to these tendencies themselves and to the activities they suggest.

In the Technical Section of this issue of The Journal appear the first papers before the Local Sections of the Society this season.

The Sections papers will be continued in the April and May issues, and then again in the issues following the Spring Meeting. Several good papers are on hand.

In connection with these Sections papers it is of interest to note that the Local Sections, acting on the suggestion of the Committee on Local Sections, are now appointing papers and research sub-committees to develop the relations between the Sections and the Meetings and Publication Committees of the Society.

This is a significant move—it means that the way is being paved for the complete nationalization of the proceedings of the Society, so that these proceedings will truly constitute a record of mechanical engineering progress in America.

Previous to the acceptance of these new by-laws, the Constitution, By-Laws and Rules of the Society contained but scant reference to any Local Section activity. There was a paragraph in the Constitution permitting the formation of professional sections and geographical groups, and there were rules regulating both in a rather indefinite way, and taking little account of the great difference between them. The Local Sections movement increased rather independently of these rules; and it might seem that more elaborate by-laws were quite unnecessary. The Committee on Local Sections felt, however, that a certain amount of uniformity in matters of routine was advisable and that, furthermore, the experience of older and successful Sections might be made available, in the form of by-laws, to new Sections. Therefore it appointed some time last year a sub-committee consisting of Prof. Walter Rautenstrauch and myself to prepare a draft for new by-laws. This draft was submitted to the Local Sections delegates a year ago for criticism and suggestions; it was modified in accordance with some of the ideas expressed at that time and submitted to the Council. After being referred to the Committee on Constitution and By-Laws for proper codification and comment, and after some joint work between this Committee and your committee, these by-laws finally emerged and were passed by the Council at its October 1917 meeting. If any details do not meet with the Sections' approval, it should be remembered that all laws are compromises, except those made by an autocrat, which generally please but one person—the autocrat himself.

The New By-Laws and Their Interpretation

The by-laws naturally contain several paragraphs pertaining to matters of routine, such as the procedure in forming a new Section, the definition of territory and membership, the personnel and duties of the local committees, the method and time of election, contributions on the part of the parent Society and the use of such contributions, the use of uniform stationery, etc., all of which aim at unifying Sections procedure, to the strength of the organization.

More interesting than these is the paragraph on "Local Section members," granting to each Section the right to include a new class of membership, if it so desires—local members of the Section who are not members of the parent Society. Any dues collected from such local members belong to the Section, and the parent Society has no control over their disbursement. Opinions will vary as to the advisability of permitting this class of local membership,—they will vary mainly on account of the difference in problems that Sections have to meet and owing to the difference in local conditions. Some Sections have such members, others may find it useful to have them, others may not. The decision rests with the Sections themselves.

Useful Activities of the Sections

On Section activities the new by-laws contain a number of paragraphs. Here, of course, there is a great deal to say, for the activity of the Sections is necessarily the activity of the Society. Papers shall be read, that is a matter of course. It has always been the main function of our Society and there is no new suggestion in this. Attention, however, should be called to the paragraph suggesting that such papers, after being read before the Sections, be submitted to the Committee on Meetings and to the Publication Committee for possible further use. It is urged that this practice be generally adopted. It will furnish to The Journal much valuable material. It will also tend to improve the quality of papers read before Sections, because the author of a well-prepared address will be assured of a larger audience, particularly if his paper is accepted for a general meeting of the Society and published in the Transactions.

Another recognized activity consists in social functions and the fostering of acquaintanceship among engineers, an important and a very useful part of the Sections work.

The Keynote of All Sections Work—Coöperation

Foremost, however, of all the activities mentioned in the by-laws appears to be coöperation. Coöperation with other

[1] Address delivered before the Conference of Local Sections Delegates of the Society at the Annual Meeting of The American Society of Mechanical Engineers, New York, December 1917.

engineering organizations, be they local engineering societies or sections of other national societies, and coöperation with other organizations of whatever kind, in any enterprise having the approval of the Section. We cannot too earnestly recommend the cooperation with other local sections and the affiliation with local engineering societies or clubs. The experience in St. Louis, Philadelphia, Milwaukee and other cities has been so extremely satisfactory that it should encourage similar combinations in other localities. The recognition of coöperation in other than strictly professional work, which is accorded in the paragraphs referred to, is a radical innovation in the policy of our Society, but more will be said on this particular point.

By-Laws Constructive, Not Obstructive

Perhaps after my introductory remarks about a new spirit expressed in our By-Laws, this short résumé has proven disappointing. Perhaps a casual glance over these by-laws does not show anything so strikingly novel. Perhaps also, and probably, some real or contemplated activity in some of the Sections has already been along the lines suggested in all the paragraphs on Sections activity. Let me express right here and most emphatically, that these by-laws are not believed to point the way to something never thought of before, they do not contain a single new and brilliant thought; but they do, it is believed, take proper cognizance of changing ideas and of newer tendencies. They do not stand in the way of certain aims which should be encouraged and which are welcomed by the engineer of vision and by the firm believer that the engineering profession has higher ideas than perfection in the calculation of stresses and the design of machinery and structures.

By-Laws Recognize Modern Tendencies

In discussing more fully the spirit of the new by-laws and the degree to which they show recognition of modern tendencies, we must take these tendencies themselves into consideration.

First, these by-laws seem to express a spirit, not only of democracy, but of a particular kind of democracy. Democracy, which in its political sense means majority rule, we have of course always had in our Society whenever the members were sufficiently interested to use their power. But even if members everywhere could be induced to take an equal amount of interest in the affairs of our Society, majority rule alone would not yet be satisfactory. Majority rule of a certain kind is unendurable and more tyrannical than the rule of many an autocrat. If vital questions affecting a small community are decided by the majority of fifteen or twenty million voters in a huge country, it is small consolation for this community to know that a decision against its wishes and its vital interests has been reached by the rules of democracy. Not only may injustice result from having a government so far removed from those it governs, but there may arise a feeling of helplessness and a lack of interest. Bertrand Russell says in one of his books: "The modern great state is harmful from its vastness and the resulting sense of individual helplessness. Even in a democracy, all questions except a very few are decided by a small number of officials and eminent men; and even the few questions which are left to the popular vote are decided by a diffused mass-psychology, not by individual initiative."

Sections Require, and Retain, Self-Determination

It is this feeling of helplessness, this suppression of the individual initiative, which we must guard against even in an organization having only 9000 voters instead of fifteen or twenty or thirty millions. Engineers in districts remote from New York require an organization nearer to themselves than the national society, nearer not only in distance but in interest. It is to this need that the whole Sections movement owes its existence, and it is self-evident that, in order to do their best, such local organizations require the greatest degree of self-determination and the greatest freedom from outside interference consistent with harmonious coöperation with the parent Society. Sections must manage their own affairs: they will know their local needs and conditions, and as long as they do not commit the national society by any of their actions, little control from headquarters will be needed; and, no doubt, affairs will be handled properly and to the best interests of the Sections themselves.

Let nobody fear that the position of the parent society will be impaired by this policy. Let nobody fear sectarianism. The danger of our present world organization lies not in too little centralization of power but in the excess of such centralized power. Government too far removed from the individual voter is offensive, in fact, it is dangerous. Let us realize this, let us have strong sections taking interest in local affairs. Home rule, which to so great an extent has been responsible for the success of our national government, must be the order of the day in the world that is to come. Let us have it in our Society and in our Section management.

Coöperation and More Coöperation—What It Can Do

As stated, the By-Laws suggest coöperation, coöperating mainly with other engineering groups like local sections of other national societies and local engineering societies, but also with other organizations of whatever kind for the furtherance of objects benefiting the engineering profession or the community at large. Coöperation with other engineering societies or sections, aside from being a necessity in communities where our Sections are too small, lends variety to meetings, helps to secure better papers, and avoids duplication of work in many instances. But mainly it is to be recommended because engineers of different branches should come in closer touch, should know and understand each other better, each other's work and problems and difficulties. They should discuss more the joint interests of our profession, our aims and hopes and ideals. They should plan more for joint work, of which there is plenty.

There is standardization, so far almost exclusively done by individual engineering societies. It seems that a great deal could be done by having national societies coöperate to establish national standards, instead of A.I.E.E. standards, S.A.E. standards, A.S.M.E. standards, and whatever they all may be.

And do not let us stop at the national frontiers. Let us join with foreign engineers to establish international standards. We are learning much just now regarding the lack of international uniformity, when we are doing so much work for the European nations who have different standards, yes, who even have different systems of measurements. Some beginning has been made, and just now the International Aircraft Standards Board in Washington is doing useful work.

But not only for war is such standardization desirable, it is important also in the work of peace. We have entered the group of nations which export industrial products to a large extent. Our weakness in manufacturing is special work; our

strength, quantity manufacture of standardized products. International standardization would be of greater benefit to us than to almost any other nation.

Coöperation with other engineers will also help us to increase and to exert the influence of the engineering profession. Strong local engineering societies, to which are affiliated all the sections of the national societies, are the best guardians of the engineer's local interests. Coöperation with non-engineering organizations will also increase the influence of engineers and will make available to the community their services and advice on subjects on which their knowledge is greater and their judgment better than that of the average citizen.

How far a section or any engineering society should go in taking up subjects not closely related to engineering or the engineering profession, it is of course impossible to advise. When, however, an engineering society takes an official stand, it should be only on a matter affecting the engineer as such, but regardless as to whether it is engineering work or economic and social legislation.

Broadens the Engineer, Brings Him in Touch with Affairs

Hand in hand with coöperation goes the broadening of the engineer. Coöperation widens our horizon, and a wider horizon in turn enables us to coöperate better. I want to make a strong plea for a broader scope of the engineer's interests, for a broader education. I mean not only broader school and college education. I want to plead especially that the engineer, after graduation, continue not only study and interest in engineering subjects other than his own, but also in economic and social questions, which so vitally affect our work. The knowledge we acquire in college is valuable, but the best thing we can take with us from college into after life, as James Bryce once expressed it, is the taste for knowledge. Do not let us lose that, do not let the young man lose it when he comes from college and when he necessarily must specialize to a great extent in order to get a start.

No period in the world's history has been so under the influence of engineering work and development, as the present; during no previous period has the engineer himself depended to such an extent on economic and social conditions as now. Is it then not logical to say that the engineer should and must now be in closer touch with the legislation and administration of country, state, and city than ever before?

The world is moving fast just now. When we are fixing prices of food, of fuel, of raw and partly finished products, when we consider control and even operation of our railroads by our Government, we certainly have adopted economic ideas not in favor heretofore. When the Conference of Organized Labor is addressed by the President of the United States, and when the executive council of this same organized labor files a resolution outlining a foreign policy for the nation and insisting upon participation in the peace conference by labor delegates, certainly changes are taking place in our country.

And with it all, these changes seem but small compared with those across the ocean. Any class of men so vitally affected by economic and labor conditions as the engineers must study these developments; anybody but him who lives in dreamland, must reckon with them. Do not deceive yourselves by thinking that except for the one great revolution the changes going on are not so vital and that things may get back to where they were before. Try to compare today with yesterday. If you can discover a milestone in the past ten or fifteen years ago which indicates conditions as they were, compare and you will realize the journey we have taken. You are so accustomed to plotting curves. Plot, so to speak, your curves of economic and social changes with the abscissa time. See how they changed from past to present and try to divine where they will lead in future.

The question of the standing enjoyed by our profession will solve itself if we but broaden and coöperate. In the past the engineer has specialized, and with ability and strenuous effort he has succeeded in doing great things. But too often it has been someone else who coördinated and directed and interpreted his efforts and who, therefore, received, and perhaps to a considerable degree deserved, the credit for success in an enterprise. I am not one of those who believe that advertising the engineering profession is the panacea for these ills. True, the general public had for a long time misunderstood the engineers' work; it had considered him quite generally a man without imagination. As to the general willingness, however, at this time, to concede the engineer a prominent place, there can be little doubt. The war has furnished all the advertising necessary for the engineer.

The Desired Result Within Reach

It may be felt that I have strayed far from Sections By-Laws, that I have gone roaming into fields rather unconnected with our work as Sections and Sections Committee. But the new by-laws are an expression of modern tendencies; the committees that framed them and the men who passed them in the Council were under their spell, consciously or subconsciously. And as I see our by-laws, they suggest and they encourage more democracy within our Society, coöperation and broader interests, a stronger and more worth-while engineering profession, and service to our country and the world. Certainly when we go dreaming on these subjects there is no limit to our imagination and no measure for the enthusiasm and inspiration which we may derive.

A conference of Ohio engineering societies was held at Columbus January 29. The meeting resulted in the formation of a permanent organization named the Association of Ohio Technical Societies, with Clyde T. Morris, professor of civil engineering of Ohio State University, as president and C. E. Drayer of Cleveland as secretary. All local societies and local sections of the national societies in the state, twelve in all, were represented, except one which has since indicated its desire to be included, so that the representation now includes all.

Resolutions were adopted endorsing the ten cardinal principles adopted by the Committee on Engineering Coöperation at its conference last March; urging local societies to endeavor to have at least one engineer named on any board having to do with the expenditure of public funds where engineering experience would be of assistance; and endorsing the report of the Inter-society Relations Committee of the Cleveland Engineering Society suggesting that the national societies consider as a prerequisite to membership that a candidate show membership in an accredited local society. Employment, participation in civic affairs and statutory regulation of engineering practice were discussed, the last at length.

All delegates seemed to recognize that regulation by law of the practice of engineering is coming, and that if engineers do not recognize this situation and do the lawmaking themselves, somebody else will.

PROBLEMS OF CRANKSHAFT DESIGN

A Paper in Which Mathematical Deductions from Examples from Prevailing Practice Are Utilized to Derive Factors of Safety and Other Specific Values

By OTTO M. BURKHARDT, BUFFALO, N. Y.

GASOLINE engines, of the kind at present produced in large quantities for airplanes and motor vehicles, may turn over at 3000 r.p.m. or faster. The forces necessary to induce and maintain these speeds, as well as other forces closely associated with high speeds, are numerous; but with a particular object in mind, this paper will be confined to the three most important groups of forces—the pressures due to the gaseous mixture, the inertia forces, and the centrifugal forces. The smooth running and the life of an engine depend mainly on these three factors.

The reciprocating masses linked to the crankshaft will be considered as one mass concentrated at one point in the axis of the cylinder. This simplification implies that the inertia forces are, like the gas pressures, acting primarily in the direction of the cylinder axis, a condition that permits arithmetical addition of both groups of forces. To the same category belongs another group of forces which, according to a well-known law, has its origin in the angularity of the connecting rod. The different component forces have been determined in respect to two engines of equal capacity for 24 crank positions. These positions are uniformly spaced at intervals of 30 deg.

TABLE 1 DIMENSIONS AND WEIGHTS FOR ENGINES OF SIMILAR DESIGN

	Six-Cylinder	Twelve-Cylinder
Cylinder bore, in	3.75	3.00
Stroke, in. (=bore × 1.667)	6.25	5.00
Weight of reciprocating parts, lb. (one cylinder)	4.07	2.60
Weight of rotating parts, lb. (one cylinder)	2.40	1.93
Weight of rotating parts, lb. (two cylinders)		3.86

and comprise two revolutions, which constitute one complete cycle in case of four-stroke-cycle engines.

Corresponding components when combined as resultant forces and graphically represented in magnitude and direction, yield irregular characteristic diagrams with which every engine designer should acquaint himself.

As subjects for investigation, medium-size six- and twelve-cylinder engines, both of the same cylinder volume, were chosen. Both engines are supposed to be similar in design and up to the same standard of construction. Some particulars relating to these engines are given in Table 1.

Fig. 1 is a force diagram pertaining to the six-cylinder engine. The concentric circle is a graphical representation of the centrifugal forces acting on the crankpin at a speed of 2700 r.p.m. The combined gas and inertia forces as above referred to are represented by the irregular polygons.

For instance, O-3 of this diagram represents the magnitude and direction of the combined gas and inertia forces if the crankpin is in position 3, that is, 60 deg. from the top dead center. For one complete cycle the different strokes are represented as follows:

Power stroke, by forces O-1 to O-7
Exhaust stroke, by O-7 to O-13
Suction stroke, by O-13 to O-19
Compression stroke, by O-19 to O-1.

To obtain a clear picture of the total forces acting on a crankpin, we must combine both diagrams as follows: O-1 of the polygon with O-1 of the concentric-circle diagram, and so on. This yields the diagram shown in Fig. 2, which represents the magnitude and direction of the resultant forces acting on the crankpin of a six-cylinder vertical engine.

The combined gas and inertia forces for one unit of a twelve-cylinder engine and the corresponding centrifugal forces are diagrammatically represented in Fig. 3. We observe that these forces are much smaller but quite analogous to those given in Fig. 1. The combination of the gas and inertia forces with the centrifugal forces yields the diagram shown in Fig. 4, which represents in magnitude and direction the resultant forces per cylinder acting on the crankpin of a twelve-cylinder engine. It must be borne in mind, however, that in the case of the engine under consideration, two single-cylinder engines are acting on one crankpin. We have, therefore, to superimpose two diagrams so that their vertical axes include an angle of 60 deg., as in Fig. 5. The crank positions 1 to 24 in the diagram are plotted according to the clockwise rotation of the crankshaft. The distinction between the right- and left-hand block of cylinders is made through the indices *R* and *L* by similarly viewing the engine. According to the conventional sequence of firing, we obtain: 1L, 6R, 5L, 2R, 3L, 4R, 6L, 1R, 2L, 5R, 4L, 3R. From this we see that the engine on the right is in phase 420 deg. behind the other, or (what amounts to the same thing) 300 deg. ahead of it. It follows that we must combine force O-1L due to the left-hand engine with force O-11R due to the right-hand engine and so on. Properly carried out for all simultaneous acting forces, this yields a diagram, Fig. 6, representing in magnitude and direction the forces acting on the crankpin of a twelve-cylinder V-type engine.

It is difficult to neutralize by balance weights the effect on the crankpin of the forces shown in Figs. 2 and 6. The reason is that the centrifugal forces involved are due to a mass performing a relative motion. That is to say, the rotating mass of the connecting rod does not rotate truly about its own center but turns relatively to another mass, which turns about a center of its own.

In order to be entirely effective under such circumstances, balance weights would in turn have to perform relative motions. This introduces extra friction and complication. Balance weights for this effect are quite feasible, however, for six-cylinder engines, but they are almost an impossibility for twelves. The diagrams reveal the fact that the forces are smallest in a horizontal direction. This suggests that the oil holes in the crankpin should be placed at right angles to the radial lines through the center of the pin. The preferable direction would be opposite to that of rotation. To prevent the oil from escaping, a labyrinth should be cut in the bushing bearing surface, where the forces are a minimum.

[1] Mathematical Research Engineer, Pierce-Arrow Motor Car Company.

Abstract of paper presented at a meeting of the Engineering Society of Buffalo, Automotive Section, October 24, 1917.

A glance at Figs. 2 and 6 shows that the difference in the loads acting on the crankpin of either engine is not marked. The maximum load in the case of the twelve is 4040 lb., and in the case of the six, 4795 lb. The difference between the two is $18\frac{3}{4}$ per cent of the former. These loads increase approximately as the square of the speed. If then the twelve-cylinder engine runs at 2940 r.p.m., it is subject to the same maximum load as is the six when running at 2700 r.p.m. Mention is made of this because it is generally found in practice that a car with a twelve-cylinder engine is geared so that the engine runs at a slightly higher speed than a six-cylinder engine would be made to run.

The life of a crankshaft bearing depends largely on the magnitude of the mean pressure resulting from the various loads acting during one complete cycle, and this has been found to be 15 per cent smaller with the six than with the twelve. It is an axiom in bearing design that a certain permissible load per unit of bearing surface should not be exceeded. Nevertheless we shall not content ourselves with speaking of maximum or mean loads exclusively, a mistake which is committed by altogether too many engineers who endeavor to design high-speed-engine bearings with a certain specific load as their only guide.

Designers also should not lose sight of the fact that intermittent loads such as are encountered in high-speed internal-combustion engines affect bearings differently than does a steady load. It is well understood that a load acting continually in one direction is likely to cause lubrication difficulties. To what extent a bearing will behave well under the effect of a steady load is shown by an experiment[1] made by Professor Goodman, who states that he has had a journal running for weeks with a surface velocity of 4 ft. per sec. under a steady load of 2 tons (4480 lb.) per sq. in., the journal being kept at a temperature of 110 deg. fahr. by a stream of water forced through it. It is evident that bearing loads of this magnitude are hardly permissible under conditions where the load is subject to frequent and abrupt changes in direction unless an unusual amount of attention is being given to the maintenance of a certain running clearance by frequent adjustments. Therefore it is advisable under ordinary circumstances either to avoid fluctuations in load or to reduce the specific bearing pressure. For instance, the maximum permissible load on crankpins of slow-running stationary gas engines and locomotives is about 1500 lb. per sq. in. of bearing surface.

Furthermore, it is essential for an engineer to bear in mind the well-known fundamental empirical law of fluid motion, namely, that the resistance to sliding is due to the shearing of the fluid film and is consequently a function of the velocity of shearing, the viscosity of the fluid, and the shearing area. This law has proved useful for solving lubrication problems and conforms with the well-known experiments by Beauchamp Tower[2] which showed that the frictional resistance of a journal at a constant temperature is directly proportional to the square root of the rubbing velocity and is independent of the total load.

The laws of friction and carrying power thus far mentioned assume the presence of an oil film of not less than a certain thickness between the journal and the bearing. Without this film no bearing can be safe against undue abrasion. To maintain this much-desired oil film the designer should as far as possible protect bearings from unequal pressure distribution, from abrupt changes in the direction of these pressures, and from an undue rise in temperature.

The pressure distribution, which in most cases is more or less imperfect, depends on the design of the crankshaft, and will be discussed more in particular later. The character of pressures can be determined by means of diagrams. From these diagrams we may derive the mean bearing pressure, which, when multiplied by the circumferential velocity of the journal and the coefficient of friction, represents the work expended in friction.

The rise in temperature may be expressed as a function of the work expended in friction, if we limit ourselves to conditions under which the radiating surface of the bearing and the feed of oil are the same.

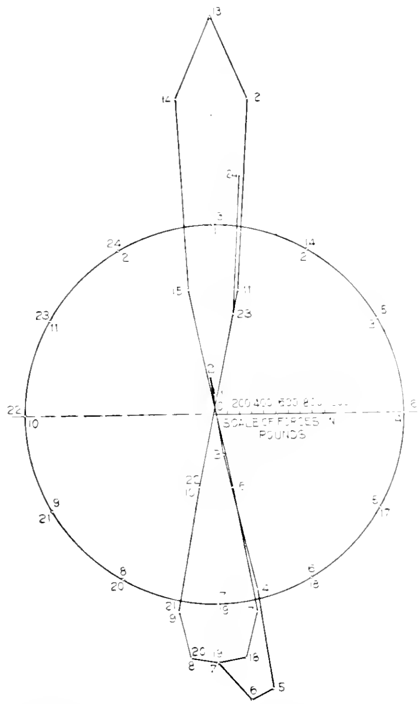

Fig. 1 Centrifugal Forces and Combined Gas and Inertia Forces Acting on Crankpin of Six-Cylinder Engine

The frictional work per square inch of bearing surface is mathematically expressed by:

$$w = \mu \frac{P}{dL} \cdot \frac{d\pi N}{12 \cdot 60} = \mu p v \qquad [1]$$

where

w = work expended in friction per sec. and per sq. in. of bearing surface
μ = coefficient of friction
P = total bearing load, lb.
p = specific bearing load, lb. per sq. in.
d = diameter of shaft, in.
L = length of bearing, in.
N = speed of shaft, rev. per min.
v = circumferential velocity of shaft, ft. per sec.

[1] Unwin, Elements of Machine Design, part 1, p. 243.
[2] Proc. Inst. M. E., 1883 and 1884.

From [1] it follows that

$$pv = \frac{PV}{229L} \qquad [2]$$

According to data gathered from well performing and durable engines it may be stated that the value pv should not exceed 17,000 ft-lb. per sec. This value is far in excess of other similar values. Güldner states that in case of stationary gas engines the maximum limiting value of pv based on experience is about 1500 ft-lb. per sec. for bearings lined with white metal. From this it is evident that a value of 17,000 ft-lb.

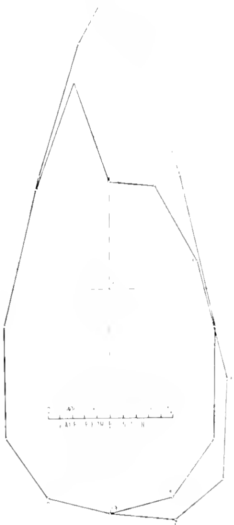

Fig. 2 Combined Centrifugal, Gas and Inertia Forces Acting on Crankpin of Six-Cylinder Engine

per sec. is permissible only in cases where forced lubrication is used.

In this connection it might be suggested that determination of pv values for various lubricating systems would be very desirable.

To apply this pressure-velocity criterion to the two engines under consideration it is necessary to determine the mean pressure of a complete cycle from Figs. 2 and 4. These are 2870 and 1650 lb. for the six and twelve, respectively. Assuming a crankpin diameter of $2\frac{1}{8}$ in. for either engine, we obtain, at 2700 r.p.m., a rubbing velocity of

$$V = \frac{2\frac{1}{8} \times \pi \times 2700}{60 \times 12} = 25.02 \text{ ft. per sec.}$$

With a crankpin length of 2 in. we obtain, in the case of the six,

$$pv = \frac{2870 \times 2700}{229 \times 2} = 16{,}900 \text{ ft-lb. per sec.}$$

With a crankpin length of 1 5/32 in. we obtain, in the case of the twelve,

$$pv = \frac{1650 \times 2700}{229 \times 1\,5/32} = 16{,}825 \text{ ft-lb. per sec.}$$

The total crankpin length of the twelve, if the connecting rods are arranged side by side, should therefore be 2 5/16 in. This is about 15 per cent more than the corresponding length of the six. With equal crankpin diameters for both engines, the crankpin lengths must be proportional to the load. In order to verify this the mean total load acting on the crankpin of a twelve has been determined from the diagram in Fig. 6. As expected, it is 3300 lb., or 15 per cent more than the total load acting on the crankpin of the six.

This and all further comparisons between the six- and twelve-cylinder engines are based on the assumption that both engines are running at the same speed. But, as has been emphasized before, it is general practice to run a twelve-cylinder engine somewhat faster than a six. If this were taken into consideration, the difference between both engines would of course be more pronounced.

Before accepting the crankpin lengths given above as representing the final values, we will ease our minds with regard to the magnitude of the specific bearing pressure. In the case of the six we have a maximum load of 4795 lb. The projected bearing area of a crankpin $2\frac{1}{8}$ in. in diameter and 2 in. long is $4\frac{1}{4}$ sq. in. This gives a specific pressure of 1125 lb.

In the case of the twelve we have a maximum load for each cylinder (taken from Fig. 4) of 2660 lb. and a projected bearing area of $2\frac{1}{8} \times 1\,5/32 = 2.46$ sq. in. This necessitates a

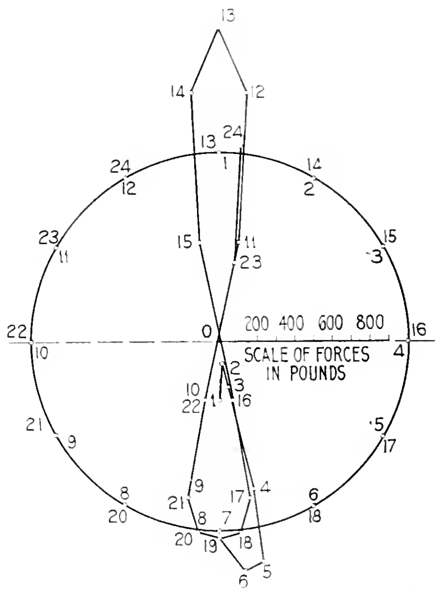

Fig. 3 Centrifugal Forces and Combined Gas and Inertia Forces Due to One Cylinder Acting on Crankpin of Twelve-Cylinder Engine

specific bearing pressure of 1080 lb. The difference between both values is only 4.1 per cent, and both are of such magnitude as to be just about permissible. If the engines are to be used for automobile propulsion, then it may be borne in mind that maximum speed is generally not maintained for any great length of time. The loads above given would represent, then, the exception and not the rule.

Automobile engines, however, are frequently subject to hard usage when long hills are climbed on high gear. Under such conditions the explosive pressures alone determine the loads on the bearings, because the speed of the engine is generally

so low that the inertia and centrifugal forces are negligible. Assuming an explosion pressure of 380 lb. per sq. in. for both engines, we obtain total explosive loads of 4200 and 2690 lb. for the six and the twelve, respectively. In the first case we obtain a specific crankpin pressure of 4200/4.25 = 990 lb., while in the second we obtain 2690/2.46 = 1095 lb. The difference between both engines is here 10.6 per cent in favor of the six. The loads of the two engines due to explosive pressure alone are somewhat smaller than those obtained before at high engine speed.

All forces acting on the crankpin necessitate reactions on the main bearings. The total load on the main bearings also includes the centrifugal forces due to the crankpin and the adjacent crank cheeks. Theoretically, and now even practically, it is a simple matter to attach weights to the crankshaft that will relieve the main bearings on the centrifugal forces. Whether it is an advantage to do so will be presently investigated by means of diagrams.

The forces to be dealt with at first are those relating to the six-cylinder engine resolved into components in a manner as determined for a crankshaft of the seven-bearing type.

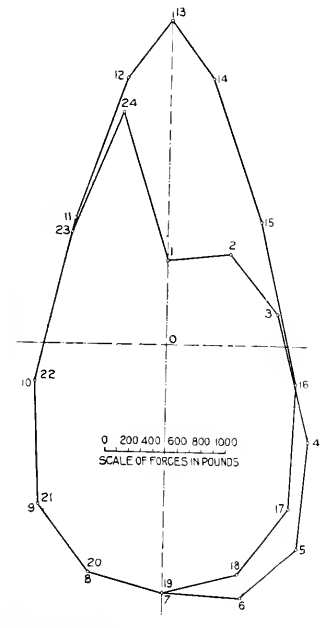

Fig. 4 Combined Centrifugal, Gas and Inertia Forces Due to One Cylinder Acting on Crankpin of Twelve-Cylinder Engine

We are now concerned with two groups of diagrams:

a Main-bearing load for a crankshaft without balance weights: Fig. 7, loads on main bearings I and VII (counting from front of engine); Fig. 8, loads on II, III, V and VI; and Fig. 9, load on IV.

b Main-bearing load for a crankshaft with balance weights: Fig. 10, loads on main bearings I and VII; Fig. 11, loads on II, III, V and VI; and Fig. 12, load on IV.

It is plainly evident from the scale of the diagrams that the balance weights act to reduce considerably the loads on the bearings, but, as already stated, magnitude is not the last word to be said about loads. Sudden fluctuations in the direction of the load are equally, if not more, detrimental to a bearing than the mere magnitude of the loads. Quick changes in the direction of a force acting on a mass are always accompanied by inertia effects. We must expect, therefore, that the journals carrying loads as shown in Figs. 10 to 12 will develop an undesired reciprocating or rocking action. Figs. 7 to 9, however, represent comparatively steady loads. The journals carrying these loads will creep around on the bearing surface, an action in principle like that involved when a planetary gear rolls within an internal gear. This facilitates lubrication, because the lubricant, while adhering to the metal surfaces, is continually wedged in between the two bounding

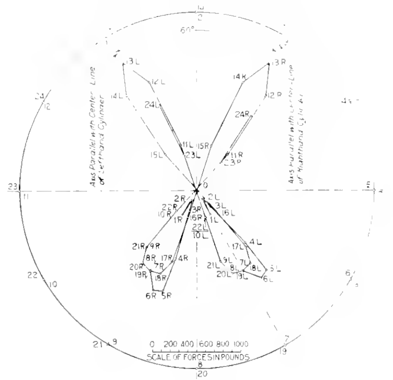

Fig. 5 Centrifugal Forces and Combined Gas and Inertia Forces Due to Two Cylinders Acting on Crankpin of Twelve-Cylinder Engine

surfaces. From this it is seen that beyond pounds of load per bearing there is, so far, nothing to say in favor of balance weights.

The length of the bearings necessary to carry the respective loads safely can be determined by the formula $pv = 17{,}000$ ft-lb. per sec. With a main-bearing diameter of $2\frac{1}{8}$ in. we obtain for 2700 r.p.m. of the engine a circumferential velocity of $v = 25.02$ ft. per sec. The mean loads on the bearings, as obtained from the diagrams, are given in Table 2, together with the necessary bearing lengths, the values of pv and the specific bearing pressures.

In the case of bearings I and VII a liberal amount should be added to the length of the bearing to take care of the loads due to the timing gears and the flywheel, and at least $\frac{1}{4}$ in. should be added to every bearing to allow for fillets. But in spite of this we find that the bearing lengths for the balanced type are entirely too short to hold the requisite oil pressure. If they are lengthened so that they are in conformity with *this* practical consideration we will obtain bearings for a crankshaft *with* balance weights about as long as those for a crankshaft *without* balance weights.

Apart from these analytical considerations it has now become an established fact that the smooth running, life and power of a well-designed engine with a seven-bearing shaft cannot be improved by the addition of balance weights. This is true in spite of the fact that any shaft with balance weights will perform much better on any balancing machine than will its prototype without balance weights. This paradoxical result is easily explained if we bear in mind that a shaft when running in a balancing machine is not subject to the sudden im-

pulses which are a necessary evil inherent to the reciprocating engine. It seems that the best method to make these impulses harmless is to smooth them out by means of the centrifugal forces, which, as we know, are available "free of charge."[3]

It remains now to determine the loads on the main bearings for the twelve-cylinder engine in a manner similar to that which was adhered to in the case of the six. However, since there is not the slightest difference in the procedure, it is permissible to draw conclusions from former results. We must therefore reconcile ourselves with the fact that in all cases the

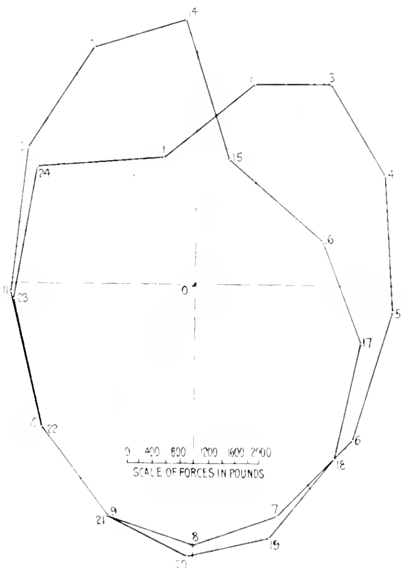

FIG. 6 COMBINED CENTRIFUGAL, GAS AND INERTIA FORCES DUE TO TWO CYLINDERS ACTING ON CRANKPIN OF TWELVE-CYLINDER ENGINE

mean pressure of a complete cycle will be about 15 per cent in excess of the corresponding pressures represented in Figs. 7 to 12. This conclusion is based on the results derived from the force diagrams shown in Figs. 2, 4 and 6. These diagrams show that the mean pressure on the crankpin of a twelve-cylinder engine is 15 per cent larger than that on the crankpin of a six.

In the case of a twelve with two connecting rods mounted side by side on one crankpin the distribution of load over the whole length of the crankpin is not uniform, because the loads on the two connecting rods do not at every instant act with equal intensity. The point of application of the resulting loads given in Fig. 6 is therefore not in the middle of the crankpin, as is the case with the loads given in Fig. 2. The two main bearings adjacent to the crankpin (seven-bearing crankshaft) will not receive at every instant exactly half the loads given in Fig. 6, but alternately the one will receive somewhat more and the other somewhat less than half of the total for well known mechanical reasons.

This rough-and-ready analysis, however, permits the conclusion that the main bearings of a twelve-cylinder engine should be designed to give at least 15 per cent more bearing surface than main bearings which have proved successful for a six-cylinder engine of equal capacity.

In the preceding discussion we have been dealing with various dimensions for crankpins and main bearings. These

TABLE 2 DATA FOR BALANCED AND UNBALANCED CRANKSHAFTS

Bearing number	Type of crankshaft	Mean load	Theoretical bearing length	Value of pv	Mean specific bearing pressure
I, VII	Balanced	774	$\frac{3}{4}$	16,200	645
	Unbalanced	2180	$1\frac{5}{16}$	16,425	677
II, III, V, VI	Balanced	839	$\frac{7}{8}$	15,800	633
	Unbalanced	2190	$1\frac{5}{16}$	16,500	660
IV	Balanced	1520	$1\frac{3}{16}$	16,725	670
	Unbalanced	4350	3	17,040	682

dimensions were chosen according to the dictation of sound engineering. While this method is satisfactory, it is well to verify the results obtained, perhaps in the following manner. Both engines so far spoken about will develop probably a

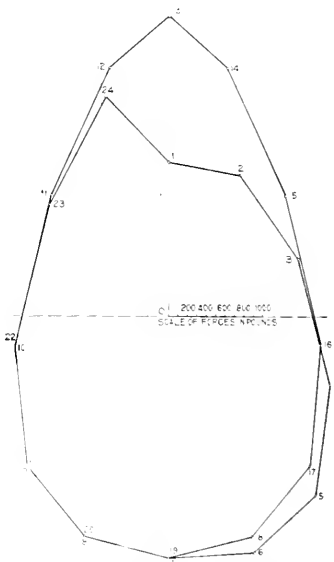

FIG. 7 LOADS ON MAIN BEARINGS NOS. I AND VII OF CRANKSHAFT WITHOUT BALANCE WEIGHTS

maximum torque of about 3000 in-lb. This would correspond to about 48 hp. at 1000 r.p.m. However, the torque on the crankshaft is subject to considerable fluctuation, depending on the number of impulses. This fluctuation, which, of course, has some bearing on the operating smoothness of an engine, was made the subject of many investigations in the early days of the six, and again at the advent of the eight and the twelve. Such investigations have revealed that the multi-cylinder engine, six, eight, twelve, etc., certainly deserves great credit for its smooth torque.

Owing to the small number of impulses, the torque on the crankpin of a six-cylinder engine may at intervals be two and

a half times as large as the torque indicated on the dynamometer. In considering the strength of the crankshaft we must therefore deal with a torque of, say, 7500 in-lb. With a crank radius of $3\frac{1}{8}$ in. this torque results in a tangential force of 2400 lb., acting through the crank cheek on the crankpin as indicated in Fig. 13.

If we at first assume the crank cheeks as being infinitely strong, we can consider the crankpin as a cantilever. With a crankpin length of 2 in., plus half the width of the cheek, the total length of the cantilever will be about $2\frac{1}{2}$ in. The bending moment is, consequently, $2400 \times 2\frac{1}{2} = 6000$ in-lb. The moment of resistance to bending of a $2\frac{1}{8}$-in. diameter cylinder with a 1-in. hole is 0.896 in.^{3} With an elastic limit of 110,000 lb. per sq. in. (chrome-nickel steel) we obtain from these data 16.4 as the factor of safety. Crankpins are further subject to some shearing and bending due to the load acting directly on them, but in the above calculation this has not been taken into consideration. If we allow for these extra stresses we may obtain a final factor of safety of 12, which is not too much for so important a part as a crankshaft.

After this we may now assume the crankpin to be infinitely strong. From this point of view we must expect the crank

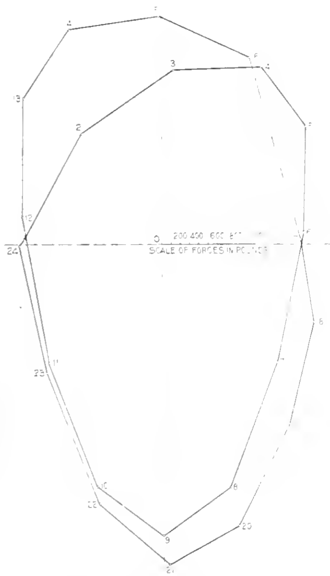

Fig. 8 Loads on Main Bearings II, III, V and VI of Crankshaft Without Balance Weights

cheeks to deflect in a manner as shown in Fig. 13. The twisting moment to be resisted by the cheeks evidently is $2400 \times 3 = 7200$ in-lb. The moment of resistance to torsion of a rectangular section is $2b^2h/9$. The permissible fiber stress in case of twist is about 75 per cent of that permissible for bending. Taking this into consideration, and maintaing a factor of safety of 12, gives the following equation:

$$7200 = 2 \times \frac{0.75 \times 110{,}000}{12} \times \frac{2}{9}\, b^2h$$

From this, taking $h = 2\frac{3}{4}$ in., we obtain the thickness of the cheek b as 0.925 in.; or, to give an even figure, 15/16 in. This small special allowance is desirable because the crank cheeks, like the crankpins, are subject to compound stresses.

In this connection it may be remarked that, as a rule, the crank cheeks are found to be the weakest parts. Fig. 13 and the calculations explain why so many shafts break along the lines marked A B C.

In the case of the twelve-cylinder engine the maximum torque on the crankpin will be only about 50 per cent more than that indicated on the dynamometer. We shall therefore have to deal with a torque of about 4500 in-lb. With a crank radius of $2\frac{1}{2}$ in. we derive from this torque a tangential force of 1800 lb. acting through the crank cheeks on the crankpin. With a crankpin length of 2 5/16 in., plus half the width of the cheek, we have a total length of $2\frac{3}{4}$ in. The bending

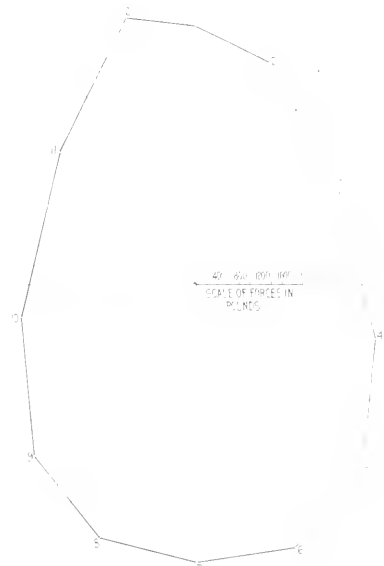

Fig. 9 Loads on Main Bearings IV of Crankshaft Without Balance Weights

moment on the crankpin is therefore $1800 \times 2\frac{3}{4} = 4950$ in-lb. The factor of safety derived from this is 20. The twisting moment in the crank cheeks is $1800 \times 3\ 3/16 = 5740$ in-lb.

The thickness of the cheeks with a factor of safety of 12 we derive as before from the equation:

$$5740 = 2 \times \frac{0.75 \times 110{,}000}{12} \times \frac{2}{9}\, b^2h$$

From this we obtain a cheek thickness of 0.83 in., or, say, $\frac{7}{8}$ in.

In order to compare a three- and seven-bearing shaft it must first of all be observed that the distance between the centers of the two main bearings is about two and a half times as much in the former shaft as in the latter. The transverse deflection of a straight shaft increases as the cube of the distance between the supports. It is evident, therefore, that if other conditions are the same, a three-bearing shaft will deflect up to $(2\frac{1}{2})^3$; that is, nearly sixteen times as much as a seven-bearing shaft.

It is hardly necessary to point out that excessive deflections are certainly not conducive to the operating smoothness of an engine. Not only that, but even the durability of the bearings is impaired, because a deflected shaft will not permit uniform

pressure distribution in the bearing. Any eccentricity of the loading relatively to the middle of the bearing will create a tendency to drive out the oil at one end. This is the reason why bearings that swivel so as to accommodate themselves to any inclination of the journal on account of bending of the shaft are found to be of great advantage. However, as such bearings cannot be applied very well to crankshafts, it is advisable to design crankshafts so that their deflections approach a minimum.

The deflection of a shaft varies inversely as the moment of inertia of its weakest section. In order, then, to hold a three-bearing shaft within the same limit of transverse deflection as may be obtained with a seven-bearing shaft the crankpin diameters of both shafts must be proportioned in the relation

torque in this case is determined by T and by the shortest distance between T and the center of the twisted crankpin, which is denoted by R. From Fig. 15 we find that $R = r + r \sin 30$ or $R = 1.5\ r$. Consequently, in this case, $M = T \times 1.5\ r$. This permits us to draw the conclusion that the torque moments or torsional deflections of a three- and a seven-bearing crankshaft stand to each other in the relation of 1.5 to 1. It must further be mentioned that the twist in a crankpin is a more serious matter than the twist in the main bearings. We must consider that the only way to reduce the vibrations set up by a twist in a crankpin is by an increase in its diameter. The deflections in the main bearings may, however, be minimized by vibration dampers.

The same line of reasoning which we have established in

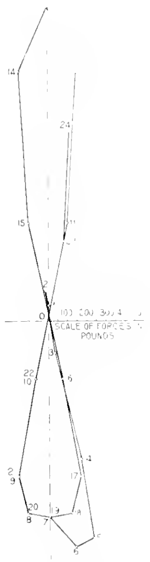

FIG. 10

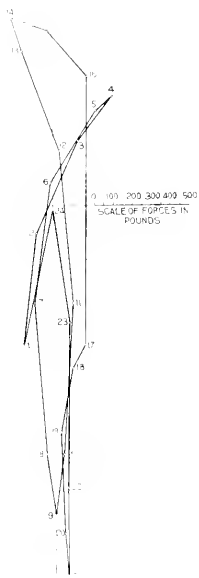

FIG. 11

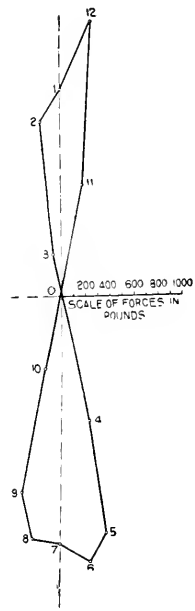

FIG. 12

FIG. 10 LOADS OF MAIN BEARINGS I AND VII. FIG. 11 LOADS ON II, III, V AND VI OF A CRANKSHAFT WITH BALANCE WEIGHTS FIG. 12 LOADS ON IV

of $\sqrt[4]{16}$ to 1, which is as 2 to 1. This necessitates a crankpin diameter of $4\frac{1}{4}$ in. for a three-bearing shaft designed to conform to our premises. For so small an engine as here under consideration this diameter is, of course, prohibitive. At the same time, it is almost prohibitive to use a seven-bearing shaft for a twelve-cylinder automobile engine on account of the excessive length. The only alternative left for the designer of such engines is to sacrifice rigidity.

The torsional deflection of a crankshaft is directly proportional to the torque moment. In a seven-bearing crankshaft a torque moment of the magnitude $M = T \times r$ occurs in the main bearings only. This torque is determined by the tangential force T acting on the crankpin and by the crank radius r, which is one-half the stroke of the engine.

In a three-bearing crankshaft a similar but more intense torque occurs, not only in the main bearings but also in the crankpin, as illustrated in Fig. 14. The momentum of the

connection with the three-bearing shaft must be followed in investigating a four-bearing, six-throw shaft. The distance between two bearings is about 1.75 times as great as in the case of a seven-bearing shaft, and consequently the transverse deflection is about five times larger. With regard to the torque in the crankpins, the same figures as before established apply, except that in this case a smaller number of crankpins are subject to twist.

As excessive transverse deflections must be detrimental to the bearings as well as to the operating smoothness of the engine, it is quite reasonable to expect that balance weights will be an advantage for the latter two types of crankshafts, which are inherently weak. Seven-bearing crankshafts, when well designed, are inherently strong enough so that they cannot be improved through the addition of balance weights. We can predict, therefore, that the use of balance weights will be limited to shafts with a smaller number of bearings than would be desirable from the viewpoint of strength. Balance weights

are like the flywheel, the symbol of some imperfection. If we compare shafts of equal strength we will further find that the weight of a three- or four-bearing, six-throw crankshaft that is properly balanced will by no means be less than that of a seven-bearing shaft.

The total piston displacements of different engines designed with a constant stroke-bore ratio are proportional to the cube of the cylinder bore. For instance, if the bore of an engine is b, and its stroke is $1.667b$, the piston displacement of this engine per cylinder is $(b^2\pi/4)\times 1.667b = 1.309b^3$.

The explosive impulses of different engines are proportional

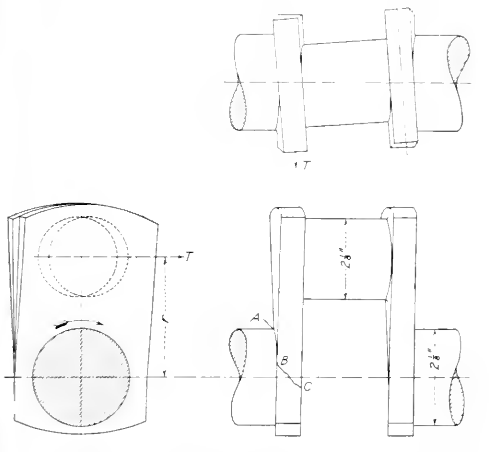

FIG. 13 PART OF CRANKSHAFT ILLUSTRATING DEFLECTION OF CRANK-CHEEKS

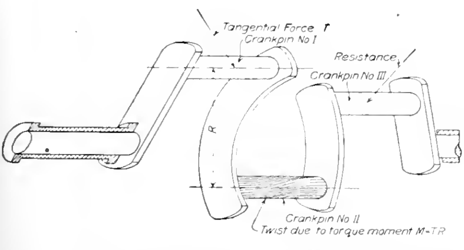

FIG. 14 PART OF CRANKSHAFT ILLUSTRATING TORQUE IN CRANKPIN IN CASE OF THREE- AND FOUR-BEARING SIX-THROW CRANKSHAFTS

to the square of the cylinder bore, providing that the same compression is used throughout. Denoting the bore of a six-cylinder engine with b_6 and that of a twelve-cylinder engine with b_{12}, we find for two engines of equal total piston displacement the following relation:

$$6 \times 1.309 \times b_6^3 = 12 \times 1.309 \times b_{12}^3$$

From this it follows that

$$b_6 = \sqrt[3]{2} \times b_{12} \qquad [3]$$

The explosive impulse E of an engine is proportional to the square of the cylinder bore. Between the explosive impulses of a six- and twelve-cylinder engine the following relation therefore exists:

$$\frac{E_6}{E_{12}} = \frac{b_6^2}{b_{12}^2}$$

When substituting for b_6 the value given in [3], we obtain

$$\frac{E_6}{E_{12}} = \frac{(\sqrt[3]{2})^2 \times b_{12}^2}{b_{12}^2} = \frac{(\sqrt[3]{2})^2}{1}$$

In practice we invariably find that the small-bore engine is working under somewhat higher compression. This results in a higher explosive force per unit of piston area. To give an example, we may assume, for the two types of engines to be compared, that the large-bore, six-cylinder engine may work with a compression pressure of 85 lb. per sq. in., and the small-bore twelve-cylinder engine with one of 90 lb. per sq. in. Substituting this in the above given relation, we obtain

$$\frac{E_6}{E_{12}} = \frac{85}{90} \times \frac{(\sqrt[3]{2})^2}{1} = 1.5 \text{ to } 1$$

From this we learn that for a certain standard of engineering the explosive impulse of a six-cylinder engine is about 1.5 times as large as that of a twelve-cylinder engine of equal total piston displacement.

In conclusion, a few words may be said about lubrication, although this can be considered a problem all by itself. To

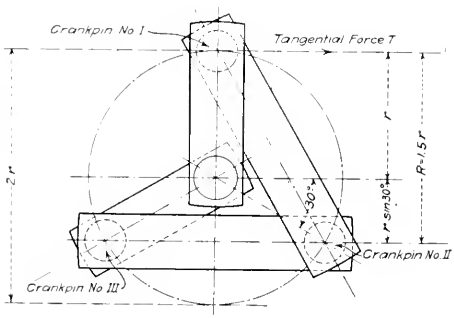

FIG. 15 PART OF CRANKSHAFT SHOWING MAXIMUM LEVERAGE IN CASE OF THREE- AND FOUR-BEARING SIX-THROW CRANKSHAFTS

obtain absolutely satisfactory conditions, the oil delivery to the bearings must be in direct proportion to the work converted into heat by the bearings. We should lay out a series of diagrams, as previously discussed, for different engine speeds and for different power outputs. The values of pv obtained from the various diagrams would give us a clear picture of how the oil delivery should be regulated. Scientific oiling would eliminate scraper rings, and thus permit lighter pistons. It would also eliminate sooted spark plugs, carbonization, preignition, and would permit higher compression.

In the production of aircraft engines, as in all other departments of engineering, it is necessary to effect a reasonable compromise between two conflicting ideals. Standardization leads to a greatly augmented rate of production, but simultaneously makes it correspondingly more difficult to effect the improvements which steadily increasing experience may show to be possible. Cases could readily be cited in which attempts at standardization of machinery on the basis of inadequate experience have proved well nigh ruinous, and the departments concerned were undoubtedly wise in the first instance in leaving open a wide field for invention and improvement. The result of this has been that our best engines are claimed to be two years ahead of the best produced by the enemy, which in true Teutonic fashion have been developed along humdrum lines.—*Engineering*, January 25, 1918.

OFFENSIVE AGAINST THE SUBMARINE

With Annotations to the Suggestions to Inventors Made by the Naval Consulting Board of the United States Regarding the Submarine and Kindred Problems

By JOSEPH A. STEINMETZ, PHILADELPHIA, PA.

Member of the Society

In discussing the tremendous creative zeal of the nation's inventors, especially in suggesting methods of solving the submarine problem, the Honorable Secretary of the Navy recently mentioned that 40,000 separate suggestions, plans, or models of offensive and defensive devices had been submitted to the Naval Consulting Board since the United States entered the war against Germany.

"The idea that the submarine will be overcome by a miraculous invention is not now seriously considered," the Secretary said. "The more intimate knowledge the civilian obtains on this subject, the more convinced he is that the submarine can be conquered by persistently hunting it down by the weapon of which it is most afraid. This is the armed service boat, equipped with all the latest scientific devices and typified in the modern torpedo-boat destroyer. Foreign naval authorities have frankly stated their admiration of the degree of perfection of American designs.

"In regard to the protection of ships against torpedo attack, the undeniable evidence of recent months of submarine activity has demonstrated that the immunity of a vessel depends very largely on its speed and maneuvering ability. There is a possibility that some artificial means of protecting cargo-carrying vessels may be found practicable. In no other field have so many suggestions or so many duplicate inventions been presented to the Board."

The Secretary said that the thought on submarine defense may be subdivided into three groups:

1 Any methods to accomplish the destruction of submarines, involving detection and destruction after detection

2 Means of avoiding submarine attack, involving instructions for merchant vessels, proper handling of vessels, camouflage, smoke screens, and other confidential information known to American naval authorities

3 Protection of ships against torpedo hits.

All the suggestions submitted received careful consideration by the Board, and much valuable aid has been given to various branches of the war service. Many inventions of real merit have been submitted; on the other hand, many proposals have been found to be impractical, largely due to the failure of inventors to inform themselves properly of principles.

To destroy a submarine we must first find it, and therefore the problem of catching, as mentioned, is in its proper order of importance. The difficulty is that the submarine has the greater advantage of lower visibility, approximating invisibility. Before it can be located, it gets home a surprise torpedo. Ninety per cent of the damage and loss comes from that first torpedo, and the necessity of forehand knowledge of the submarine's location, in relation to the approaching ship, bears an equal percentage of importance to the equation.

In certain conditions of sea and weather it is practically impossible, by visual observation, to detect a periscope. Various listening devices are being developed with most encouraging results.

To locate the submarine does not solve the problem of its extinction, and the Secretary is right in recognizing a solution of the menace by direct-gunfire attack. The more guns we mount on our commerce ships and the greater the increase of our swift-destroyer class, the more certainly have we met the submarine. We must blow him out of the water and hunt him from base to base by direct-gunfire attack.

Of late there has been perfected a means of deep-water attack against submerged submarines by the use of the selective-depth bomb. This device, variously charged with from 50 to 500 lb. of TNT or other high explosive, is so arranged that it will detonate at a predetermined depth, estimated to reach the level of the submarine that is lurking below the surface. These depth charges are launched from fast surface craft whose speed carries them away from the eruptive danger following the explosion. The under-water shock is sufficient to break in the hull plating of a submarine in any direction and up to a distance equal to about three times the vertical depth at which the charge explodes.

A well-known type of depth bomb provides a hollow float connected to a thin cable or cord wound around the outside of the explosive container, the depth of detonation being determined by the length of the unwinding cord that pulls the detonator when the mine reaches its selected depth.[1]

Reference is here suggested to the topographical map and contour of the bed of the North Sea, which, contrary to popular supposition, is a comparatively shallow body of water, except for three guts or submarine lanes and the greater deep channel along the Norwegian coast.

The Dogger Bank ridge is but 50 ft. deep, and the average bottom of the North Sea lanes about 200 to 300 ft.; while the deep strip, or main lane on Norway's edge, is 900 ft. deep.

An attack by continuous barrage discharge of depth mines from numerous patrols covering each known submarine lane would check the freedom of these passages with justifiable chance of destroying the enemy U-boats.

The Naval Consulting Board, known so favorably to us all, has worked indefatigably in the consideration of the vast number of suggestions that have been offered. As a guide to help solve the submarine menace the Board issued a bulletin[2] entitled The Submarine and Kindred Problems. As this information is official and helpful to a clear understanding of submarine warfare, offensive and defensive, it would be proper to quote fully from the bulletin.

Protection Against Submarine Attack

This subject, which is occupying the public mind as is no other, divides itself into a number of problems, the most important being the following:

a Means of discovering the approach of a hostile submarine and locating it so as to permit of prompt action for combating its attack

Abstract of paper presented before the Philadelphia Section of The American Society of Mechanical Engineers, December 11, 1917.

[1] U. S. Patent Application Serial No. 161,874.

[2] Bulletin No. 1, July 14, 1917. Copies free by addressing Navy Department.

b Protection of cargo-carrying ships by nets, guards and screens
c Protection through decreasing the visibility of vessels
d Methods of destroying or blinding a hostile submarine.

To these may be added:

e Mines, their use and control
f Torpedoes, use and counter-defense.

Submarines, to operate most effectively, must approach within close range of the vessel which is intended to be torpedoed. The installation of offensive weapons on the merchant marine has increased the necessity for the utmost care being exercised by the submarine commander in remaining unseen by the officers on the vessel to be attacked.

Reports from abroad indicate that in many cases submarines must have remained along certain lanes of travel for periods extending into weeks of waiting with the expectation of torpedoing certain vessels. Under certain favorable conditions, where the waters are less than 200 ft. in depth, the safe limit of descent, a submarine might lie at rest on the bottom, and, if equipped with sensitive listening devices, attempt to detect the approach of a vessel. As soon as this evidence was secured the submarine might come to the surface for a quick observation by means of the periscope and in this manner obtain the proper aim which would be required to register an effective hit.

In case the water is more than 200 ft. in depth, a submarine must be kept in motion to obtain steerage way in order to hold its proper depth of submergence. This speed may not exceed four or five miles per hour, but to remain submerged, and at the same time unobserved, the water must be at least 60 ft. deep.

The latest type of submarine which is being used abroad has a surface speed of at least 17 knots and a submerged speed of probably less than 10 knots. The superior gunfire from the merchantman which has been properly equipped would make it necessary for the submarine commander to obtain his observations, such as would permit accurate aiming of the torpedo, during the very brief interval of time required to come to the surface for observation through the periscope and to again submerge.

If running near the surface, the periscope might be raised, a quick observation taken, and lowered again within 30 seconds. If, however, the submarine is on the surface and hatches uncovered, from one to four minutes will be required to completely submerge, depending upon circumstances.

A submarine of recent type probably has a total radius of action of as much as 8000 miles when traveling at a moderate cruising speed of from 10 to 11 knots, and may remain away from its base for as much as one month, without requiring either fuel or other supplies during this period.

This type of submarine may have as many as 3 periscopes, 2 conning towers, and 2 rapid-fire guns attached to the upper portion of its hull. The vessel is steered by very efficient gyroscopic compasses, which are unaffected by extraneous magnetic or electrical influences.

The *U-53* on her espionage visit to Newport Naval Station and her subsequent torpedoing of a half-dozen friendly and neutral ships within sight of our shore, is a concrete instance of what can be done as to radius of action and what may be again attempted in greater force.

A recent estimate of an allied naval officer determines that the enemy submarines are at surface over 95 per cent of their time when cruising, thus giving opportunity of accidental sinking by night ramming by surface craft as well as for direct surprise attack during fog intervals.

The fact that submarines are submerged so little of the time has developed a simple yet efficient strategy to determine their location. The Allies have used their submarines as feed lures for seagulls, which hover over the hulls tempted by their food, and follow untiringly in the wake of the submerged craft. The gulls, not distinguishing between friend and foe, follow the German submarines patiently, expecting to be fed, and quite innocently declare the location of the enemy boats to the allied patrols.

A general understanding of the capabilities of the modern submarine for offensive operations will make it easier to appreciate the importance of the three problems which follow:

(a) Means for D[illegible]

The Aeroplane. When the conditions [illegible] are favorable, a submarine is readily discernible from an aeroplane flying at a sufficient height, even though the submarine be submerged to a considerable depth.

While aeroplanes have thus been used successfully in the English Channel, they are unable to fly far out to sea where the submarines are now most active. Mother ships for carrying and launching aeroplanes might be used in this connection, but there are only a small number of such ships in operation and the construction of others under present conditions is necessarily a slow process.

The aeroplane promises to play a very serious and important part in sea warfare and torpedo service.

Admiral Fiske, U. S. N., retired, invented some years ago a torpedoplane which is in effect a seaplane carrying on its keel parallel a marine torpedo. The torpedoplane delivers its attack directly in line with the enemy ship. It skims close to the surface and releases the torpedo, which speeds to its target.

The Germans are reported to have used this device successfully in sinking allied surface craft in the North Sea. Private initiative and subscribed money are now reputed to be developing this method into a practical device for our own use.

A similar weapon is described in U. S. Patent No. 1,223,212, covering an aero-marine torpedo which provides for a tubular-shaped charge towed by an aeroplane. The latter, rising in flight, drags a wire towline across the victim ship and, speeding onwards, brings the torpedo into explosive contact.

Aeroplanes have been suggested for use in attacking submarines by trailing under-water deflected bombs.[1]

Location of submerged U-boats by the use of kite observation balloons towed from battleships is one of the later developments of offense. From the high elevation the observer controls an extensive sea area, which permits the discovery of the submarine, the location being announced by wireless and the destroyers and seaplanes with depth bombs called to the attack.

Various sound-recording devices, intended to locate surface vessels, submarines, and even moving torpedoes, are now being carefully tested. Water is an excellent conductor of sound, and the development and improvement of such apparatus offers a promising field for inventive endeavor to those who possess adequate scientific training and laboratory facilities.

Many devices are suggested which depend upon optical means of detection, such as special forms of telescopes and field glasses to be mounted on ships or on scouting vessels. Many special forms of searchlights and projectors have been suggested.

The fact that a moving torpedo leaves in its wake a stream of air bubbles caused by the exhaust air from its propelling engines, offers, under favorable conditions, one means for discovering the approach of a torpedo. This evidence is, however, difficult to detect in a rough sea or at night, and, furthermore, the bubbles do not reach the surface of the water until after the torpedo has traveled toward its target a distance of from 50 to 200 ft.

The warhead torpedo weighs approximately 2500 lb. and travels about 10 to 15 ft. below the surface of the sea at a speed of 25 to 40 miles. We have a record of a British coastal dirigible, while flying in company with a convoy of merchantmen, sighting the track of an oncoming torpedo and a moment later observing the crash of the explosion on the target. An enemy submarine taking advantage of the state of the sea for concealment, had with great daring dived beneath the armed escort and boldly torpedoed her victim. The weather was rough and rapidly getting worse; the dirigible picked up the torpedo wake and followed back along the dead line to its source and located the submarine as a dim green shadow stealthily submerged. The airship hovered over the cigar-shaped form vaguely outlined, released numerous depth bombs, and destroyed the submarine.

[1] U. S. Patent No. 1,218,586.

The dragging of trawls, or nets, by special guard boats, not only with the view of locating submerged submarines but also to sweep up floating and stationary mines, is frequently suggested. Under certain conditions this operation is practicable and effective.

It will be seen that each of the above methods, however useful, has its limitations, and scientists and inventors should apply themselves not only to the task of improving these, but also of finding supplementary methods and devices.

(b) *Protection of Cargo-Carrying Ships by Nets or Screens*

Many designs of such devices are suggested, and most of them are intended to be attached to the hull of the vessel to be protected. Many other suggestions along these lines, and differing only in some of their minor characteristics from the foregoing, have been received by the Board. Up to the present time not one of these proposals involving screens of any kind has received the approval of the Navy Department or of the merchant marine. The principal objections offered to these devices are that they are heavy, difficult to hold in position, unmanageable in a heavy sea, and that they interfere with the speed and with the ability of the vessel to maneuver. The undeniable evidence which has been accumulated during the past few months of submarine activity has demonstrated that the immunity of a vessel to submarine attack is dependent very largely on its speed and also its maneuvering ability. The percentage of vessels having speeds of 15 knots or more which have suffered from submarine attack is very small, while the losses of slow vessels, whose speed is less than that of a submerged submarine, is practically 100 per cent of those attacked. Many of the suggested devices would prevent the launching of lifeboats or rafts from the vessel to be protected. It is barely possible, however, that there may be developed some form of this general plan which will be found practicable. In no other field have so many suggestions or so many duplicate inventions been presented to the Board.

As far back as 1877 a patent was issued containing the following paragraph: "The nature of my invention consists in combining with a vessel a sectional reticulated shield or guard, suspended at a suitable distance from the hull of the ship, and partly or wholly surrounding the same, which shield extends downward a sufficient distance below the water line to arrest a floating torpedo or explode one attached to an attacking vessel."

From that time until the present day many designs have been made, tried, and discarded. It is well known that a shield of sufficient strength and proper design will stop a torpedo, explode it, and render it harmless to the hull of a vessel, if the shield is a sufficient distance away. This distance is generally conceded to be about 30 ft. However, it depends very much upon the strength of a vessel's hull and the details of design made to localize the damage.

It has been the aim of all navies to do away with any form of shield or net protection as, in action, speed and maneuvering qualities are imperative; and generally in wartime a fleet depends for a great part of its tactical value upon its ability rapidly to change its base. Modern naval construction is made to allow torpedo attack without disabling the vessel or preventing her from continuing the fight and eventually reaching her home port. It is known that in the present war battleships have been torpedoed more than once in the same fight, continuing the battle and arriving at the home port at a fair rate of speed.

One of the great shipyards in England is interested in a torpedo-defense pontoon-supported screen that has been favorably noted in the American scientific press. This device is not a part of the ship nor attached to it, but provides a floating spar-like pontoon with a full-length sheet-steel flexible apron. These screens can be towed by the slower ships when moving through mine fields or submarine zones, giving extensive broadside protection. The pontoon screens can be towed as separate units by tugs or trawlers, and the defended ship can move safely forward, protected by these flanking screens.[1]

The author will be glad to send to anyone interested in the further development of this line of defense an illustrated booklet on Submarine Problems and Torpedo Defense.

(c) *Protection Through Invisibility*

The point of lookout on a submarine being close to the water, the position of a vessel at a distance can be determined only by observing its smoke, which floats high in the air. Improved smokeless combustion is therefore desirable. Relative invisibility may also be afforded by methods of painting.

A method of camouflage to suddenly create a fog cloud about a ship is made possible by an arrangement of pipes running along outside the length of the hull, parallel and near to the keel and connected up to the steam boilers. By quickly opening the control valve the steam pressure vents through small openings in the pipe and rises as a fog cloud, instantly enshrouding the ship and confusing the submarine as to aim and direction. This is one of the many patents pending, and is mentioned only to encourage our engineers and inventors to further activities.

It is possible and desirable, if ship-design prejudice could be overcome, to build a low-visibility hull by reducing or eliminating the masts and spars and laying the funnels horizontally near the deck levels, supplementing the draft by further arrangement of blowers.

In the earlier days of the war, submarines were lured into close range by screening the deck guns of merchant steamers and liners and by false-rigging destroyers to simulate helpless sailing craft, but this deceit is increasingly difficult to accomplish as the later U-boats mount powerful long-range guns.

(d) *Destruction and Blinding of the Submarines*

A rapid-fire gun is effective when the submarine is seen within accurate range of the gun; but the target is so small that it is difficult to hit.

The powerful effect of any submarine explosion on all neighboring bodies provides a simple means of destroying or crippling an undersea boat. Once it has been even approximately located, the setting-off of a heavy charge of high explosive, well submerged in the vicinity of the submarine, will bring about this result.

A simple type of selective depth bomb has already been described, and the news items of destruction of enemy submarines by this method of attack give encouraging indication that in this device we have a weapon that spells the doom of the U-boat.[2]

In certain areas, a quantity of heavy, black petroleum or similar substance which will float on the surface of the water has proved an effective means of clouding the optical glass in the periscope's exposed end.

This spreading of oil results, however, in a waste without commensurable result, as a recent device operated from inside the submarine permits of the perfect cleansing of the periscope's outlook glass by projecting against the oil smooch a pressure jet of gasoline or other wash.[3]

Under favorable conditions of wind and position, many vessels have saved themselves from torpedo attack by the production of a smoke screen. This may be formed either by incomplete combustion of the oil used for fuel by most naval vessels, or it may be created by burning chemicals, such as phosphorus and coal tar, or mixtures in which both of these and other materials are used.

[1] Reference is also made to U. S. Patents Nos. 1,219,879 and 1,171,153.

[2] U. S. Patent Application Serial No. 161,874.

[3] U. S. Patent No. 1,222,156.

After hiding itself from the submarine in a cloud of dense smoke, the vessel, if possessed of sufficient speed, may be able by a quick maneuver to change her position and escape before the submarine is able to discharge a torpedo.

The serious fault with this plan has been the accidental condition of windage, for it is apparent that if the wind blows from the direction of the submarine toward the ship she cannot hide quickly in her smoke screen, which is blown away from her.

An improvement of great value meets this need by use of smooth-bore deck guns discharging smoke shells against the submarine, which puts the enemy into a murk screen permitting the merchant ship to escape or, by change of course, to attack the submarine and sink it by gunfire or ramming.[1]

Mines and Torpedoes for Naval Operations

(e) *Mines*

Ever since the first use of gunpowder in the prosecution of war, mines and torpedoes have received great attention, both from the warrior and the inventor. Mines are either fixed or floating. The fixed or stationary submarine mine is fired by contact, electricity, timing device, or fuse. Such mines, which are extensively used by all navies, are rugged in design and may contain large charges of explosives. They are placed in position by especially equipped mine-laying vessels. Such a mine is provided with an anchoring device.

Floating mines differ from fixed mines in that they are unanchored, and, unless guard boats are at hand to warn friendly vessels of their proximity, may be as dangerous to friend as to foe. Such mines must be, according to laws of war, designed to become inoperative within a few hours after being set adrift.

The submarine has been successfully used as a mine layer and can enter defended sea areas and plant mine fields, uncharted and undetected. An elaboration of this function is noted in the possibility of submarines liberating containers of asphyxiating gases or smoke clouds from a position under the enemy battlefleet or surface ships and causing tremendous loss and havoc.

The defense against such surprise being eternal vigilance and full protection to the crews by night and day use of gas masks.[2]

Harbors and waterways are not entirely safe from submarines that may enter submerged below the mine flotation level to avoid contact, and then rise to the surface for observation and bombardment or to release aeroplanes, for distant depredations.

A proposed harbor defense against the enemy submarine awash or surface battlecraft, comprises a method of gas- or smoke-cloud liberation from containers anchored to the bottom and electrically controlled, or detonated, from shore observation stations, thus involving the enemy in a murk or incapacitating gas cloud.

This camouflage mine field could be cheaply created and would be easy to install; and while depriving the enemy of power of observation or fire control, it would yet disclose his position by his military-mast tops rising above the low-hanging cloud and permit the shore batteries to deliver their attack.[3]

(f) *Torpedoes*

The modern submarine torpedo is about 20 in. in diameter and 20 ft. in length, is self-propelled, is not steered by magnetic means, and keeps a fairly accurate course for several thousand yards at an average speed of more than 30 miles an hour. Its weight is approximately a ton and a quarter, and, when traveling at normal speed, it possesses great momentum; in fact, in one case when the high explosive charge in the warhead failed properly to detonate, the body of the torpedo penetrated the steel hull of the ship attacked. Torpedoes are also provided with means to more or less effectively cut through screens, nets, or guards placed in their path.

A torpedo is projected from a submarine or other vessel by means of a special form of tube or gun. A small charge of gunpowder or compressed air is employed to start the torpedo, after which—if of the usual self-propelling type—it is driven through the water by its own compressed-air motor, the air being supplied from a strongly built reservoir within the body of the torpedo itself. The torpedo is kept upon its course by a gyroscope steering mechanism, which is immune to outside magnetic disturbances.

The detonation of the torpedo is accomplished through a mechanism placed within its warhead; and if the torpedo is either abruptly diverted from its course or is checked in its forward motion, the firing device, which is operated by arrested momentum rather than by any form of a projecting firing pin, instantly ignites the heavy charge of explosive contained within the warhead. The explosion, if it takes place within 20 ft. of the vessel, will usually rupture the ship's plating, because of the terrific blow transmitted through the water from the point of the explosion to the ship's side. The depth at which a torpedo travels . . . is usually between 10 and 15 ft. below the surface.

Confining the Submarines

The question as to why submarines are not destroyed before they reach the open sea is a most natural one, and the best answer which it is possible to give, according to the officers of our navy and those of the foreign commissions who have visited this country, is as follows:

The submarine bases are very strongly protected by land batteries, aeroplane observers, and large areas of thickly mined waters extending to such distances that the largest naval gun cannot get within range of the bases. In spite of these protections, there is now going on a continuous attempt on the part of the allied navies to entrap or otherwise defeat the submarines as they emerge from the protected areas. Nets are laid and as promptly removed by the enemy, whose trawlers are in turn attacked by our destroyers. The design of these nets and the detailed arrangement of their fastenings and attachments offer a broad field for invention, but it should be remembered that they must be capable of being used in waters in which there is a tidal current running from two to five miles per hour. Many suggestions for "bottling up" these bases have been offered, but, as will be realized, it is not desirable to publish information which would indicate even in the smallest degree this country's plans.

Ambitious plans have been presented suggesting a great bomb-curtain sea net, strung in sections miles long and pendant 200 ft. deep, to close the North Sea from Scotland to the three-mile limit off the Norway coast. The difficulties are stupendous and the cost would be tremendous, but many important engineers and the scientific and technical press express hope that it will yet be done. This great net would be float-supported, and at the crosswires of the 20- to 30-ft. meshes there would be attached explosive contact bombs to destroy any submarine that would nose in.[1]

Ships and Shipbuilding

Many suggestions are made for ships of unusual form to provide for safety in case of a torpedo or mine exploding near or against the hull. Most of these plans are an elaboration of the usual watertight bulkhead construction now required as structural design for all modern ships.

The multiplicity of watertight compartments in any hull design tends to add to the vessel's safety.

The modern tank steamer used to carry fluid cargoes, such as petroleum products or molasses, is a good example of this design, which has been in general use for many years.

[1] U. S. Patent Application Serial No. 195,289.
[2] U. S. Patent No. 1,222,498.
[3] U. S. Patent Application Serial No. 155,316.

[1] U. S. Patent Application Serial No. 157,389.

[illegible] a [illegible] mine or torpedo frequently [illegible] the [illegible] plating, in some cases opening a [illegible] but the destructive effect on the [illegible] caused by the explosion of a mine or torpedo may be [illegible] by special hull construction.

[illegible] compressibility of water gives the required fulcrum [illegible] explosion of the warhead, and the hull plates break in- [illegible] under the impulse of the expanding white-hot gases. It [illegible] follows that the destructive effect would be mini- [illegible] direct proportion to the non-resistance of the ful- [illegible]. To accomplish this desired result an ingenious method [illegible] patent which provides perforated pipe-line outlets parallel to the ship's keel and connected up to the high-pressure steam line.

Upon the approach of a torpedo the steam is switched into the outlets and the rising zone of bubbles displaces the sea water and creates a [illegible] of reduced resistance tending in great measure to [illegible] force of the torpedo explosion.

CONCLUSION

In making [illegible] various patents and applications of devices, it is [illegible] thereby to illustrate types and general methods that [illegible] engineer and inventor may know in part what has already been done. Even though some of these references may [illegible] the thousands of misconceived devices examined and [illegible] by the Naval Consulting Board, they have been helpful to the national cause as guides and guards to inventors yet unborn.

[illegible] Patent Application Serial No. 201,949.

A VOLUME REGULATOR FOR BLAST-FURNACE ENGINES

By L. C. LOEWENSTEIN, WEST LYNN, MASS.

Member of the Society

Blast-furnace operation has attained a high degree of refinement in the proportioning of the various materials composing the charge—the ore, the fuel and the flux. The weight of oxygen—introduced as atmospheric air—per charge has, however, until recently been subject to much uncertainty due primarily to the difficulty of measuring with any degree of accuracy the volume of air delivered. The adjustment of the air supply to the furnace was, therefore, usually made only when the operator found evidence that the furnace was badly overblown or underblown, a process which resulted in a more-or-less variable product and certainly in a reduction in the possible maximum output of the furnace.

With the advent of the centrifugal compressor giving a perfectly steady air blast, the metering of the air supply became more practical and, therefore, more usual. With perfectly definite and uniform charging a definite and uniform weight of air per minute is desirable. Constant-volume governors have been designed on two principles, one by metering the air by means of a venturi meter and the other by using an impact float. The venturi-meter governing has been improved by using a multiple venturi meter in which large pressure drop can be obtained in the throat without a corresponding loss in power. This difference in pressure is used on a mercury pot whose motion up and down is translated to the governing mechanism of the driver of the air compressor. The proper setting of this meter is accomplished by changing the tension of the spring until a scale calibrated in cubic feet of air per minute shows that the desired quantity of air is obtained.

In the impact-float method the air is taken through a conical opening in which is suspended a float, this float moving a horizontal beam about a pivot. The horizontal beam actuates the governing mechanism of the driver of the air compressor. On this horizontal beam is a sliding weight which can be set at calibrated marks representing cubic feet of free air per minute. With the weight set in a definite position a certain definite quantity of air is obtained.

In both of these methods, however, the readings on the calibrated scale are only correct when the initial air conditions are standard, that is, are similar in barometer, temperature and humidity to which the scale has been calibrated. Any change in either the temperature of the inlet air or in the atmospheric barometer or in the humidity of the air, changes the weight of the air metered, and, therefore, its oxygen content. As the blast furnace requires an exact weight of oxygen, the above method of holding constant volume is liable, in extreme cases, to have an error of from 15 to 20 per cent.

A volume corrector is herewith presented which when used in connection with the air-metering device will correct for any changes in temperature, barometer and humidity, so that the air supplied to a blast furnace will, at all times, under any atmospheric conditions, deliver a perfectly definite and predetermined weight of oxygen to the blast furnace. This volume corrector is so designed that it requires only one setting for each correction, that is, one setting for any initial temperature, one setting for any existing barometer and one setting for humidity as usually obtained by the difference of readings on a wet- and dry-bulb thermometer.

THE blast furnace is primarily an apparatus for producing pig iron; but incidentally it may also be regarded as a huge gas producer. The materials fed to it are the iron ore, the fuel (coke), and the fluxes (limestone), which are charged at the top of the furnace or throat; and the air blast, which is blown in near the bottom of the furnace at the tuyeres. The materials discharged from the furnace are pig iron and slag, which are tapped from the bottom or crucible of the furnace, and the gases and dust, which pass out of the top of the furnace. The iron ore in a blast furnace is deoxidized or reduced, for which purpose the furnace is charged with sufficient carbonaceous fuel to do two things: to abstract all the oxygen from the reducible metallic oxides and to furnish enough heat at high enough temperature to melt down to superheated liquids the pig iron and slag—combinations of irreducible metallic oxides—that are formed. The fuel must supply the reducing energy and the melting-down or smelting requirements; the first by action upon the metallic oxides at a red to a white heat and abstracting their oxygen; the second by being burned at the foot of the furnace by the hot-air blast, and there generating the heat and higher temperatures necessary for the smelting down of the materials already reduced.

In a secondary way the blast furnace may also be regarded as a huge gas producer, run by hot forced blast, in which the incombustible portions of the contents are melted down (with a little unburnt carbon) to liquid metal and slag and are run

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out beneath, while the gaseous products pass upward through 50 to 100 ft. of burden and escape above. The escaping gases are primarily of the composition of producer gas, with some of its carbonous oxide changed to CO_2 by the oxygen abstracted from the burden; with some CO_2 added from the decomposition of the carbonates of the charge: and with the usual increment of moisture from the charge and volatile matter (if any) from the distillation of the fuel. Hence, the blast furnace is a huge gas producer, giving a rather inferior quality of combustible gas in large quantities, while reducing to metal and slag the burden of iron ore and flux (limestone) which is put in with the fuel. In fact, the unoxidized and combustible ingredients of the escaping gas represent a large part, often the largest part, of the total calorific power of the fuel.

Air Requirements in Blast Furnaces

From the above it can be readily seen that if the charging of a furnace is uniform, it is quite essential to have the amount of air supplied to the furnace also uniform in quantity. The air pressure required for forcing the air through the furnace varies with the condition of the burden or charge. If the particles of ore, fuel, and limestone are large, that is, the spaces between these particles ample, there is a freer passage for the air than if the particles of ore, fuel, and limestone are small and closely packed. Under certain conditions the furnace may require a pressure of, say, 10 to 15 lb. to force a certain quantity of air through it, while under other conditions, when the material in the furnace is tightly packed, a much higher pressure, sometimes as high as 25 to 30 lb., is required to force through the same amount of air.

Air Compressors for Blast Furnaces

It is therefore absolutely necessary that the air compressor be capable of adapting itself automatically to supply a predetermined *weight* of air, corresponding to the charge in the furnace, regardless of the resistance encountered up to a certain prescribed maximum. Usually the limiting air pressure is 30 lb., as this is the maximum pressure the stack itself will withstand with safety.

The expression *weight of air* is used advisedly, because the blast furnace requires a definite weight of oxygen to combine with the carbon in the coke charged to the furnace. In general practice we refer to this definite weight of air (or oxygen) as a "constant volume of air," but this volume must have reference to specific conditions of temperature, barometer and humidity, because any variation of these conditions changes the weight of oxygen contained in a given volume. The standard conditions most commonly referred to are dry air at 60 deg. fahr. temperature and 30 in. barometer. Air under these specified conditions contains, of course, a perfectly definite weight of oxygen per cubic foot.

Reciprocating Engines and Blowers

Up to the advent of the centrifugal compressor, reciprocating compressors were chiefly used for blast-furnace work. The governor of the compressor driver was set to maintain a speed corresponding to the desired quantity of air, the general idea being that each stroke of the compressor represented a practically constant quantity of atmospheric air regardless of the discharge pressure.

The r.p.m. of the reciprocating compressor was, however, but a poor guide as to the weight of air supplied, and it was left to the judgment of the blast-furnace operator as to whether or not the furnace was receiving the proper amount of air. If in his opinion the furnace was receiving too little air, that is, if it was underblown due to the charge in the furnace offering more resistance to air flow than previously, he would call for a higher speed of the reciprocating compressor. Speeding up the driver would then furnish a somewhat greater quantity of air at the higher pressure. If, however, the blast furnace was overblown, the reciprocating compressor was slowed down, and the quantity of air furnished was reduced. This method of operating, however, necessitated a decided change of condition in the furnace before the furnace operator knew that the air supply to the furnace was not correct, and in many cases the furnace got into a very poor condition before the operator changed the air supply and improved conditions.

With the gradual introduction of greater refinements in determining the quantities and the chemical composition of the ore, fuel and flux entering each charge in the blast furnace, the uncertainty in the quantity of air supplied began to stand out more and more as the weakest link in the chain. There was not only the need for a reliable method for measuring the quantity of air, but engineers were asking for apparatus which,

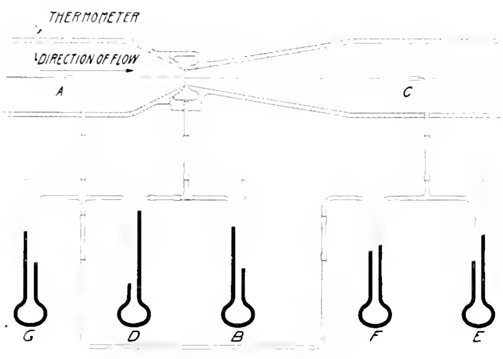

Fig. 1 Venturi Meter

Readings on U tubes *B* and *D* and of the barometer are necessary

while metering the air, would also automatically maintain constant any desired quantity, regardless of the furnace conditions.

[The paper here reviews briefly the underlying theory and formulæ for the flow of gases, and then enters into the following discussion of the commercial methods of regulation of air to the blast furnace.—Editor.]

Commercial Methods for Measuring Air

The commercial methods for measuring air most commonly employed are: (1) The Receiver Method, (2) The Orifice Method, (3) The Pitot Tube, (4) The Venturi Meter, and (5) The Impact-Float Method. Of these the first two methods waste the air they pass, and are therefore suitable only for temporary testing purposes. The other methods allow the air to pass to destination, and may therefore be left continuously in the system.

In the Receiver Method the compressed air is passed into a closed system consisting of a tank and piping of known dimensions and full originally of air of atmospheric pressure and temperature, which conditions are taken as standard. After the compressed air has been flowing into the system for

sufficiently long period, say, half an hour or an hour, the pressure and the temperature are again observed.

In the Orifice Method the compressed air is allowed to discharge into the atmosphere through an orifice of known area and known velocity coefficient. The initial temperature is measured by means of a bare thermometer inserted through the wall of pipe immediately preceding the orifice without well or casing of any kind. The pressures may be observed independently, or, preferably, the pressure drop may be observed by means of an impact tube.

Next to the Receiver Method, the Orifice Method is the most certain and the most reliable method for measuring air, and it is therefore generally recommended as the standard for the calibration of other air-measuring methods. A uniform rate of flow, however, is presupposed, as a pulsating flow, such as comes from reciprocating or positive-pressure compressors, cannot be measured reliably by any method which depends on a density × velocity² observation unless the discharge piping is of an extreme length sufficient to dampen out all pulsations.

The Venturi Meter shown diagrammatically in Fig. 1 consists essentially of a direct and a reversed nozzle placed throat to throat, making a common throat. In general, two U-tubes B and D, or the equivalent, are necessary, one to give the static pressure B in the throat and the other to give the pressure drop D from the main pipe, or high-pressure region, to the throat. It will be noticed that the impact tube A points upstream, so as to include whatever velocity head may exist in the main pipe. After the air passes the throat, the pressure rises again to nearly, but not quite, its original value. This may be demonstrated by the use of impact tube C, pointing upstream, in the pipe beyond the throat. U-tube F communicating with both impact tubes A and C will give directly the pressure loss caused by the insertion of the venturi meter into the system.

The direct nozzle should be short and well rounded, while the reversed nozzle should be well tapered with a half angle of about 4 deg. The inside of the meter must be smoothly finished, and particular care must be taken at the entrance of the U tube into the throat of the meter to avoid all burrs and roughness. Also the impact tube in the main pipe should be small to avoid any eddies and disturbances due to the introduction of the impact tube.

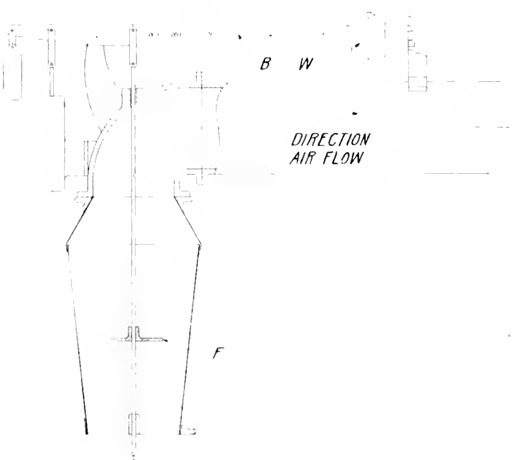

FIG. 2 IMPACT FLOAT AIR METER

The quantity of air may be computed from

$$Q = (423fa \div \sqrt{T_1}) \sqrt{[P_2(P_1 - P_2) - 0.0665\,(P_1 - P_2)^2]} \quad [1]$$

where

Q = cu. ft. of standard air (14.70 barom. and 60 deg. fahr.) per min.
T_1 = absolute temperature in main pipe in deg. fahr.
f = velocity coefficient of throat, usually between 0.95 and 0.99
a = area of throat in sq. in.
P_1 = absolute initial (high) pressure in inches Hg
P_2 = absolute pressure in throat in inches Hg
$P_1 - P_2$ = pressure drop.

In designing a venturi meter for a particular case, the area a is so chosen that the value of $P_1 - P_2$ for the quantity of air most commonly used should be large enough to be read conveniently and with reasonable accuracy and yet not so large as to cause an excessive pressure drop and power loss in the meter.

It is preferable to measure the air before it is compressed, so that P_1 and T_1 are the atmospheric pressure and absolute atmospheric temperature, respectively. A single U-tube like U-tube B in Fig. 1 is then sufficient. The actual pressure P_1 must be obtained from the existing barometer and then P_2 can be computed from the reading $P_1 - P_2$ on the U-tube.

The U-tube can also be calibrated in cubic feet of air per minute instead of indicating only inches of mercury pressure. When so calibrated it can only refer to some standard or average condition of air, and any change in temperature, barometer or humidity will affect the correct reading on such a calibrated scale.

IMPACT-FLOAT METHOD

The Impact-Float Method described previously in a paper by Mr. R. H. Rice before this Society and illustrated in Fig. 2 consists in allowing the air to be metered to impinge on a float F, usually in the form of a disk, suspended vertically in a cone. The air enters the small end of the cone, and its velocity is steadily reduced as it passes up toward the larger end of the cone. The force tending to lift the float, and whatever is attached to it, against gravity consists partly of the direct impact of a part of the air against the float, and partly of the pressure drop caused by the passage of the air through the annulus between the float and the cone in a sort of *vena contracta*. As the float rises in the cone, this force is reduced by the lowered velocity of the air, so that the position of the float in the cone is a function of the quantity of air passing through the cone.

It is desirable, however, for reasons which will appear later in connection with air regulation, to confine the position of the float within narrow limits, regardless of the quantity of air. This is accomplished as shown in Fig. 2 by connecting the float to a horizontal lever or beam B, the force on the float being balanced by a sliding weight W, which can be moved to any part of the beam. The beam is so graduated that the position of the sliding weight on it gives directly the volume of the air entering the cone.

The impact on the float or the momentum of the air is evidently mV, where m is the mass of air impinging on the float per second and V is its velocity. Since for a constant cross-section m is proportional to γV, where γ is density of the air, the impact on the float is proportional to γV^2 or to $m^2 \div \gamma$. Similarly, the pressure drop through the annulus around

the float is $\gamma V^2/2g$, where V is now the velocity in the annulus, and is therefore also proportional to m^2/γ.

When the air flows through the annulus between the float and cone a *vena contracta* obtains whose area varies with each volume of air flowing. On account of this, formulæ for the float force or reaction based on purely mathematical deductions require modification based on experimental results. The slope of the cone and the ratio of float diameter to cone diameter and also the average velocity of the air through the cone in uence the value of this float force. For long cones having a slope of about one inch in five inches and with floats having areas between 50 per cent and 95 per cent of the annulus area and using average velocities through the cone under 100 ft. per sec., the following formula found experimentally will hold:

$$F = 9 \times 10^{-4} Q^2 \gamma \times (A/a^2) \qquad [2]$$

in which

F = total force of float in lb.
Q = cu. ft. of air per min.
γ = density of the air in lb. per cu. ft.
A = float area in sq. ft.
a = annulus area in sq. ft.

until the beam is level, exactly as in the case of the beam on a pair of beam scales. The pointer on the weight W then indicates the amount of air flowing.

Constant-Volume Governing

Of the above-mentioned methods of measuring air in general, only the last two, the Venturi Meter and the Impact Float, are commercially used for regulating the supply of air to blast furnaces. With the advent of the centrifugal compressor a blowing apparatus became available which could be very nicely regulated in respect to holding any constant volume of air supply to the furnace. The centrifugal compressor delivers an absolutely steady stream of air without any pulsations whatever, and the pressure delivered by such a unit varies closely with the square of its speed. Hence, any volume regulation of air need only influence the speed of the driver of the centrifugal compressor. Up to a very short time ago all volume regulation for centrifugal compressors was based upon a calibrated scale for some standard condition of air, usually assumed as dry air at the average temperature and barometer existing at the location of the set. We again emphasize here

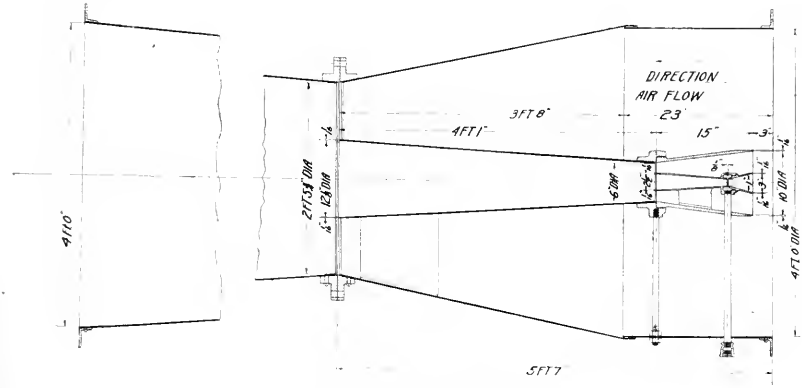

Fig. 3 Triple Venturi Meter

Used for securing a reasonable drop of pressure without excessive power loss

The upward moment of the force F about the fulcrum of the beam (Fig. 2) is counterbalanced partly by the downward moment of the weight of the float and partly by the moment of the sliding weight, which is downward, but may be upward for small volumes of air. In any case, however, the system may be reduced to one having a weightless float and beam, so that the upward moment of the float force F is balanced by the downward moment of the sliding weight W. Since both the weight W and the lever arm of F are fixed, the lever arm of W must be always proportional to the force F, or to M^2/γ, in which M is Q referred to standard conditions of barometer, temperature and humidity, and therefore represents a definite weight of air.

In other words, the beam must have a quadratic scale; that is, the longitudinal distance of the sliding weight from the zero on the beam is four times as great for 20,000 cu. ft. and nine times as great for 30,000 cu. ft. as it is for 10,000 cu. ft. The graduations on the beam are made correct for the average atmospheric conditions of the air at the place where the instrument is to be used.

In metering the air all that is necessary after the beam is calibrated is to move the sliding weight W along the beam

the fact that constant-volume governing is referred to, whereas the object desired is to introduce a constant *weight* of oxygen into the furnace.

The governing of a centrifugal compressor, in order to hold constant volume, requires the use, first, of a meter for measuring the volume of air flow. The necessary qualifications of such a meter, taking into consideration the large quantities of air used in blast-furnace operation, are: (1) It must not waste any of the air it meters; (2) the power consumed in the metering and governing processes must be small, which makes it necessary that the friction losses of air flow through the meter be small; (3) the governor must be sensitive, so that a small change in the quantity of air supplied will be sufficient to actuate the governor.

The Multiple Venturi Meter

An ordinary venturi meter in which the entire quantity of air flowing must be drawn through a sufficiently small throat to give a suitable drop of pressure would involve considerable power loss. To reduce this power loss a multiple venturi has been devised, consisting of a number of concentric venturis.

Referring to Fig. 3, which shows a multiple venturi, a very small part of the total air flow passes through the small or inner venturi. At the throat of this small venturi the largest pressure drop is obtained. A larger quantity of air flows around the inner venturi and through the second venturi, but the bulk of the air flow is around the second and through the third or outer venturi.

Consider a flow of 15,000 cu. ft. of standard air per minute through the triple venturi shown in Fig. 3, the air flowing from right to left as indicated. The air at inlet to the venturi is assumed to be at practically atmospheric pressure and temperature. By the use of Equation [1] and by assuming a probable velocity coefficient $f = 0.95$ for the inner venturi and $f = 0.85$ for the two outer venturis, we can show that the following conditions obtain. Through the inner venturi 175.8 cu. ft. of standard air flows. The pressure at the throat is 22.65 in. Hg, representing a drop of pressure of 7.28 in. Hg. About 1777 cu. ft. of standard air per minute flows through the middle venturi. The drop of pressure from atmosphere (29.93 in. Hg) to the throat of this venturi is 0.73 in. Hg. All the remaining air (13,047 cu. ft.) passes through the outer or third venturi, and the drop of pressure from atmosphere to the throat of this venturi is 0.69 in. Hg.

The loss of power in metering the air through this triple venturi, when passing 15,000 cu. ft. of standard air per minute, can be determined from the loss of pressure between that existing at the entrance to each venturi and the pressure existing at the exit or discharge end of each venturi, taking into account the volume of standard air passing through each. This gives a loss of power of 0.18 hp. for the smaller or inner venturi, 1.06 hp. for the middle venturi and 31.38 hp. for the outer or largest venturi, making a total power loss through the entire triple venturi of 32.62 hp.

The largest drop of pressure in this triple venturi meter occurs in the throat of the inner or smallest venturi. With a flow of 15,000 cu. ft. of standard air per minute, the calculated drop is 7.28 in. Hg (3.57 lb. per sq. in.) pressure. With air entering the meter from atmosphere, the throat pressure will be negative (suction). With varying flow of air through the venturi, the suction at the throat of the inner venturi will also vary; and this varying suction can be used for governing the driver of a centrifugal compressor so as to hold a definite "*constant volume*" of air flow per minute.

THE VENTURI METER CONSTANT-VOLUME GOVERNOR

Fig. 4 shows in a somewhat diagrammatical manner a means for accomplishing this. The pipe leading from the throat of the inner venturi meter is connected to part A representing a mercury-sealed pressure bell, or mercury pot. Suction pressure at the venturi throat is established in the space B between the stationary part of the pot and the upper and movable bell. Variations of pressure in B cause this bell to move up or down. The suction pressure is sealed from atmosphere by a column of mercury surrounding the long sheet-steel skirt or extension of the bell. There is sufficient clearance space between this sheet-steel skirt and the inner and outer shell surrounding it to prevent any frictional contact. The movement of the bell in the mercury pot is transmitted through the links C, D, and E to the steam-valve control to the turbine, thereby opening and closing the number of valves admitting steam to the turbine. An adjustable spring F can be set so as to counterbalance the pull of the bell for any desired volume of air. Handwheels G are used for setting the spring tension, as can be readily understood from the figure. Dashpot H dampens out the oscillations of this gear.

The method of setting for regulation is as follows: Having determined exactly the number of cubic feet of standard air desired per minute, the operator turns the handwheel G and observes the height of the registering mercury column, also attached to the pipe leading from the throat of the inner ven-

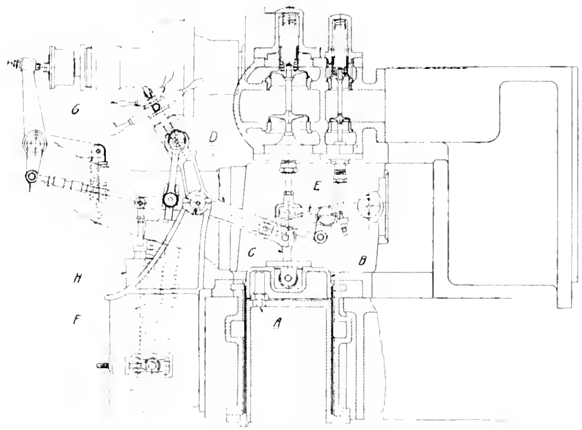

FIG. 4

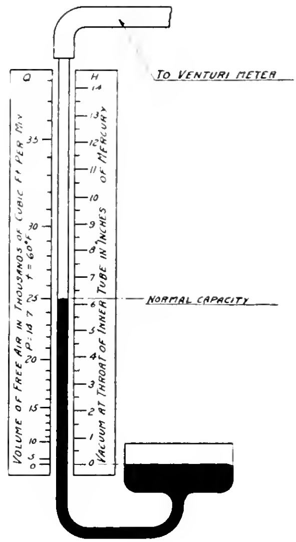

FIG. 5

FIG. 4 CONSTANT-VOLUME GOVERNOR FOR VENTURI METER. FIG. 5 U-TUBE AND QUANTITY SCALE FOR VENTURI METER

FIG. 4 Uses a mercury pot subjected to the pressure of the throat of the venturi meter shown in Fig. 3 and with adjustments so that it can hold any desired volume as indicated on a calibrated mercury tube shown in Fig. 5.
FIG. 5 Used with a venturi meter as shown in Fig. 3 and with a constant-volume governor as shown in Fig. 4.

turi. This mercury column is not only inscribed in inches of mercury, but is also calibrated in cubic feet of air per minute, as shown in Fig. 5.[1] When the mercury column registers the desired number of cubic feet of standard air per minute, handwheel G is locked. Any change in air flow through the venturi will change the suction in the pipe leading from the throat of the inner venturi to the mercury pot shown in Fig. 4, and also to the gage in Fig. 5. A change of suction on the mercury pot, however, influences the governing mechanism so as to increase the steam admission to the turbine when the suction decreases, or decrease the steam admission to the turbine when the suction increases. By this means constant-volume governing is obtained. Increasing the steam admission to the turbine speeds up the unit, thereby increasing the discharge pressure of the compressor, and vice versa. Equilibrium must be established between the spring tension set by handwheel G and the pressure in the confined space in the mercury pot before the governing mechanism comes to rest.

The calibration of mercury column indicating number of cubic feet of air per minute refers to standard air, that is, air of the average temperature and barometer and humidity for which the unit has been calibrated. Fig. 5 shows a calibrated scale for a normal capacity of 25,000 cu. ft. of air per min., whereas Fig. 3 shows a multiple venturi of a much greater normal capacity, probably 40,000 cu. ft. per min.

The Impact-Float Constant-Volume Governor

The second method for regulating turbo-compressors for blast-furnace work involves the use of the impact oat which was originally conceived as part of the means for constant-volume governing. Fig. 2 shows the impact float suspended in a conical pipe and attached to a beam calibrated in cubic feet of air per minute. If this beam were attached by linkages to the governing mechanism of the driver of a centrifugal compressor, it could be made to take care of its governing.

Fig. 6 shows such a constant-volume governor. Float F is suspended by a vertical rod from beam B. The float is made so it can be heated with a small amount of compressed air introduced through the hollow suspension rod S so as to prevent moisture from condensing and freezing upon the float in winter. The beam is fulcrumed at A and is balanced by counterweight C and movable sliding weight W. Dashpot D prevents too rapid movements or oscillations. Handwheel H on one end of the beam moves the sliding weight W longitudinally along the beam by means of a threaded shaft and nut. The sliding weight can thus be set at any definite position indicating the desired volume of air per minute. Any movement of the beam is transmitted through linkages M, N, O and T to a controlling pilot valve V which will admit steam or oil under pressure to either one or the other side of a piston P. This piston is connected directly to a nest of controlling valves which admit steam to separate groups of turbine nozzles. The turbine governor G is used as a speed-limiting device, so arranged that when the turbine reaches a speed corresponding to that at which the compressor would deliver the maximum permissible pressure (for blast-furnace work usually 30 lb. per sq. in. gage), it moves linkages L, K, and N and thereby influences the governing pilot valve from opening more valves for steam admission. In other words, at this speed it takes the control of the turbine out of the hands of the constant-volume governor.

[1] For Figs. 3, 4 and 5 the author is indebted to the Southwark Foundry and Machine Company.

The important feature of this method of constant-volume governing is the very small pressure drop involved by the air passing through the conical pipe of the meter. The area of the float is so large that a very low velocity of air and an extremely small pressure difference on the two sides of the float is sufficient to afford all the force necessary to move the entire governing mechanism. This fact also makes the governor sensitive to the smallest variation in the quantity of air passing through the compressor.

The force exerted upon the impact float when used as a constant-volume governor can be determined from Equation [2].

It has been found advisable to make the area of such a float equal to

$$A = 700(Q_1/Q)[1/\sqrt{(p\gamma)}] \ldots\ldots\ldots\ldots [3]$$

in which

A = area of float in sq. ft.
Q = correct quantity of cu. ft. of standard air per minute for a definite position of sliding weight
$Q_1 = Q + q$
q = smallest change of volume in cu. ft. of air per min. desired to produce an effect governing
γ = density of air in lb. per cu. ft.
p = mean effective pressure in lb. per sq. in. for which the compressor has been designed.

It will be noticed that the smaller the value of q, the more sensitive will be the governing and the smaller will be the force available for governing purposes. If q is taken reasonably large the governing forces become greater, but the constant-volume governor will be less sensitive. In other words, q is a measure of the per cent of the regulation desired.

When the float is in proper position for the compressor to deliver its normal rating of air against the normal pressure, the annulus area between the float and the cone may be found from the following equation:

$$a = 0.0017Q\sqrt{(\gamma/P_m)} \ldots\ldots\ldots\ldots [4]$$

in which

a = annulus area in sq. ft.
Q = the normal rating of the compressor in cu. ft. of air per min.
P_m = the mean effective pressure corresponding to the normal pressure rating in lb. per sq. in.
γ = density of air in lb. per cu. ft.

It is advisable to make the inlet-pipe diameter for supplying atmosphere air to the constant-volume governor and hence to the compressor of such diameter as to limit the velocity of air to approximately 30 ft. per sec. The constant-volume-

TABLE 1 FLOAT AREAS AND FORCES USED IN IMPACT FLOAT METHOD

Normal rating of unit, cu. ft. of standard air per min.	Quantity of air delivered, cu. ft. per min.	Float area, sq. ft.	Float force, lb.
50,000	45,000	7.43	168
40,000	40,000 35,000	6.87	167 128
30,000	30,000 25,000	4.90	171 118
20,000	22,500 20,000 18,300	3.14	112 89 75

governor cone should extend into an inlet box which would admit air with uniform distribution into the cone. It is therefore advisable to have the inlet box as large as possible.

Table 1 gives an idea of the float forces and float areas employed in practice, the float force having been measured experimentally in each case.

Inaccuracies of Constant-Volume Governors

Both the venturi-meter and the impact-float methods of constant-volume governing applied to centrifugal compressors have resulted in improving the regulation of blast furnaces. Unfortunately, this means of regulating cannot be applied to any other type of air-compressing machinery because all other known types of compressors do not produce an absolutely steady flow of air. The advent of constant-volume governing has eliminated the only remaining guesswork heretofore employed in regulating the air supply to a blast furnace. With

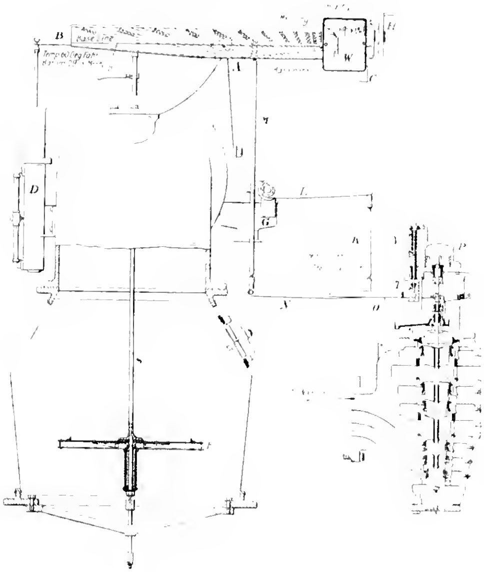

Fig. 6 Volume Corrector

Shown mounted on the beam of a constant volume governor

careful analysis of the iron ore and coke charged to the furnace and a careful weighing of them as they are charged, the amount of oxygen necessary for combustion of the coke and reduction of the iron ore is accurately and easily determined. It is then only necessary in the venturi method to adjust the governing mechanism so that the indicating mercury column shows the desired quantity of atmospheric air per minute; or, in the impact-float method, merely to set the sliding weight on the governing beam to the indicated quantity of atmospheric air desired. In the latter case the weight can be set immediately and the governor will automatically establish the proper air flow, whereas, in the former case, adjustment must be made slowly until the desired air flow is obtained. In both cases, however, if the atmospheric conditions of the inlet air change from the so-called standard or average conditions for which the governors were calibrated, the actual quantity of air delivered, or more correctly, the actual *weight* of oxygen sent to the blast furnace, will vary. This variation may be considerable.

For instance, if the standard air conditions are taken as dry air at 60 deg. fahr. and 29 in. Hg and the governor is calibrated for these conditions, it is possible to conceive a summer condition of 100 deg. fahr. with a barometer of 26 in. and fully saturated air (as on a rainy and stormy day). There is 14 per cent less oxygen per cubic foot of air under these conditions than under standard conditions. In winter, atmospheric air may be at 0 deg. fahr., the air perfectly dry and a barometer of 30 in. Hg. A cubic foot of this air will contain 8 per cent more oxygen than the standard air. It is, therefore, perfectly possible to supply from 8 per cent too much oxygen to 14 per cent too little oxygen to the blast furnace, if regulation is dependent on constant-volume-governor settings of standard or average conditions of atmospheric air.

The Volume Corrector

The main object of this paper is to describe a new instrument named a volume corrector which can be applied to the sliding weight and calibrated scale of an impact-float constant-volume governor for correcting this governor when handling air of any temperature, barometer or humidity. An instrument similar in principle and somewhat similar in construction can also be applied to the indicating mercury column of the venturi meter so as to obtain proper volume correction.

The volume corrector applied to the impact-float constant-volume governor is shown in Fig. 6. The seale beam *B*, instead of having vertical calibration lines for standard conditions of air, has sloping constant-volume lines engraved upon it. The volume corrector proper is mounted on the front of the sliding weight *W*. Fig. 7 is a photographic view of a part of this scale beam with volume corrector mounted on the sliding weight; and Fig. 8 is the same with the hinged door of the volume corrector open, as is the case when the instrument is to be set.

Fig. 9 shows a little more clearly the arrangement of this instrument. There are three milled heads, *A*, *B*, and *C*, provided for adjusting pointers indicating barometer, temperature and humidity. All that is required of the operator is to set these pointers correctly. After obtaining the actual barometer reading from a standard barometer, and the actual temperature of the incoming air, and observing the existing humidity (which is usually done by noting the temperature difference between a wet- and dry-bulb thermometer, pointer *a* is set at the proper barometric reading, pointer *b* at the proper temperature reading, and pointer *c* moved so as to intersect the curve corresponding to the observed temperature difference between the wet- and dry-bulb thermometers.

The movement of each of these pointers influences the final position of the main pointer *P*. This main pointer moves in a vertical direction with respect to the scale on the beam. After the volume corrector is properly set, the sliding weight to which the volume corrector is permanently attached is moved horizontally along the beam until the main pointer *P* intersects the sloping line on the graduated scale designating the proper volume of standard air required. When so set the sliding weight is in the proper position. This permits corrections to be made for variation in temperature, barometer and humidity so that a constant *weight* of oxygen is supplied no matter what the conditions of the atmospheric air. Having determined that the blast furnace requires a definite volume of standard air (dry air at 60 deg. fahr. and 29 in. Hg), the

governor with corrected setting of the sliding weight will deliver the proper amount of actual air which would contain the same *weight* of oxygen as would be contained in the required quantity of standard air.

The amount of oxygen in dry air varies directly as the density of the air. The density of air is directly proportional to the barometric pressure and inversely proportional to the absolute temperature. Expressed symbolically, $\gamma \propto B/T$. As the float force is proportional to M^2/γ, a change in density γ with the governor set to maintain a constant weight M of air per second will cause the governor to change the speed of the compressor until a new weight M_1 is delivered, such that the new value of M_1^2/γ_1 is the same as the original value of M^2/γ. Expressed symbolically, for a given setting of the sliding weight, $M^2 \propto \gamma$, or $M \propto \sqrt{\gamma} \propto \sqrt{(B/T)}$. For moist air the barometer no longer represents the pressure of the air itself, for part of the barometric pressure is due to the vapor pressure in the air. This vapor pressure must therefore be subtracted from the observed barometric pressure in order to get the net air pressure to be used in computing the air density and hence the weight of oxygen per cu. ft. of air. For saturated air (a relative humidity of 100 per cent) the vapor pressure can be read directly from steam tables for the observed atmospheric temperature. If the air is not quite saturated, the relative humidity, or the percentage of the possible maximum of moisture in the air, can be determined in a number of ways; usually, from a dry- and wet-bulb thermometer arrangement. The vapor pressure for a given temperature is proportional to the relative humidity, and this must then be subtracted from the observed barometric pressure in computing the air density.

The graduated scale on the beam of the constant-volume governor was designed by taking a horizontal base line such as was shown in Figs. 6, 7 and 8, and shown schematically in Fig. 10 as AA', and placing thereon the proper calibration for standard air (dry, 60 deg. fahr., 29 in. Hg). The zero on this line gives the position of the sliding weight when the constant-volume governor beam is in equilibrium and no air is flowing. The point B (Fig. 10) represents the position of the sliding weight for 10,000 cu. ft. flow; and point C its position for 20,000 cu. ft. flow, etc. The distance AC is made equal to four times AB. Similarly the distance AD, where D represents the 30,000 cu. ft. point, is made equal to nine times AB. With respect to temperature, the graduations on AA' hold good so long as the prevailing atmospheric temperature is 520 deg. fahr. absolute. When the prevailing temperature is other than 520 deg. fahr. absolute, the relations of the distances AB, AC, AD to each other remain unchanged; but they must all be multiplied or foreshortened by the same ratio. This is accomplished in the following manner:

Referring to Fig. 10, let the line OAB' be perpendicular to the base line AA'; and let OA represent to some scale 520 deg. fahr. absolute, and OB' represent 2080 deg. fahr. absolute to the same scale, so that $OB' = 4\ OA$. Draw $B'C'$ parallel to AA' and CC' parallel to OB'. Also prolong the straight line OB until it intersects the line $B'C'$ in the point P (not shown). The triangles OAB and $OB'P$ being similar, $B'P : AB :: OB' : OA$; or $B'P = 4\ AB$. But $B'C' = AC = 4\ AB$. Therefore $B'P = B'C'$; or P coincides with C'. In other words, the intersection C' of the line CC' with $B'C'$ is a point on the straight line OB.

Now in actual operation when the governor is set to deliver 20,000 cu. ft. of standard air per minute for a temperature of 520 deg. fahr. and should the actual temperature be four times as high, or 2080 deg. fahr. absolute, the governor will, as explained before, with the same setting of the sliding weight, regulate for only 10,000 cu. ft. of standard air per minute, because the density of the air at 2080 deg. fahr. absolute is one-fourth of that at 520 deg. fahr. absolute. The pointer of the sliding weight must under those conditions then read 10,000 cu. ft. without the sliding weight itself being disturbed in any way. In the volume corrector this would be accomplished by pushing up the final pointer along a uniform temperature scale until it reads 2080 deg. fahr. absolute, because the pointer traveling upward would then, as proved above, just intersect the 10,000 cu. ft. line OBC'. It will be noticed that all the

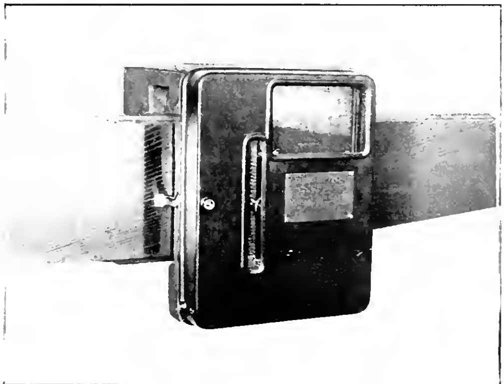

Fig. 7 Photographic View of the Volume Corrector
Front door of casing closed

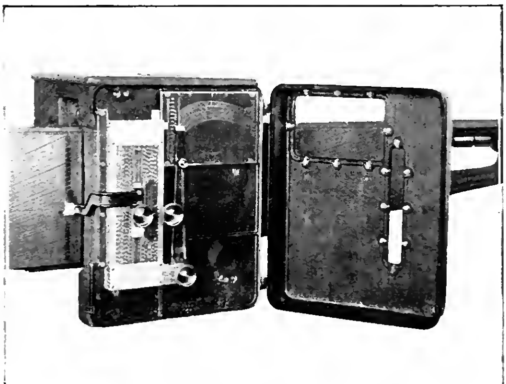

Fig. 8 Photographic View of Volume Corrector
Front door of casing opened

sloping lines representing definite volumes of air per minute meet at O. This would represent the point of absolute zero if the same temperature scale was carried down on the prolongation of the line AB. From the above it can be seen that if the volume corrector be made to carry a temperature scale with the same distances as employed in the engraving of the scale on the beam, and the main pointer P of the volume corrector be made to move vertically up and down the proper distance to this scale, the sliding weight can be set for any observed temperature of atmospheric air so as to deliver the proper volume of air containing the same weight of oxygen as is

contained in the previously calculated necessary volume of air of standard conditions.

Further consideration will show that as far as the density or the square of the volume is concerned, doubling the absolute temperature is equivalent to halving the barometer. In other words, any barometric change can be expressed by an equivalent temperature change. For instance, if 29 in. Hg is taken as the standard barometer and 60 deg. fahr. (520 deg. absolute) as the standard temperature, a change to 28 in. barometer, the temperature remaining at 60 deg. fahr., is equivalent to a change to a temperature of (29 × 520)/28 or 538.6 deg. fahr. absolute (78.6 deg. fahr.) with the barometer remaining at 29 in. Hg. The distance on the barometer scale from 29 in. to 28 in. must therefore equal the distance from 60 deg. fahr. to 78.6 deg. fahr. on the thermometer scale, whereas the correction necessary from 29 in. Hg to 25 in. Hg barometer is equivalent to a change to a temperature of (29 × 520)/25 or 603.2 deg. fahr. absolute (143.2 deg. fahr.) with the barometer remaining at 29 in. Hg. The distance on

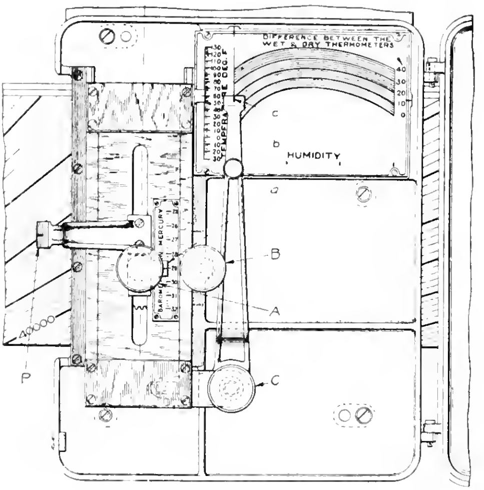

FIG. 9 VIEW OF VOLUME CORRECTOR SHOWING DETAILS

the barometer scale from 29 in. to 25 in. must therefore equal the distance from 60 deg. fahr. to 143.2 deg. fahr.

The barometric scale constructed on the above principle for the volume corrector is evidently a reverse and reciprocal (that is, non-uniform) scale. For constructional reasons, and chiefly to take care of humidity corrections explained later, it is desirable to have this scale uniform without affecting in any way the accuracy of the instrument. This is accomplished in the following manner:

Referring to Fig. 11, which gives a view of the volume corrector shown in Fig. 9 but with some of the front cover plate removed, *A*, *B* and *C* are the pins to which the milled heads *A*, *B* and *C* of Fig. 9 are attached. The main pointer in Fig. 9 is moved up and down in a vertical slot by means of pin *p* in Fig. 11. When the operator moves milled head *A* so that pointer *a* indicates the barometer reading, gearwheel *D* (Fig. 11) rotates about pin *A* because it is meshed into a rack *E* which remains stationary. Motion is given to pin *p* (which is held in a vertical slot) by the slot *S* in gearwheel *D*. This slot is in the form of a cam and so designed that pin *p*, and therefore the main pointer *P*, moves the proper distance vertically. The main pointer will move a less distance vertically when barometer pointer moves from 32 in. to 31 in. than it will when moving from 31 in. to 30 in., and less from 31 in. to 30 in. than it will from 30 in. to 29 in. Therefore, although the barometer scale over which pointer *A* moves has uniform divisions, the actual vertical distance through which the main pointer *P* moves is non-uniform and follows a reciprocal scale.

The setting of temperature is accomplished through milled head *B* which is attached to a plate movable vertically between

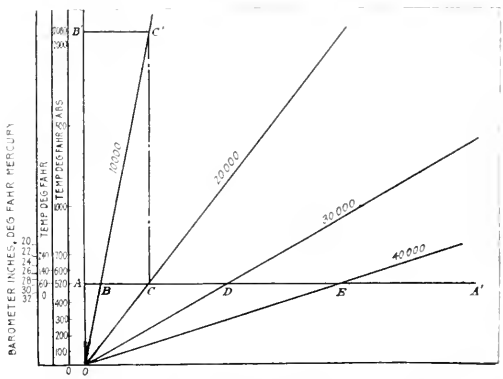

FIG. 10 DIAGRAM ILLUSTRATING CONSTRUCTION OF SCALES ON VOLUME CORRECTOR

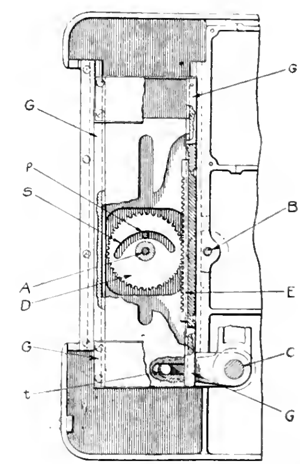

FIG. 11 SECTIONAL VIEW OF VOLUME CORRECTOR

gibs *GG* and which carries with it the rack *E*, gearwheel *D*, and pin *p* with main pointer *P*. Moving *B* up and down does not revolve gearwheel *D* at all (that is, does not disturb the barometer setting), but simply moves main pointer *P* over a temperature scale shown in Fig. 9. Pointer *b* is set opposite the proper temperature reading.

The corrections for humidity in the volume corrector are based upon the following considerations: The barometric-pressure reading as usually observed is equal to the sum of the air pressure plus the vapor pressure. If the air is

saturated, that is, if it contains all the water vapor it is capable of holding without precipitation at the particular temperature, the value of the vapor pressure at the given temperature can be ascertained experimentally or taken from the steam tables. If the degree of saturation or the relative humidity is, say, only 20 per cent or 50 per cent, then the vapor pressure as determined experimentally must be multiplied by 0.20 or 0.50 as the case may be.

The most usual method of ascertaining the relative humidity of the air is by means of a wet- and dry-bulb thermometer arrangement. In its simplest form it consists of two similar thermometers, the bulb of one of which is covered by a wet piece of sponge. If the air is fully saturated no evaporation into it can take place and the two thermometers record the same temperature. When the air is only partly saturated, the evaporation from the wet bulb lowers the thermometer reading; so that the difference in the readings of the wet and dry thermometers can be taken as a measure of the relative humidity of the air. For any combination of relative humidity and atmospheric temperature the vapor pressure is a definite quantity. This vapor pressure must be subtracted from the observed barometer reading in order to give the net or correct air pressure to be used on the barometer scale above described; since it is the density (and therefore the actual pressure) of the air alone that is of importance, and not the density of the mixture of air and water vapor.

It is important to note that the humidity correction in pounds per square inch or in inches of mercury is independent of the actual barometer reading, and depends only on the atmospheric temperature and on the difference between the wet- and dry-bulb thermometer readings (relative humidity). The humidity correction can therefore be made mechanically if the pointer P on the sliding weight is given an additional correction or movement which would be the equivalent amount of a certain subtraction of pressure on the barometric scale equal to the correction for the pressure due to vapor. It is for this reason that it is preferable to make the divisions on the barometric scale uniform, so that, for instance, a half-inch mercury correction would require the same movement no matter at what reading the barometer scale happened to be set. As will be shown later, the volume corrector accomplishes this; therefore, no matter where the barometer pointer a is set, the humidity correction moves the main pointer P on the sliding weight the proper amount. It will also be noticed that the humidity is a function of the atmospheric temperature, that is, when the temperature is high the water vapor in the saturated air is higher than when the temperature is low. In the volume corrector the setting of the temperature pointer b on the temperature scale automatically sets the humidity pointer c to the correct temperature also.

Referring to Fig. 9, the correction for humidity is made by loosening milled head C and swinging pointer c until it intersects or indicates the proper amount of difference in reading between the wet- and dry-bulb thermometer. The movement of the long arm carrying pointer c about the center of milled head C moves pin t attached to a plate carrying gearwheel D, but does not move rack E. Moving gearwheel D vertically up or down rotates D because E is stationary and thereby moves the main pointer P similarly, as heretofore described.

Accurate Constant-Volume Governing

The volume corrector therefore is an instrument which can be set by an operator at the existing barometer, temperature and humidity of the atmospheric air and when so set will permit the setting of the sliding weight on the scale beam in a position so that the constant-volume governor will hold or deliver the correct volume of air which would contain the same weight of oxygen as would be contained in a certain predetermined and desired volume of standard air.

This means that the blast-furnace operator, knowing the chemical compositions of the coke and iron ore and the amounts charged to the furnace in a stated period of time, can determine the exact volume of standard air (dry, 60 deg. fahr., 29 in. Hg) which will contain the proper amount of oxygen necessary for combustion of the coke and reduction of the iron ore in the blast furnace. He need not perform any mathematical calculations as to how much more or how much less air must be supplied when the atmospheric conditions are not those considered standard in order to be sure the blast furnace is receiving at all times its exact and necessary weight of oxygen.

The volume corrector needs resetting every time the operator notices any change in the barometer, temperature or difference between the wet- and dry-bulb thermometer reading in order to be sure of securing the most efficient regulation. The air conditions, however, do not vary rapidly and the practice of inserting in an engine-room log every half hour the steam pressure, r.p.m., vacuum and other information can easily be extended to include readings of the barometer and wet- and dry-bulb instrument. Even with the front cover of the volume corrector closed, transparent places are provided which will permit any one checking or observing these settings. The need of a volume corrector is apparent from the fact that it is possible to have a variation of weight of oxygen delivered to a furnace of 5 to 10 per cent ordinarily and in extreme cases as high as 20 per cent as a result of variations in atmospheric-air conditions, especially as between winter and summer. The gains in quality and quantity of output of a blast furnace obtained even by the former methods of constant-volume governing without volume corrections will be still further improved by the use of constant-volume governing with proper volume corrections.

As a result of representations received from the Advisory Council of the Committee of the Privy Council for Scientific and Industrial Research, and of public meetings held in Glasgow, a joint committee of the Institution of Engineers and Shipbuilders in Scotland, and the West of Scotland Iron and Steel Institute, have prepared a draft memorandum outlining the proposed constitution for a Scottish Engineering, Shipbuilding, and Metallurgical Research Association. The draft memorandum proposes that the objects of the new association should include the following: (1) To promote research and other scientific work in connection with the trades and industries included within the scope of the association; (2) to apply for and accept grants from the Government for the purposes of the association; (3) to establish, form and maintain museums, collections, libraries, etc., and to translate, compile, collect, publish, lend, sell any literature, statistics and information in connection with the trades or industries concerned; (4) to encourage discoveries and inventions in connection with these trades or industries; (5) to establish, promote, coöperate with, receive into union or combine with any other bodies, or persons engaged or interested in similar research work, either in Scotland or elsewhere; and all such subsidiary powers as may be necessary for carrying out the objects of the Association.

REVISION OF BOILER CODE

THE Council of the Society directed that a hearing be conducted in accordance with the recommendation in the Boiler Code that a meeting at which all interested parties may be heard be held at least once in two years to make such revisions as may be found desirable in the Code and to modify the Code as the state of the art advances. The first of these meetings was held at the Society's headquarters in New York, December 8 and 9, 1916.

The Council also directed that the proposed revisions in the Boiler Code be published in THE JOURNAL with the request that they be fully and freely discussed, so as to make it possible for any one to suggest changes before the Rules are brought to the final form and presented to the Council for approval. This has been done, and the revisions are presented below in the form finally proposed for submission to the Council, except as they may be modified by editing without change of sense. Discussions should be mailed to Mr. C. W. Obert, Secretary of the Boiler Code Committee, 29 West 39th Street, New York, N. Y., and they will be presented and acted on by the Boiler Code Committee.

PAGE 1

TITLE PAGE

Change line at bottom of p. 1 which reads as follows:

Edition of 1914 with Index

to read as follows:

Edition of 1918

(New edition of Boiler Code to be copyrighted under date of 1918)

PAGE 2

LETTER TO THE COUNCIL

Change letter to the Council to read as follows:

To the Council of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

GENTLEMEN: Your Committee respectfully submits the following revised report on Rules for the construction of, and allowable working pressures on stationary boilers, this report forming a part of the task that has been assigned to it. Stationary boilers as here considered are land boilers and include portable and traction boilers. The Rules do not apply to boilers which are subject to federal inspection and control, such as marine boilers, boilers of steam locomotives and other self-propelled railroad apparatus.

The primary object of the Rules is to secure safe boilers. The interests of boiler users and manufacturers have been carefully considered and the requirements made such that they will not entail undue hardship by departing too widely from present practice.

The Code applies only in part to certain special forms of boilers such as those of the forced circulation or flash type. New matter has been added to state that the material for boilers of this class shall conform to the requirements of the Code, and that other requirements shall also be met except where they relate to special features of construction made necessary in boilers of this type, and to accessories that are manifestly not needed or used in connection with such boilers, such as water gages, water columns, and gage cocks.

In those states and municipalities which have adopted the Boiler Code, your Committee recommends that all requests for interpretations of the Boiler Code be referred to the state authorities having jurisdiction over such matters. In order to maintain uniformity of practice it is also suggested that the authorities having jurisdiction be requested to submit all inquiries where there is any question of doubt to the Boiler Code Committee. Where there is a question respecting the interpretation of the Code, or where constructions apparently are not covered by the Code, it will be most desirable to have the matter referred to the Boiler Code Committee. Unless this procedure is followed, the aim to obtain uniformity in the application of the Code will be defeated. The Boiler Code Committee desires to coöperate to the limit of its ability in assisting in the application of the Code, and will take pleasure in considering all matters where there is any question of doubt that may be brought before it by the various states and municipalities that adopt the Code.

The Committee does not pass on questions concerning specific designs of boilers or appurtenances thereto.

The specifications given in the Code are the same as or similar to those of the American Society for Testing Materials. The Specifications for Boiler Plate Steel published in the Code (Edition of 1914) were approved and recommended in their modified form, October 9, 1914, by The Association of American Steel Manufacturers, the American Boiler Manufacturers' Association, the National Tubular Boiler Manufacturers' Association, the National Association of Thresher Manufacturers and the representatives present of leading Water Tube Boiler Manufacturers, with whom the Boiler Code Committee was in conference on September 16, 1914, and by whom further modifications were afterwards offered.

The Specifications for Lapwelded and Seamless Boiler Tubes were approved by the Boiler Tube Manufacturers of America, September 25, 1914. Changes made in the specifications published in the original Code have been considered by sub-committees of the American Society for Testing Materials, of The Association of American Steel Manufacturers, and of the Boiler Code Committee in order that coöperation might be secured through these sub-committees making joint recommendations to their respective organizations.

Your Committee recommends that a hearing be held by the Boiler Code Committee at least once in four years at which all interested parties may be heard, in order that such revisions may be made as are found to be desirable, as the state of the art advances.

Yours truly,

JOHN A. STEVENS, *Chairman.*

Wm. H. Boehm, Boiler Insurance
Rolla C. Carpenter, Engineering Research
Frank H. Clark, Railroad Sub-Committee, THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
Francis W. Dean, Consulting Engineers
Thomas E. Durban, Chairman, The American Uniform Boiler Law Society. All types of boilers
E. R. Fish, American Boiler Manufacturers Association
Elbert C. Fisher, Scotch marine and other types of boilers
Charles E. Gorton, Steel heating boilers
Arthur M. Greene, Jr., Engineering Education
Richard Hammond, Scotch marine and other types of boilers
A. L. Humphrey, Railroad Sub-Committee, THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
Charles L. Huston, Boiler plate manufacturer
D. S. Jacobus, Water-tube boilers
S. F. Jeter, Boiler Insurance
Wm. F. Kiesel, Jr., Railroad Sub-Committee, THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
F. R. Low, Technical Press
W. F. MacGregor, National Association of Tractor and Thresher Manufacturers
Edward F. Miller, Engineering Research

Submitted to the Council of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, [illegible] dated [illegible].

M. F. Moore, Steel heating boilers
I. E. Moultrop, Boiler users
Richard D. Reed, Cast-iron heating boilers.
H. H. Vaughan, Railroad Sub-Committee, THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
C. W. Obert, Secretary to Committee.

PAGE 5

HEADING

Insert above heading of p. 5 the following:

A.S.M.E. Boiler Code

PAGE 7

HEADING

Insert above heading of p. 7 the following:

A.S.M.E. Boiler Code

PAGE 8

PAR. 9. MAKE THE FOLLOWING CHANGE IN PAR. 9:

In second line, omit "and" after the word "headers" and insert a comma.

ALSO ADD A SENTENCE AS FOLLOWS:

Malleable iron may be also used when the maximum allowable working pressure does not exceed 200 lb. per sq. in., and the form and size of the internal cross-section, perpendicular to the longest dimension of the box, shall be such that it will fall within a 7 in. by 7 in. rectangle.

PAR. 12. CHANGE PAR. 12 TO READ AS FOLLOWS:

12 Cast iron shall not be used for nozzles or flanges attached directly to the boiler at any pressure or temperature, nor for boiler and superheater mountings such as connecting pipes, fittings, valves and their bonnets, for steam temperatures of over 450 deg. fahr.

PAR. 13. CHANGE PAR. 13 TO READ AS FOLLOWS:

13 Water-leg and door-frame rings of vertical fire-tube boilers, and of locomotive and other type boilers, shall be of wrought iron or steel, or cast steel of Class A or Class B grade, as designated in the Specifications for Steel Castings. The OG or other flanged construction may be used as a substitute in any case.

PAR. 14. INSERT THE FOLLOWING AT THE BEGINNING OF PAR. 14:

In determining the maximum allowable working pressure.

PAGE 9

PAR. 19. CHANGE PAR. 19 TO READ AS FOLLOWS:

19 The minimum thickness of butt straps shall be as given in Table 1. Intermediate values shall be determined by interpolation. For plate thicknesses exceeding $1\frac{1}{4}$ in., the thickness of the butt straps shall be not less than two-thirds of the thickness of the plate.

TABLE 1. CHANGE VALUE FOR MINIMUM THICKNESS OF BUTT STRAPS FOR 1 IN. THICKNESS OF SHELL PLATES FROM $\frac{3}{4}$ IN. TO $\frac{11}{16}$ IN.

PAGE 10

PAR. 21. MODIFICATION OF THIS PARAGRAPH IS IN THE HANDS OF A SPECIAL SUB-COMMITTEE OF THE BOILER CODE, COMMITTEE ON TUBE SIZES.

PAGE 11

OMIT SUBHEADING UNDER CAPTION: SPECIFICATIONS FOR BOILER PLATE STEEL. ALSO OMIT 7-LINE FOOTNOTE AT BOTTOM OF PAGE.

PAR. 25. MAKE THE FOLLOWING CHANGE IN THE TABLE:

Omit last line of Table which reads as follows:

"Copper.................. Not over 0.05 per cent"

PAGE 12

PAR. 29. MAKE THE FOLLOWING CHANGES IN PAR. 29:

29 *Modifications in Elongation.* *a* For material over [illegible] in. in thickness, a deduction shall be made from the percentage of elongation in Par. 28*a* of four times the thickness in inches in excess of [illegible] in. to a minimum of 20 per cent.

b Strike out the words "or under" from the first line.

PAR. 30. CHANGE PAR. 30 TO READ AS FOLLOWS:

30*a* *Test Specimens.* Tension test specimens shall be taken longitudinally from the bottom of the finished rolled material, and bend test specimens shall be taken transversely from the middle of the top of the finished rolled material. The longitudinal test specimen shall be taken in the direction of the longitudinal axis of the ingot, and the transverse test specimen at right angles to that axis.[1]

b *Bend Test.* The bend test specimen shall bend cold through 180 deg. without cracking on the outside of the bent portion, as follows: For material 1 in. or under in thickness, around a pin the diameter of which is equal to the thickness of the specimen; and for material over 1 in. in thickness, around a pin the diameter of which is equal to twice the thickness of the specimen.

PAR. 31. CHANGE FIRST SECTION OF PAR. 31 TO READ AS FOLLOWS:

31 *Homogeneity Tests.* Homogeneity tests shall be made for fire-box steel on both the broken tension test specimen taken from the lower part of the plate, and on the bend test specimen taken transversely from the middle of the top of the plate. The tests made on the broken tension test specimen shall not show any single seam or cavity more than one-quarter inch long in either of the three fractures obtained in a test of homogeneity, which shall be made as follows:

INSERT A FOOT-NOTE TO READ AS FOLLOWS:

The requirements for the homogeneity tests of the bend test specimen taken transversely from the middle of the top of the plate will be determined by tests, and until such requirements are agreed on by the Boiler Code Committee and published by the A.S.M.E., no homogeneity tests need be made on material taken from the middle of the top of the plate.

PAGE 13

PAR. 33*a*. CHANGE PAR. 33*a* TO READ AS FOLLOWS:

33 *Number of Tests.* *a* One tension and one bend test shall be made from each plate as rolled.

PAGE 15

OMIT SUB-HEADING UNDER CAPTION: SPECIFICATIONS FOR BOILER RIVET STEEL.

PAGE 19

OMIT SUB-HEADING UNDER CAPTION: SPECIFICATIONS FOR STEEL BARS

PAGE 22

OMIT SUB-HEADING UNDER CAPTION: SPECIFICATIONS FOR STEEL CASTINGS

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[1] Exceptions are made for tension test specimens for plate which is rolled longitudinally with reference to position when used in a boiler shell; see Par. 190.

PAGE 26

OMIT SUB-HEADING UNDER CAPTION: SPECIFICATIONS FOR GRAY IRON CASTINGS

PAGE 29

OMIT SUB-HEADING UNDER CAPTION: SPECIFICATIONS FOR MALLEABLE CASTINGS

PAGE 31

OMIT SUB-HEADING UNDER CAPTION: SPECIFICATIONS FOR BOILER RIVET IRON

PAR. 123. MAKE THE FOLLOWING CHANGE IN PAR. 123*a*:

Change the percentage of yield point from 0.6 tensile strength to read 0.5 tens. str.

PAGE 34

OMIT SUB-HEADING UNDER CAPTION: SPECIFICATIONS FOR STAYBOLT IRON

PAR. 141. MAKE THE FOLLOWING CHANGE IN PAR. 141:

Change the percentage of yield point from 0.6 tensile strength to read 0.5 tens. str.

PAGE 37

OMIT SUB-HEADING UNDER CAPTION: SPECIFICATIONS FOR REFINED WROUGHT IRON BARS

PAGE 40

OMIT SUB-HEADING UNDER CAPTION: SPECIFICATIONS FOR LAPWELDED AND SEAMLESS BOILER TUBES

PAR. 164. MAKE THE FOLLOWING CHANGE IN PAR. 164*a*:

In the second line, insert a comma after the word "knobbled."

PAR. 167*a*. CHANGE PAR. 167*a* TO READ AS FOLLOWS:

167 *Flange Test.* *a* For tubes not more than 6 in. diameter a test specimen not less than 4 in. in length shall have a flange turned over at right angles to the body of the tube without cracking or showing any flaw. This flange as measured from the outside of the tube shall have a width of from 1/8 in. to 1/2 in., the width between these limits to be not less than 10 per cent of the outside diameter of the tube. For tubes more than 6 in. diameter the flange test is not required.

PAGE 41

PAR. 169. CHANGE PAR. 169 TO READ AS FOLLOWS:

169 *Hydrostatic Tests.* Tubes under 5 in. in diameter shall stand an internal hydrostatic pressure of 1000 lb. per sq. in. and tubes 5 in. in diameter or over, an internal hydrostatic pressure of 800 lb. per sq. in., provided that the fibre stress does not exceed 16,000 lb. per sq. in., in which case the test pressure shall be determined by the following formula:

$$P = \frac{32{,}000}{D} \times t$$

where t is the wall thickness in inches; D is the inside diameter in inches. Lapwelded tubes shall be struck near both ends, while under the test pressure, with a 2 lb. steel hand hammer, the blow to be equivalent to 2 lb. falling 2 ft.

PAGE 42

PAR. 174. CHANGE PAR. 174 TO READ AS FOLLOWS:

174 *Workmanship.* Finished tubes 3½ in. or under in outside diameter shall be circular within 0.02 in. and the mean outside diameter shall not vary more than 0.015 in. from the size ordered. For tubes over 3½ in. in outside diameter, these variations shall not exceed 0.5 per cent of the outside diameter. All tubes shall be carefully gaged with a B.W.G. gage and shall not be less than the gage specified. Tubes on which the standard slot gage, specified, will go on tightly at the thinnest point, will be accepted. The length shall not be less, but may be 0.125 in. more than that ordered.

PAR. 176. CHANGE PAR. 176 TO READ AS FOLLOWS:

176 *Marking.* The name or brand of the manufacturer, the material from which it is made, and the pressure in lb. per sq. in. at which it was tested, shall be legibly stenciled on each tube.

PAGE 44

PAR. 182. MODIFICATION OF THIS PARAGRAPH IS IN THE HANDS OF A SPECIAL SUB-COMMITTEE OF THE BOILER CODE COMMITTEE OF BACK PITCH

PAR. 183. ADD THE FOLLOWING WORDS TO THE END OF PAR. 183:

this distance to be measured from the centers of the rivet holes to the nearest edge.

PAR. 184. CHANGE PAR. 184 TO READ AS FOLLOWS:

184 *Circumferential Joints.* *a* The strength of circumferential joints of boilers, the heads of which are not stayed by tubes or through braces, shall be at least 50 per cent of that required for the longitudinal joints of the same structure.

b When 50 per cent or more of the load which would act on an unstayed solid head of the same diameter as the shell, is relieved by the effect of tubes or through stays, in consequence of the reduction of the area acted on by the pressure and the holding power of the tubes and stays, the strength of the circumferential joints in the shell shall be at least 35 per cent of that required for the longitudinal joints.

c In circumferential joints of horizontal return tubular boilers the shearing strength of the rivets shall be not less than 50 per cent of the full strength of the plate corresponding to the thickness at the joint.

PAGE 45

PAR. 186. CHANGE PAR. 186 TO READ AS FOLLOWS:

186 *Welded Joints.* The ultimate strength of a joint which has been properly welded by the forging process, shall be taken as 28,500 lb. per sq. in., with steel plates having a range in tensile strength of 47,000 to 55,000 lb. per sq. in. Autogenous welding may be used in boilers in cases where the strain is carried by other construction which conforms to the requirements of the Code and where the safety of the structure is not dependent upon the strength of the weld. Autogenous welding shall not be used in place of calking on girth joints.

PAR. 187. CHANGE PAR. 187 TO READ AS FOLLOWS:

187 *Riveted Longitudinal Joints.* The riveted longitudinal joints of a shell or drum which exceeds 36 in. in diameter, shall be of butt and double-strap construction. This rule does not apply to the portion of a boiler shell which is staybolted to the firebox sheet.

PAR. 190. CHANGE PAR. 190 TO READ AS FOLLOWS:

190 In horizontal return tubular boilers with lap joints no course shall be over 12 ft. long. With butt and double strap construction longitudinal joints of any length may be used, provided the tension test specimens are so cut from the plate that their lengthwise direction is parallel with circumferential seams of the boiler and the tests meet the standards prescribed in the specifications for boiler plate steel.

PAGE 46

PAR. 192. ADD NEW SECTION TO PAR. 192 AS FOLLOWS:

c The strength of those ligaments between the tube holes which are subjected to a longitudinal stress shall be at least one-half the required strength of those ligaments which come between the tube holes which are subjected to a circumferential stress.

PAGE 47

PAR. 193. MODIFICATION OF THIS PARAGRAPH IS IN THE HANDS OF A SPECIAL SUB-COMMITTEE OF THE BOILER CODE COMMITTEE ON DIAGONAL LIGAMENTS

PAGE 48

PAR. 194. REPLACE THE FIRST SECTION OF PAR. 194 BY THE FOLLOWING:

194 *Domes.* The longitudinal joint of a dome 24 in. or over in diameter shall be of butt and double-strap construction irrespective of pressure. When the maximum allowable working pressure exceeds 100 lb. per sq. in., the flange of a dome 24 in. or over in diameter shall be double riveted to the boiler shell.

PAGE 49

PAR. 195. ADD AFTER NOTATION FOLLOWING FORMULA:

Where two radii are used the longer shall be taken as the value of L in the formula.

CHANGE THE LAST SENTENCE OF THIS PARAGRAPH TO READ AS FOLLOWS:

When a dished head has a manhole opening, the thickness as found by these Rules shall be increased by not less than $1/8$ in. over that called for by the formula.

PAR. 198. CHANGE PAR. 198 TO READ AS FOLLOWS:

198 A manhole opening in a dished head shall be flanged to a depth of not less than three times the *required* thickuess of the head measured from the outside.

PAGE 50

PAR. 199. ADD TO THE LIST OF VALUES OF C THE FOLLOWING:

$C = 150$ for stays screwed through plates or made a taper fit and having the heads formed on the stays before installing them and not riveted over, said heads being made to have a true bearing on the plate and the diameter of the heads being not less than 1.3 times the diameter of the stays.

REVISE MATTER FOLLOWING LIST OF VALUES OF C TO MAKE IT READ AS FOLLOWS:

If flat boiler plates not less than $3/8$ in. thick are strengthened with doubling plates securely riveted thereto and having a thickness of not less than $2/3$ t, then the value of t in the formula shall be three-quarters of the combined thickness of the boiler plate and doubling plates but not more than one and one-half times the thickness of the boiler plate, and the values of C given above may also be increased 15 per cent.

When two sheets are connected by stays and but one of these sheets requires staying, the value of C is governed by the thickness of the sheet requiring staying.

Acceptable proportions for the ends of through stays are indicated in Fig. 12a.

PAR. 200. CHANGE PAR. 200 TO MAKE IT READ AS FOLLOWS:

200 *Staybolts.* The ends of screwed staybolts shall be riveted over or upset by equivalent process. The outside ends of solid staybolts, 8 in. and less in length, shall be drilled with a hole at least 3-16 in. diameter to a depth extending at least $1/2$ in. beyond the inside of the plates, or hollow staybolts may be used. On boilers having a grate area not exceeding 15 sq. ft., or the equivalent in gas or oil fired boilers, the drilling of staybolts is optional. Solid staybolts over 8 in. long, and flexible staybolts of either the jointed or ball and socket type, need not be drilled. Staybolts used in waterlegs of water-tube boilers shall be hollow or drilled at both ends, irrespective of their length.

PAR. 201. INSERT THE FOLLOWING SIDEHEAD IN THE FIRST LINE:

Structural Reinforcements.

ADD TO PAR. 201 THE FOLLOWING:

If the outstanding legs of the two members are fastened together so that they act as one member in resisting the bending action produced by the load on the rivets attaching the members to the head of the boiler, and provided that the spacing of these rivets attaching the members to the head is approximately uniform, the members may be computed as a single beam uniformly loaded and supported at the points where the through braces are attached.

PAGE 51

PAR. 202. INSERT THE FOLLOWING SIDEHEAD IN THE FIRST LINE:

Stays.

PAR. 203 CHANGE PAR. 203 TO READ AS FOLLOWS:

203*a* The maximum spacing between centers of rivets or between the edges of tube holes and the centers of rivets attaching the crowfeet of braces to the braced surface, shall be determined by the formula in Par. 199, using 135 for the value of C.

b The maximum distance between the edges of tube holes and the centers of other types of stays shall be determined by the formula in Par. 199, using the value of C given in Par. 199 which applies to the thickness of plate and type of stay used.

c The maximum spacing between the inner surface of the shell and lines parallel to the surface of the shell passing through the centers of the rivets attaching the crowfeet of braces to the head, shall be determined by the formula in Par. 199, using 175 for the value of C.

d The maximum distance between the inner surface of the shell and the centers of braces of other types shall be determined by the formula in Par. 199, using a value of C equal to 1.3 times that value of C in Par. 199 which applies to the thickness of plate and type of stay as therein specified.

e In applying these rules and those in Par. 199 to a head or plate having a manhole or reinforced opening, the spacing applies only to the plate around the opening and not across the opening.

UNDER TABLE 3 INSERT:

For the application of Pars. 205, 206 and 207, see Appendix (Par. . . .) (illustrations in Fig. 31).

PAR. 212. CHANGE PAR. 212 TO READ AS FOLLOWS:

212*a* The maximum allowable working pressure for any curved stayed surface subject to internal pressure shall be obtained by the two following methods, and the minimum value obtained shall be used:

First, the maximum allowable working pressure shall be computed without allowing for the holding power of the stays, due allowance being made for the weakening effect of the holes for the stays. To this pressure there shall be added the pressure secured by the formula for braced and stayed surfaces given in Par. 199 using 70 for the value of C.

Second, the maximum allowable working pressure shall be computed without allowing for the holding power of the stays, due allowance being made for the weakening effect of the hole for the stay. To this pressure there shall be added the pressure corresponding to the strength of the stays for the stresses given in Table 4, each stay being assumed to resist the steam pressure acting on the full area of the external surface supported by the stay.

b The maximum allowable working pressure for a stayed wrapper sheet of a locomotive type boiler shall be determined by the first method given above and by the method which follows and the minimum value obtained shall be used:

$$P = \frac{11{,}000tE}{R - \frac{s}{2\Sigma \sin \alpha}}$$

in which

α	Angle any crown stay makes with vertical axis of boiler
$\Sigma \sin \alpha$	Summated value of α for all crown stays considered in one transverse plane and on one side of vertical axis of boiler
s	Transverse spacing (in.) of crown stays in crown sheet
E	Minimum efficiency of wrapper sheet through joints or stay holes
t	Required thickness of wrapper sheet (in.)
R	Radius of wrapper sheet (in.)
P	Working pressure of boiler, lb. per sq. in.
11,000	Allowable stress, lb. per sq. in.

c An internal cylindrical furnace which requires staying shall be stayed as a flat surface as indicated in Table 3, except that the pitch may be increased to p_1 as provided in the following formula:

$$p_1 = p\sqrt{\frac{Pt}{PR - 2{,}000t}}$$

in which p, P, R, and t are the same as in Par. 199.

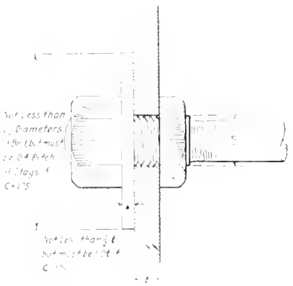


FIG. 12A ACCEPTABLE PROPORTIONS FOR ENDS OF THROUGH STAYS

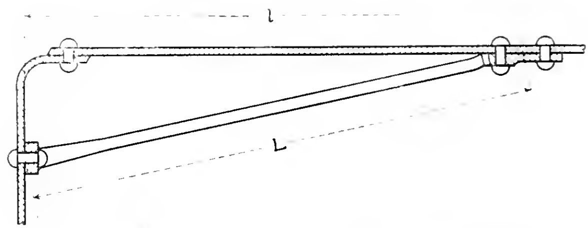


FIG. 15 MEASUREMENTS FOR DETERMINING STRESSES IN DIAGONAL STAYS

PAR. 214. CHANGE PAR. 214 TO MAKE IT READ AS FOLLOWS:

214 *Areas of Segments of Heads to be stayed.* The area of a segment of a head to be stayed shall be the area enclosed by lines drawn 2 in. from the tubes and a distance d from the shell as shown in Figs. 13 and 14. The value of d used shall be the larger of the following values but not less than 3 in.

(1) d = the outer radius of the flange, not exceeding 8 times the thickness of the head

(2) $d = \frac{5t}{\sqrt{P}}$

Where d = unstayed distance from shell in inches
t = thickness of head in sixteenths of an inch
P = maximum allowable working pressure in lb. per sq. in.

(NOTE. DIMENSIONS IN FIGS. 13 AND 14 NOW MARKED 3" TO BE CHANGED TO d).

PAR. 215. CHANGE PAR. 215 TO MAKE IT READ AS FOLLOWS:

215 When the heads of drums of water tube boilers are 30 in. or less in diameter and the tube plate is stiffened by flanged ribs or gussets, no stays need be used if a hydrostatic test to destruction of a boiler or unit section built in accordance with the construction, shows that the factor of safety is at least five.

PAR. 216. CHANGE PAR. 216 TO READ AS FOLLOWS:

216 Stays shall be used in the tube sheets of a fire-tube boiler if the distance between the edges of the tube holes exceeds the maximum pitch of staybolts for the corresponding plate thickness and pressure given in Table 3. That part of the tube sheet which comes between the tubes and the shell need not be stayed, if the nearest tangent common to two tube holes when measured on any radius of the tube sheet that intersects the tangent between the holes, does not exceed this maximum pitch by more than 3 in. The tube holes to which a common tangent may be drawn in applying this rule shall not be at a greater distance from edge to edge than the maximum pitch referred to.

PAGE 54

PAR. 218. INSERT IN FOURTH LINE BEFORE WORD "THICKNESS," THE WORD "REQUIRED."

ADD TO PAR. 218 THE FOLLOWING:

The distance in the clear between the bodies of the braces, or of the inside braces where more than two are used, shall not be less than 10 in. at any point.

PAR. 220. CHANGE PAR. 220 TO READ AS FOLLOWS:

220*a* The full pitch dimensions of the stays shall be employed in determining the area to be supported by a stay, and the area occupied by the stay, shall be deducted therefrom to obtain the net area. The product of the net area in square inches by the maximum allowable working pressure in lb. per sq. in., gives the load to be supported by the stay.

b Where stays come near bounding surfaces and special allowances are made for the spacing, the load to be carried by such stays shall be determined by neglecting the added area provided for by these special allowances. For example, if the minimum pitch by Table 3 would make a staybolt come 6 in. from the edge of the plate and a special allowance would make it come 7 in., the distance of 6 in. should be used in computing the load to be carried.

TABLE 4 MAXIMUM ALLOWABLE STRESSES FOR STAYS AND STAYBOLTS

Description of Stays	Stresses lb. per sq. in. For lengths between supports not exceeding 120 diameters	Stresses lb. per sq. in. For lengths between supports exceeding 120 diameters
a Unwelded or flexible stays less than twenty diameters long screwed through plates with ends riveted over	7,500	....
b Hollow steel stays less than 20 diameters long, screwed through plates with ends riveted over		.....
c Unwelded stays and unwelded portions of welded stays, except as specified in line *a* and line *e*	9,500	8,500
d Steel through stays exceeding 1½ in. diameter	10,400	9,000
e Welded portions of stays	6,000	6,000

c The maximum allowable stress per square inch at point of least net cross-sectional area of stays and staybolts shall be given in Table 4. In determining the net cross-sectional area of drilled or hollow staybolts, the cross-sectional area of the hole shall be deducted.

d The length of the stay between supports shall be measured from the inner faces of the stayed plates. The stresses are based on tension only. For computing stresses in diagonal stays, see Pars. 221 and 222.

TABLE 4. ADD TO TABLE 4 SO THAT IT WILL READ AS ABOVE:

PAGE 55

PAR. 221. REPLACE FIG. 15 BY REVISED CUT.

PAR. 223. CHANGE PAR. 223 TO READ AS FOLLOWS:

223 ***Design of Braces and Brace Connections.*** All rivet and pin holes shall conform to the requirements in Par. 253 and the pins shall be made a neat fit. To determine the sizes that shall be used proceed as follows:

1. Determine the "required cross-sectional area of the brace" by first computing the total load to be carried by the brace, and dividing the total load by the value of allowable stress for unwelded stays given in Table 4.
2. Design the body of the brace so that the cross-sectional area shall be at least equal to the "required cross-sectional area of the brace" for unwelded braces. Where the braces are welded, the cross-sectional area at the weld shall be at least as great as that computed for a stress of 6000 lb. per sq. in. (see Table 4).
3. Make the area of pins to resist double shear at least three-quarters of the "required cross-sectional area of the brace."
4. Make the combined cross-section of the eye at the side of the pin (in crowfoot braces) at least 25 per cent greater than the "required cross-sectional area of the brace."
5. Make the cross-sectional areas through the blades of diagonal braces where attached to the shell of the boiler at least equal to the required rivet section; that is, at least equal to one and one-quarter times the "required cross-sectional area of the brace."
6. Design each branch of a crowfoot to carry two-thirds the total load on the brace.
7. Make the net sectional areas through the sides of the crowfoot, tee irons, or similar fastenings at the rivet holes at least equal to the required rivet section, that is, at least equal to one and one-quarter times the "reqired cross-sectional area of the brace."
8. Make the combined cross-sectional area of the rivets at each end of the brace at least one and one-quarter times the "required cross-sectional area of the brace."

PAGE 58

PAR. 231. CHANGE PAR. 231 TO MAKE IT READ AS FOLLOWS:

231 *Maximum Allowable Working Pressure on Truncated Cones.* *a.* Upper combustion chambers of vertical submerged tubular boilers made in the shape of a frustum of a cone, when not over 38 in. diameter at the large end, may be used without stays if computed by the rule for plain cylindrical furnaces (Par. 239) making D in the formula equal to the diameter at the large end; provided that the longitudinal joint conforms to the requirements of Par. 239.

b. When over 38 in. in diameter at the large end, that portion which is over 30 in. in diameter shall be fully supported by staybolts or gussets to conform to the provisions for staying flat surfaces. In this case the top row of staybolts shall be at a point where the cone top is 30 in. or less in diameter.

In calculating the pressure permissible on the unstayed portion of the cone, the vertical distance between the horizontal planes passing through the centers of the rivets at the cone top, and through the center of the top row of staybolts shall be used as L in Par. 239, and D in that paragraph shall be the inside diameter at the center of the top row of staybolts.

PAGE 60

PAR. 234. UNDER "WHERE" CHANGE DERIVATION OF D TO READ:

D = least horizontal distance between tube centers on a horizontal row, in.

IMMEDIATELY BELOW THE DERIVATION OF LETTERS INSERT:

Where tubes are staggered the vertical distance between the center lines of tubes in adjacent rows must be not less than $\frac{1}{2}\sqrt{2dD + d^2}$

PAGE 61

PAR. 239. CHANGE FIRST SECTION OF PAR. 239 TO READ AS FOLLOWS:

239 *Plain Circular Furnaces.* Unstayed furnaces *more than 18 in. diameter* when riveted or of seamless construction, or such furnaces when lapwelded by the forging process, shall have walls not less than 5/16 in. thick. The maximum allowable working pressure for such furnaces shall be determined by one or the other of the following formulae:

MAKE DEFINITION OF L READ AS FOLLOWS:

L = total length of furnace between centers of head rivet seams (not length of a section), in.

INSERT AFTER THE FORMULA AND JUST PRECEDING THE EXAMPLE IN PAR. 239, THE FOLLOWING, ELIMINATING THE PRESENT SENTENCE:

Where the furnace has a riveted logitudinal joint, it may be of the lap type for inside diameters not exceeding 36 in. for furnaces 36 in. or less in height or length, and for inside diameters not exceeding 30 in., irrespective of the height or length. Otherwise butt and strap construction shall be used. The efficiency of the joint shall be greater than:

$$\frac{P \times D}{1250 \times T}$$

PAGE 64

PAR. 245. CHANGE PAR. 245 TO READ AS FOLLOWS:

245 *Cast-iron and Malleable Iron Headers.* The pressure allowed on a water-tube boiler shall not exceed 160 lb. per sq. in. when the tubes are secured to cast-iron headers, nor 200 lb. when the tubes are secured to malleable iron headers. The form and size of the internal cross section perpendicular to the longer axis of a cast-iron or malleable iron header at any point shall be such that it will fall within a 7 in. by 7 in. rectangle.

PAR. 246. CHANGE NUMBER OF PAR. 246 TO PAR. 246*a* AND CHANGE THE WORD "WITH" IN SECOND LINE TO "TO."

PAR. 247. CHANGE NUMBER OF PAR. 247 TO PAR. 246*b* AND REVISE IT TO READ AS FOLLOWS:

b A cast-iron header when tested to destruction, shall withstand a hydrostatic pressure of at least 1200 lb. per sq. in. and a malleable-iron header, 1500 lb. A hydrostatic test at 400 lb. per sq. in. for cast iron and 500 lb. per sq. in. for malleable iron shall be made on all new headers with tubes attached.

PAR. 247. INSERT A NEW PAR. 247 TO READ AS FOLLOWS:

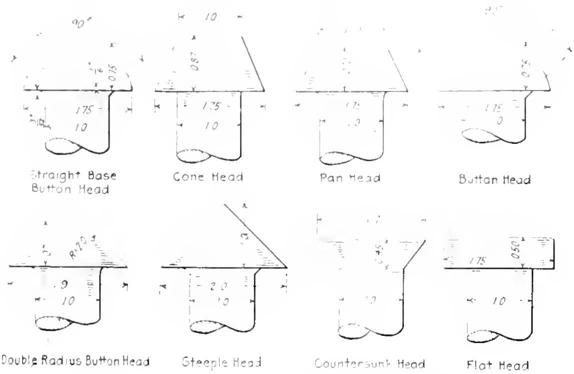
247 Where it is impossible to calculate with a reasonable degree of accuracy the strength of a boiler structure or any part thereof, a full sized sample shall be built by the manufacturer and tested to destruction in the presence of the Boiler Code Committee or one or more representatives of the Boiler Code Committee appointed to witness such test.

PAR. 250. CHANGE PAR. 250 TO READ AS FOLLOWS:

250 A fire-tube boiler shall have the ends of the tubes substantially rolled and beaded, or rolled and welded, at the firebox or combustion chamber end.

PAR. 251. CHANGE PAR. 251 TO READ AS FOLLOWS:

251 The ends of all tubes, suspension tubes and nipples shall be flared not less than $\frac{1}{8}$ in. over the diameter



Proportions may be larger or 1/10 smaller than those shown.
Fillets under heads may be used but are not required.

FIG. 17A ACCEPTABLE FORMS OF RIVET HEADS

of the tube hole on all water-tube boilers and superheaters, or they may be flared not less than $\frac{1}{8}$ in., rolled and beaded, or flared, rolled and welded.

PAGE 65

PAR. 253. CHANGE PAR. 253 TO READ AS FOLLOWS:

253 *Drilling of Holes.* All rivet holes and staybolt holes and holes in braces and lugs shall be drilled full size or they may be punched not to exceed $\frac{1}{4}$ in. less then full diameter for material over 5/16 in. in thickness, and $\frac{1}{8}$ in. less than full diameter for material not exceeding 5/16 in. in thickness, and then drilled or reamed to full diameter. Plates, butt straps, braces, heads and lugs shall be bolted in position for drilling or reaming all rivet holes in boiler plates except those used for the tack bolts required in assembling. Tack bolts for seams shall be not over 12 in. apart.

PAR. 254. CHANGE PAR. 254 TO READ AS FOLLOWS:

254 After drilling or reaming rivet holes the plates and butt straps shall be separated, the burrs and chips removed, the plates and butt straps reassembled metal to metal with barrel pins fitting the holes, and with tack bolts.

PAR. 255. ADD TO PAR. 255 THE FOLLOWING:

Forms of rivet heads that will be acceptable are shown in Fig. 17*a*.

PAR. 256. CHANGE PAR. 256 TO READ AS FOLLOWS:

256 Rivets shall be machine driven wherever possible with sufficient pressure to fill the rivet holes, and shall be allowed to cool and shrink under pressure. Barrel pins fitting the holes and tack bolts shall be used. The tack bolts shall be not over 12 in. apart, and a rivet shall be driven each side of each tack bolt before removing the tack bolt.

PAR. 257. CHANGE PAR. 257 TO READ AS FOLLOWS:

257 *Calking.* The calking edges of plates, butt straps and heads shall be beveled. Every portion of the sheared surfaces of the calking edges of plates, butt straps and heads shall be planed, milled or chipped to a depth of not less than $\frac{1}{8}$ in. calking shall be done with a round-nosed tool.

PAR. 258. CHANGE SIDEHEAD IN PAR. 258 TO READ AS FOLLOWS:

Manholes and Handholes.

ADD TO PAR. 258 THE FOLLOWING:

A handhole opening in a boiler, the greatest dimension of which exceeds 6 in., shall be reinforced in accordance with the rules for manholes.

PARS. 260-261

The Executive Committee of the Boiler Code Committee will report later respecting openings that need not be reinforced and on methods of reinforcing openings that need not come under the same rules as for manholes.

PAGE 67

PAR. 261. CHANGE THE TWO LINES OF PAR. 261 AT THE TOP OF PAGE 67 TO READ AS FOLLOWS:

l = length of center line of opening in shell in direction parallel to axis of shell plus the sum of the diameters of the rivet holes that come in or adjacent to the center line of the opening, in.

PAR. 266. CHANGE PAR. 266 TO READ AS FOLLOWS:

266 A vertical fire-tube boiler, except boilers of steam fire-engines, or boilers 24 in. or less in diameter, shall have not less than seven handholes, located as follows: Three in the shell at or about the line of the crown sheet; one in the shell at or about the water-line or opposite the fusible plug when used; three in the shell at the lower part of the waterleg. A vertical fire-tube boiler, submerged tube type, shall have two or more handholes in the shell, in line with the upper tube sheet. All boilers 24 in. or less in diameter shall have at least one opening for inspection and one opening in addition to the blow-off for washing out the boiler, these openings to be fitted with brass plugs.

PAGE 68

PAR. 268. CHANGE PAR. 268 TO READ AS FOLLOWS:

268 *Threaded Openings.* A pipe connection 1 in. in diameter or over shall have not less than the number of threads given in Table 7.

TABLE

If the thickness of the material in the boiler is not sufficient to give such number of threads, the opening shall be reinforced by a pressed steel, cast steel, or bronze composition flange, or plate, so as to provide the required number of threads.

When the maximum allowable working pressure exceeds 100 lb. per sq. in., a flanged nozzle shall be used for all pipe openings over 3 in. pipe size.

PAR. 269. CHANGE PAR. 269 TO READ AS FOLLOWS:

269 *Safety Valve Requirements.* Each boiler shall have two or more safety valves, except a boiler for which one safety valve having a relieving area of $\frac{1}{2}$ sq. in. or less, is required by the rules.

PAGE 69

PAR. 272. CHANGE PAR. 272 TO READ AS FOLLOWS:

272 Safety valves may be of the direct spring loaded pop type with seat and bearing surface of the disc inclined at any angle between 45 deg. and 90 deg. to the center line of the spindle. The valve shall be rated at a pressure 3 per cent in excess of that at which the valve is set to blow.

The method of computing the relieving area of the safety valves shall be as given in Par. 421 of the Appendix.

Safety valves may be used which give any opening up to the full discharge capacity of the area of the opening at the base of the valve, provided the movement of the valve is gradual so as not to induce lifting of the water in the boiler.

All safety valves shall be so constructed that no detrimental shocks are produced through the operation of the valve. Weighted lever safety valves shall not be used.

Par. 273. Change Par. 273 to read as follows:

273 Each safety valve shall be plainly marked by the manufacturer. The markings may be stamped on the body, cast on the body, or stamped or cast on a plate or plates riveted to the body, and shall contain the following:

a The name or identifying trademark of the manufacturer
b The nominal diameter
c The steam pressure at which it is set to blow
d Blow down, or difference between the opening and closing pressures
e The weight of steam discharged in pounds per hour at a pressure 3 per cent higher than that for which the valve is set to blow
f A.S.M.E. Std.

Par. 274. Change Par. 274 to read as follows:

274 The minimum allowable relieving capacity of the safety valve or valves required on a boiler shall be determined on the basis of 6 lb. of steam per hour per sq. ft. of boiler heating surface for water tube boilers. For all other types of power boilers with pressures above 100 lb., the minimum allowable relieving capacity shall be determined on the basis of 5 lb. of steam per hour per sq. ft. of boiler heating surface, and on the basis of 3 lb. with pressures at or below 100 lb. per sq. in. The heating surface shall be computed for that side of the boiler surface exposed to the products of combustion, exclusive of the superheating surface. In computing the heating surface for this purpose only the tubes, fireboxes, shells, tube sheets and the projected area of headers need be considered. The minimum number of safety valves required shall be determined on the basis of the minimum allowable relieving capacity and the relieving capacity marked on the valves by the manufacturer.

PAGES 70-71-72

Table 8. Transfer Table 8 to the Appendix after Par. 427 and renumber as Table 16.

PAGE 73

Par. 275*a*. Change Par. 275*a* to read as follows:

275 Safety valve capacity may be checked in any one of the three following ways, and if found insufficient, additional capacity shall be provided:

a By making an accumulation test; that is, by shutting off all other steam discharge outlets from the boiler and forcing the fires to the maximum. The safety valve equipment shall be sufficient to prevent an excess pressure beyond that specified in Par. 270.

PAGE 74

Par. 279. Add to the end of Par. 279 the following:

Where discharge pipes are used, the cross-sectional area at any point shall be at least equal to the combined areas of the discharge outlets of the valves discharging therethrough. Ample drainage shall be provided at or near each safety valve and where the water of condensation may collect.

Par. 282. Change Par. 282 to read as follows:

282 To insure the valve being free, each safety valve shall have a substantial lifting device by which the valve may be raised from its seat at least 1-16 in. when there is no pressure on the boiler.

Par. 283. Add to Par. 283 the following:

The seats and discs of safety valves shall be of non-ferrous material. The seat of a safety valve shall be fastened to the body of the valve in such a way that there is no possibility of the seat lifting.

Par. 284. Change Par. 284 to read as follows:

284 Springs used in safety valves shall not show a permanent set exceeding 1-16 in. ten minutes after being released from a cold compression test closing the spring solid. The spring shall be so constructed that the valve can lift from its seat at least 1-10 the diameter of the seat before the coils are closed or before there is other interference.

Par. 286. Change Par. 286 to read as follows:

286 The dimensions of flanges subjected to boiler pressue shall conform to the American Standard given in Tables 15 and 16 of the Appendix for the pressures therein specified, except that the face of the safety valve flange and the nozzle to which it is attached may be flat and without the raised face for pressures up to and including 250 lb. per sq. in. For higher pressures, the raised face shall be used.

Par. 287. Change Par. 287 to read as follows:

287 When the valve body is marked with the letters A.S.M.E. Std. as required by Par. 273, this shall be a guarantee by the manufacturer that the valve conforms to the details of construction herein specified.

Par. 288. Change Par. 288 to read as follows:

288 Every superheater shall have one or more safety valves near the outlet. The discharge capacity of the safety valve or valves on an attached superheater may be included in determining the number and size of the safety valves for the boiler, provided there are no intervening valves between the superheater safety valve and the boiler, and provided the discharge capacity of the safety valve or valves on the boiler, as distinct from the superheater, is at least 75 per cent. of the total valve capacity required.

PAGE 75

Par. 290. Change Par. 290 to read as follows:

290 Every boiler shall have proper outlet connections for the required safety valve or valves, independent of any other outside steam connection, the area of opening to be at least equal to the aggregate nominal area of all of the safety valves to be attached thereto.

An internal collecting pipe, splash plate or pan may be used, provided the total area for inlet of steam thereto is not less than one and one-half times the aggregate area of the attached safety valves. The holes in collecting pipes shall be at least 1/4-in. in diameter and the least dimension in any other form of opening for inlet of steam shall be 1/4-in.

Par. 291. Change Par. 291 to read as follows:

291 *Water Gage Glasses and Gage Cocks.* Each boiler shall have at least one water gage glass, the lowest visible part of which shall be not less than 2 in. above the lowest permissible water level. The lowest permissible water level for various classes of boilers shall be the location for the fusible plug as given in Par. 430 of the Appendix.

Par. 292. Change Par. 292 to read as follows:

292 No water glass connection shall be fitted with an automatic shut-off valve, except when the automatic shut-off valves are so constructed that the two connections to the water glass can be blown through separately and the steam connection cannot be entirely closed thereby. Where automatic water gages are applied they shall conform to the following requirements:

1. Check valves in upper and lower fittings must be of the non-ferrous ball type to avoid corrosion and the necessity for guides.

2. Ball check valves in upper and lower fittings must open by gravity, and the lower ball check valve must rise vertically to its seat.

3. The ball checks must not be smaller than 1/2-in. diameter, and the diameter of the circle of contact with

the seat must not be greater than $^2/_3$ of the diameter of the ball check valve. The annulus around the ball must not be less than $^1/_8$-in., and the travel movement from the normal resting place to the seat must not be less than $^1/_4$ in. The balls must be accessible for inspection.

4. The chambers in upper and lower fittings through which the balls pass on the way to their respective seats must be either square or hexagonal in shape.

5. The ball seat in the upper fitting must be a flat seat with either a square or hexagonal opening so that the stream passage can never be completely closed by this valve.

6. The shut-off valve in the upper fitting must have a projection which holds the ball at least $^1/_4$-in. away from its seat when the shut-off valve is closed.

7. The lower fitting must be provided with a positive means of rotating the ball. Means must also be provided for removal and inspection of lower ball check valve, while the boiler is under steam pressure.

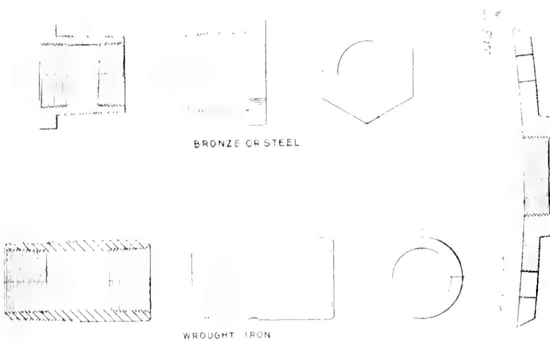


Fig. 18a Types of Boiler Flanges and Bushings

Par. 296. Add to the end of Par. 296 the following:

Where the use of a long pipe becomes necessary, a shut off valve or cock arranged so that it can be locked or sealed open may be used near the boiler. Such a pipe shall be of ample size and arranged so that it may be cleared by blowing out. Each boiler shall be provided with a $^1/_4$ in. pipe size valved connection for exclusive purpose of attaching a test gage.

PAGE 76

Par. 299. Change Par. 299 to read as follows:

299 *Nozzles and Fittings.* Flanged cast iron pipe fittings used for boiler parts, for pressures up to and including 160 lb. per sq. in., shall conform to the American Standard given in Tables 15 and 16 of the Appendix, except that the face of the flange of a safety valve as well as that of a safety valve nozzle, may be flat and without the raised face. For pressures above 160 lb. per sq. in., cast iron shall not be used for boiler pressure parts with exceptions specified in Pars. 9, 12 and 215. An allowable variation of 20 per cent from the flange thickness required by Tables 15 and 16 may be made for steel cast and forged steel fittings, leaving the drilling of bolt holes unchanged. For pressures above 250 lb. per sq. in., the flange thickness and the thickness of the bodies shall be increased to keep within the same deflection limits and to give at least the same factor of safety as the fittings specified in Tables 15 and 16. The flange of a safety valve may have a flat face for pressures up to and including 250 lb. per sq. in., and shall have a raised face at higher pressures; a safety valve nozzle may have a flat face for pressures up to and including 250 lb. per sq. in. and shall have a raised face at higher pressures. Tables 15 and 16 do not apply to flanges on the boiler side of steam nozzles or to flanges left by the manufacturer as part of the boiler, and do not apply to fittings designed as part of the boiler.

Par. 307. Change Par. 307 to read as follows:

307 *Blow-off Piping.* A surface blow-off shall not exceed $1^1/_2$ in. pipe size and the internal and external pipes, when used, shall form a continuous passage, but with clearance between their ends and arranged so that the removal of either will not disturb the other. A properly designed brass or steel bushing as shown in Fig. 18a or flanged connection, shall be used.

PAGE 77

Par. 311. Change Par. 311 to read as follows:

311 *a* On all boilers except those used for traction and portable purposes, when the maximum allowable working pressure exceeds 125 lb. per sq. in., each bottom blow-off pipe shall have two valves, or a valve and a cock, and such valves, or valve and cock, shall be extra heavy, except that on a boiler having multiple blow-off pipes, a single master valve may be placed on the common blow-off pipe from the boiler, in which case only one valve on each individual blow-off is required.

b All traction and portable boilers shall have a bottom blow-off valve; when the maximum allowable working pressure exceeds 125 lb. per sq. in., the blow-off valve shall be extra heavy.

Par. 314 Omit the last sentence so that Par. 314 reads as follows:

314 *Feed Piping.* The feed pipe of a boiler shall have an open end or ends inside of the boiler.

Par. 315. Change the last sentence of Par. 315 to read as follows:

The feed pipe shall be carried through the head or shell near the front end in the manner specified for a surface blow-off in Par. 307, and be securely fastened inside the shell above the tubes.

Add to Par. 315 the following:

In Fig. 18a is illustrated a standard form of flange for use on boiler shells for passing through piping such as feed, surface, blow-off connections, etc., and which permits of the pipes being screwed in solid from both sides in addition to the reinforcing of the opening in the shells.

In other types of boilers where both internal and external pipes making a continuous passage are employed, the boiler bushing or its equivalent shall be used.

Par. 317 Add to Par. 317 the following:

Wherever globe valves are used on feed piping, the inlet shall be under the disc of the valve.

PAGE 79

Par. 325. Change Par. 325 to read as follows:

325 Lugs or brackets, when used to support a boiler of any type, shall be properly fitted to the surfaces to which they are attached. The shearing and crushing stresses on the rivets used for attaching the lugs or brackets shall not exceed 8 per cent of the strength given in Pars. 15 and 16. For traction or portable boilers, studs with pipe threads may be used.

Par. 328. Change Par. 328 to read as follows:

328 A water-tube boiler shall have the firing doors, furnace inspection doors and clinker doors of the inward opening type, unless such doors are provided with substantial and effective latching or fastening devices to prevent them from being blown open by pressure on the furnace side.

PAR. 332. CHANGE PAR. 332 TO READ AS FOLLOWS:

332 After obtaining the stamp to be used when boilers are to be constructed to conform with the A.S.M.E. Boiler Code, it is understood that a state inspector, municipal inspector, or an inspector employed regularly by an insurance company which is authorized to do a boiler insurance business in the state in which the boiler is built and in the state in which it is to be used, is to be notified that an inspection is to be made and shall inspect such boilers during construction and after completion. At least two inspections shall be made, one before reaming rivet holes and one at the hydrostatic test. In stamping the boiler after completion, if built in compliance with the Code, the builder shall stamp the boiler in the presence of the inspector, after the hydrostatic test, with the A.S.M.E. Code stamp, the builder's name and the serial number of the manufacturer. A data sheet shall be filled out and signed by the manufacturer and the inspector. This data sheet together with the stamp on the boiler shall denote that it was constructed in accordance with the A.S.M.E. Boiler Code.

The name of the state in which the boiler is built shall be stamped under and about one-half inch below the symbol. The name or initials of the manufacturer shall be stamped below the name of the state, together with the serial number of the boiler, and not over one-half inch therefrom. (Samples of data sheets appear in the APPENDIX, after page 120.)

Stamps for the official symbol shown in Fig. 19 are obtainable from THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

PAGE 80

REVISE FIG. 20 TO READ AS FOLLOWS:

(Name of State)
..................STD
(Manufacturer's number of boiler)
.....................1
(Name and location of builder)
(Installation No.) (Name of State)
.....................1
(Year put into service)
....

PAGE 81

HEADING. MAKE HEADING OF P. 81 READ AS FOLLOWS:

A.S.M.E. Boiler Code

PART I—SECTION II

BOILERS USED EXCLUSIVELY FOR LOW PRESSURE STEAM AND HOT WATER HEATING AND BOILERS FOR HOT WATER SUPPLY[1]

PAR. 335. CHANGE CENTER HEAD ABOVE.

PAR. 335 FROM "BOILER MATERIALS" TO "GENERAL."

PAR. 336. INSERT ABOVE PAR. 336 THE FOLLOWING CENTER HEAD: "MATERIALS."

PAR. 339. CHANGE PAR. 339 TO READ AS FOLLOWS:

339 A boiler to be used exclusively for low pressure steam heating may be constructed either of cast iron, steel cast, or wrought iron or steel, or any combination of these, but in all cases the connecting rods and bolts shall be wrought iron or steel.

PAGE 82

PAR. 343. REVISE THE WORDING OF PAR. 343 AS FOLLOWS, AND ARRANGE IT AS A SINGLE PARAGRAPH:

343 In a *hot-water* boiler to be used exclusively for heating buildings or hot-water supply, when the diameter does not exceed 60 in. and the grate area does not exceed 10 sq. ft., or equivalent as defined in Pars. 359 and 360, longitudinal lap joints will be allowed. When the grate area exceeds 10 sq. ft., or equivalent as defined in Pars. 359 and 360, and the diameter of the boiler does not exceed 60 in., longitudinal lap joints will be allowed provided the maximum allowable working pressure does not exceed 50 lb. per sq. in.

[1] Domestic kitchen range boilers and their water backs, furnace heating coils and their appurtenances and domestic coil or pipe, gas or oil heaters, are not included under this Section.

PAR. 345. CHANGE PAR. 345 TO READ AS FOLLOWS:

345 A boiler used for low pressure steam heating or for hot water supply shall be provided with washout holes for the removal of any sediment that may accumulate therein. Steel shell boilers of the locomotive or vertical fire-tube type shall conform to the requirements of Pars. 265 and 266 for washout holes.

PAR. 347. IN FOURTH LINE OMIT THE FOLLOWING WORDS:

"Or any internal pipe in the boiler."

PAR. 354. CHANGE PAR. 354 TO READ AS FOLLOWS:

354*a*. No shut-off of any description shall be placed between the safety or water relief valves and boilers, nor on discharge pipes between them and the atmosphere.

b. No boiler for hot water supply shall be connected to a water supply pipe fitted with a check valve or pressure reducing valve.

PAGE 84

TABLE 9. TITLE OF TABLE 9 TO BE CHANGED TO READ AS FOLLOWS:

Allowable Sizes of Safety Valves for Steam Heating Boilers, of Water Relief Valves for Water Heating Boilers, and of Hot Water Supply Boilers.

PAR. 356. CHANGE PAR. 356 TO READ AS FOLLOWS:

356 Each safety valve used on a *steam* heating boiler shall have a substantial lifting device by which the valve may be raised from its seat at least 1/16 in. when there is no pressure on the boiler.

PAGE 85

PAR. 359. INSERT THE FOLLOWING CENTER HEAD ABOVE PAR. 359:

GRATE AREA

PAR. 359. CHANGE PAR. 359 TO READ AS FOLLOWS:

359 *Double Grate Down Draft Boilers.* In boilers of this type the grate area shall be taken as one and one-quarter times the area of the larger grate.

PAR. 361. CHANGE PAR. 361 TO READ AS FOLLOWS:

361 *Steam Gages.* Each *steam* boiler shall have a steam gage connected to the steam space or to the water column, or its steam connection, by means of a syphon or equivalent device of sufficient capacity to keep the gage tube filled with water and so arranged that the gage cannot be shut off from the boiler except by a cock placed near the gage and provided with a tee or lever handle, arranged to be parallel with the pipe in which it is located when the cock is open. Connections to gages shall be of brass, copper or bronze composition. The dial of a steam gage for a *steam* heating boiler shall be graduated to not less than 30 lb.

PAGE 86

PAR. 363. ADD TO PAR. 363 THE FOLLOWING:

Temperature Regulator. A temperature regulator shall be applied to *hot water* supply boilers which will prevent the water temperature from rising above 200 deg. fahr.

PAR. 365. CHANGE PAR. 365 TO READ AS FOLLOWS:

365 *Damper Regulators.* When a pressure damper regulator is used, it shall be connected to the steam space of the boiler.

PAGE 87

Par. 373. Change Par. 373 to read as follows:

373 *Hot-water* boilers for a maximum allowable working pressure not exceeding 30 lb. per sq. in., used exclusively for heating buildings or for hot-water supply, when constructed of cast iron, steel cast, or wrought iron or plate steel or any combination of these, shall be subjected to a shop test of 60 lb. per sq. in. hydrostatic pressure applied to the boiler or the section thereof.

Par. 374. Change Par. 374 to read as follows

374 A maximum allowable working pressure in excess of 30 lb. per sq. in. will be allowed on a hot-water boiler constructed of cast iron, steel cast, or wrought iron or plate steel or any combination of these, used exclusively for heating buildings or for hot-water supply, provided such boilers or their sections have been subjected to a shop hydrostatic test of two and one-half times the actual working pressure

Par. 377. Change Par. 377 to read as follows:

377 *Name.* All boilers referred to in this section shall be plainly and permanently marked with the manufacturer's name and the maximum allowable working pressure.

All heating boilers built according to these rules may be marked A.S.M.E. standard.

PAGE 89

Heading. Insert above heading of p. 89 the following:

A.S.M.E. Boiler Code

PAGE 90

Par. 384. Change Par. 384 to read as follows:

384 The shell or drum of a boiler in which a typical "lap seam crack" is discovered along a longitudinal riveted joint for either butt seam or lap joints shall be permanently discontinued for use under steam pressure. By "lap seam crack" is meant the typical crack frequently found in lap seams extending parallel to the longitudinal joint and located either between or adjacent to rivet holes.

PAGE 91

Par. 391*a*. Change Par. 391*a* to read as follows:

a By making an accumulation test, that is, by shutting off all other steam discharge outlets from the boiler and forcing the fires to the maximum. The safety valve equipment shall be sufficient to prevent an excess pressure beyond that specified in Par. 270.

Par. 392. Change Par. 392 to read as follows.

392 In case either of the methods outlined in sections *b* or *c* of Par. 391 is employed, the safety valve capacities shall be those given in Table 16.

PAGE 95—APPENDIX

Heading. Insert above heading of Page 95 the following:

A.S.M.E. Boiler Code

PAGE 93

Par. 402. Change Par. 402 to read as follows:

402 When the maximum allowable working pressure exceeds 125 lb. per sq. in., the blow-off pipe shall be extra heavy from boiler to valve or valves, and shall run full size without reducers or bushings. All fittings between the boiler and valve shall be steel or extra heavy fittings of bronze, brass, malleable iron or cast-iron. In case of replacement of pipe or fittings in the blow-off lines, as specified in this paragraph, they shall be installed in accordance with the rules for new installations. (See Pars. 307-313.)

Par. 403. Add to Par. 403 the following:

In case of replacement of pipe or fittings in the blow-off lines as specified in this paragraph, they shall be installed in accordance with the rules for new installations. (See Pars. 307-313.)

Par. 408. Change Par. 408 to Par. 408*a*.

Par. 409. Change Par. 409 to Par. 408*b* and insert a new Par. 409 as follows:

Where repairs are necessary which in any way affect the working pressure or safety of a boiler, a state inspector, municipal inspector, or an inspector employed regularly by an insurance company which is authorized to do a boiler insurance business in the state in which the boiler is used, shall be called for consultation and advice as to the best method of making such repairs; after such repairs are made they shall be subject to the approval of a state inspector, municipal inspector, or an inspector regularly employed by an insurance company which is authorized to do a boiler insurance business in the state in which the boiler is used.

PAGE 95

Heading. Insert above heading of p. 95 A.S.M.E. boiler code.

PAGE 103

Par. 417

Change first sentence of Par. 417 to read as follows:

417 Figs. 28 and 29 illustrate other joints that may be used in which eccentric stresses are avoided.

PAGE 107

Par. 421. Change Par. 421 to read as follows:

421 *Method of Computing Discharge Capacity.* The required discharge capacity of a safety valve or valves for a boiler may be based either on the heat units in the fuel consumed or on the amount of steam generated.

The number of heat units that each safety valve will handle, for valves of the ordinary types in which the discharge capacity is proportioned to the lift, may be obtained as follows:

$U = 161{,}000 \times P \times D \times L$ for Bevel Seats at 45 deg.
$U = 227{,}500 \times P \times D \times L$ for Flat Seats
$U = 72{,}500 \times P \times A$ for seats of any angle

The amount of steam that a valve will discharge may be found as follows:

$W = 110 \times P \times D \times L$ for Bevel Seats at 45 deg.
$W = 155 \times P \times D \times L$ for Flat Seats
$W = 50 \times P \times A$ for seats of any angle

where

U = Number of heat units per hour that a safety valve will handle, B.t.u.
W = Quantity of steam that a safety valve will handle per hour, lb.
P = Absolute boiler pressure = gage pressure + 14.7 lb. per sq. in.
D = Inside diameter of valve seat, in.
L = Vertical lift of valve disc, measured with 3 per cent excess pressure, in.
A = Relieving area in sq. in. = $3.1416 \times D \times L \times$ sine of seat angle.

Par. 422. Change Par. 422 to read as follows:

422 The maximum quantity of fuel C that can be burned per hour at the time of maximum forcing is determined by a test. The maximum number of heat units per hour, or $C \times H$ is then determined, using the values of H given in Par. 427. The weight of steam generated per hour is found by the formula:

$$W = \frac{C \times H \times 0.75}{1{,}100}$$

The sum of the safety valve capacities marked on the valves shall be equal to or greater than W.

PAGE 108

PAR. 423. REPLACE MATTER AFTER STATEMENT OF EXAMPLE BY THE FOLLOWING:

$$C \times H = 2150 \times 12{,}100 = 26{,}015{,}000$$
$$W = C \times H \times 0.75 \div 1100 = 17{,}740$$

A $3\frac{1}{2}$ in. bevel seated valve with 0.11 in. lift would discharge in heat units

$$U = 161{,}000 \times 239.7 \times 3\tfrac{1}{2} \times 0.11$$
$$= 14{,}858{,}000$$

and in weight of steam

$$W = 110 \times 239.7 \times 3\tfrac{1}{2} \times 0.11$$
$$= 10{,}150$$

From which it can be seen that either method indicates that two such valves will give the proper relieving capacity.

PAR. 424. REPLACE MATTER AFTER STATEMENT OF EXAMPLE BY THE FOLLOWING:

$$C \times H = 2000 \times 6400 = 12{,}800{,}000$$
$$W = C \times H \times 0.75 \div 1100 = 8730$$

A bevel seated $3\frac{1}{2}$ in. valve is marked by the manufacturer 0.11 in. lift and discharge capacity for 100 lb. pressure = 4840 lb.; hence two such valves would be required.

ALSO CHANGE HEADINGS IN TABLES FOLLOWING THIS SENTENCE TO READ AS FOLLOWS:

H = B.t.u. per lb.
and H = B.t.u. per cu. ft.

PAGE 111

TABLE 16

TABLE 16. THIS TABLE TO BE RENUMBERED. IN THE NOTES UNDER TABLE 16 ADD AFTER THE LAST SENTENCE THE FOLLOWING:

All extra heavy fittings and flanges to have a raised surface of 1/16 in. high inside of bolt holes for gaskets.

PAGE 113—APPENDIX

PAR. 428. ADD AT THE END OF PAR. 428:

and shall be renewed at least once each year.

PAR. 430. ADD THE FOLLOWING CLAUSE TO THE END OF PAR. 430:

r Fire Engine Boilers are not usually supplied with

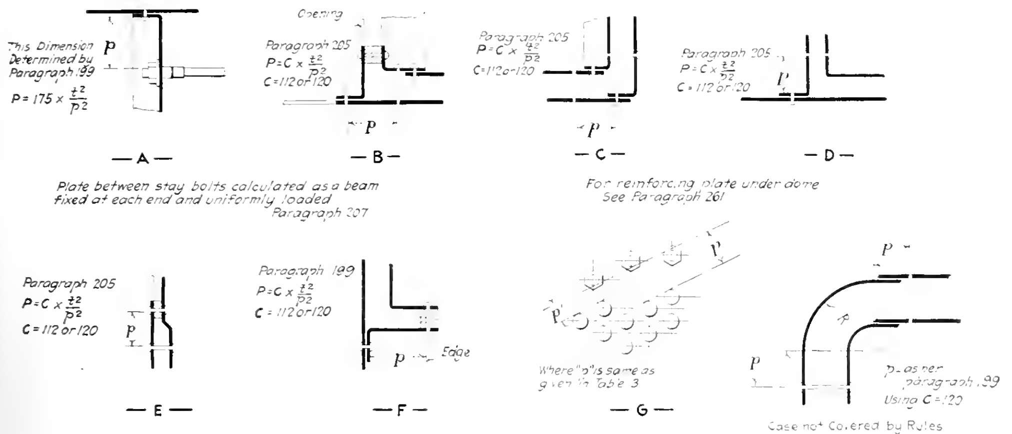


FIG. 31 DETAILS SHOWING APPLICATION OF PARS. 205, 206 AND 207 TO THE STAYING OF WET-BOTTOM BOILERS

PAR. 425. REPLACE MATTER AFTER STATEMENT OF EXAMPLE BY THE FOLLOWING:

$$C \times H = 1000 \times 18{,}500 = 18{,}500{,}000$$
$$W = C \times H \times 0.75 \div 1100 = 12{,}620$$

A bevel seated $2\frac{1}{2}$ in. valve is marked by the manufacturer 0.08 in. lift and discharge capacity for 275 lb. pressure = 6350 lb., hence two such valves would be required.

PAR. 426. REPLACE MATTER AFTER STATEMENT OF EXAMPLE BY THE FOLLOWING:

$$C \times H = 3000 \times 960 = 2{,}880{,}000$$
$$W = C \times H \times 0.75 \div 1100 = 1960$$

A bevel seated 2 in. valve is marked by the manufacturer 0.07 in. lift and discharge capacity for 150 lb. pressure = 2500 lb., hence one such valve would be required.

PAGE 109

PAR. 427. CHANGE FIRST SENTENCE OF PAR. 427 TO READ AS FOLLOWS:

427 For the purpose of checking the safety valve capacity as described in Par. 422, the following values of heats of combustion of various fuels may be used.

fusible plugs. Unless special provision is made to keep the water above the firebox crown sheet other than by the natural water level, the lowest permissible water level shall be at least 3 in. above the top of the firebox crown sheet.

Under Table 3 reference is made to Fig. 31 showing application of Pars. 205, 206 and 207.

RECOMMENDATIONS FOR REPAIRS WHEN MADE BY WELDING AND REINFORCING BY THE ELECTRIC, OXY-ACETYLENE, OR OTHER PROCESSES

From General Rules and Regulations Prescribed by the Board of Supervising Inspectors, U. S. Steamboat-Inspection Service

"All calking edges on internally fired boilers may be reinforced by these processes.

"Calking edges of the shells of externally fired boilers, above the fire line only, may be reinforced.

"Cracks extending from edge of lap to rivet, except on seams below the fire line in externally fired boilers, may be welded.

"Cracks not exceeding 30 inches in length in back connec-

MANUFACTURERS' DATA REPORT OF BOILER
As Required by the Provisions of the A.S.M.E. Rules

1. Boiler manufactured by .... at...............
2. Boiler manufactured for .... of...............
3. Type of boiler **LOCOMOTIVE** and other Internally-Fired Boilers. STATIONARY......... BOTTOM.....
(State if wet bottom or open bottom.)
SERIAL NO..........

(Other forms to be used for HORIZONTAL RETURN TUBULAR and other Externally-Fired and Water Tube Boilers.)

4. Shell plates and butt straps made by...
5. (*a.*) Mill test report on shell plates:..Yield point....................
(Tensile strength. Lb. per sq. in.) (Lb. per sq. in.)
(*b.*) Elongation..........%. Phos....0..........%. Sul....0...........%. Man....0....to 0............%
(In 8 inches.)
6. Mill test report on butt straps.. Thickness..........in.
(Brand and tensile strength.)
7. Stamps on shell plates.. Thickness..........in.
(Brand and tensile strength.)
8. Furnace sheets made by.................... Stamped.. Thickness..........in.
(Brand and tensile strength.)
9. Heads made by.......................Stamped.. Thickness..........in.
(Brand and tensile strength.)
10. Rivets made by.. Material....................
11. Stays made by.. Material....................
12. Channel or angle irons on heads..Upper tubes to shell.........in.
(No. and size on each head.)
13. (*a.*) Stays above tubes...
[No. each head, and type (through, head to head, or diagonal, welded or weldless) and net cross-sectional area of each size of each type.]
(*b.*) ....Area to be stayed................sq. in.
(Each head above tubes.)
(*c.*) Stays below tubes...
[No. each head, and type (through, head to head, or diagonal, welded or weldless) and net cross-sectional area of each size of each type.]
(*d.*) ....Area to be stayed................sq. in.
(Each head below tubes.)
14. (*a.*) Stay bolts:—Made by.......................... Material.............................Size..........sq. in.
(Area at bottom of thread.)
(*b.*) Maximum pitch of.................in.×................in.
[Circumferential (or Horizontal) X Vertical.]
15. **Shell:—Diam**...............in. Length over all..............ft...............in. No. of courses...........
(Inside of outside course.)
16. (*a.*) Longitudinal joints:—Type of.. Riveting........................
(Double, triple, quad., etc.)
Diam. rivet holes..........in. Pitch of rivets.........."×........."×........." Efficiency of joint.......%
(Minimum pitch on each row.)
(*b.*) Circumferential joints:—Type of.. Riveting........................
Diam. rivet holes..........in. Pitch of rivets.........."×........."×........." Efficiency of joint.......%
(Minimum pitch on each row.)
17. Tubes—No.......Gage......... Diam.............in. Length................ft................in.
18. Steam outlets:—No.......... Material of nozzle or reinforcement......................... Sizes..........in.
(Cast steel or cast-iron, pressed steel or steel plate.)
19. Grate area................sq. ft.
20. Size of feed connection............in. Size of bottom blow-off connection............in.
21. Constructed for a max. allow. work. pressure of............lb. per sq. in. Tested to.............lb. per sq. in.
(Hydrostatic pressure.)
22. If boiler has a dome, send working drawing of dome, also showing connection to boiler and openings in shell under dome.

REMARKS:—...
....

We certify the above data to be correct and that all details of **MATERIAL, CONSTRUCTION and WORKMANSHIP** on this boiler conform to the A.S.M.E. Rules.

(Signed)...
(Manufacturer.)
..............................19 by...............................

Received........................19 Checked.......................19 by........................
Authorized State or Insurance Inspector.
Rules allow a max. allow. work. pressure of..........lb. per sq. in., this being based on............................

Fig. 32 Front Side of Data Sheet Form

CERTIFICATE OF BOILER SHOP INSPECTION

Insurance Company's Serial Number...
BOILER WORKS OF....................................... at.......................................
I, the undersigned, holding a certificate of competency as an inspector of steam boilers in THE STATE OF......................., and employed by the...
of...................., inspected internally and externally, the boiler specified in this report, on....................
.....................19 , and certify that the statements made on this report are correct, corresponding with the mill test reports of material as furnished by the builders, and measurements made of the boiler when completed; and that this boiler is constructed in accordance with the A.S.M.E. Rules.

....
Inspector of Boilers for State or Boiler Insurance Company.

Fig. 33 Rear Side of Data Sheet Form

tion sheets, wrapper sheets, bottoms of combustion chambers, heads, and other stayed surfaces may be repaired by welding.

"Where cracks are repaired by welding, holes shall be drilled entirely through the plate at each extreme end of the crack, except in small cracks from rivet to calking edge.

"Circumferential or lengthwise cracks not exceeding 16 inches in length in plain or corrugated furnaces may be welded.

"Where plates in back sheets of back connections, wrapper sheets of sides and bottoms of back connections of any boilers, side sheets and legs of furnaces and bottoms of furnaces of fire-box boilers, and other stayed surfaces are reduced in thickness not exceeding 40 per cent of the original thickness, they may be reinforced, such reinforcing not to exceed an area of 200 square inches in any one plate.

"When such reinforcing extends over stays and braces, such stays and braces shall come completely through the reinforcing so as to be plainly visible to the inspectors.

"When the corroded portion of stayed or riveted surfaces of the back sheets or wrapper sheets or bottoms of back connections of any boilers, or side sheets and bottom sheets of furnaces or legs of fire-box boilers exceeds 300 square inches, the same may be repaired by the removal of the corroded portion and the replacement thereof by a new piece of plate, the edges of the new plate being welded in position.

"Staybolts, braces, or rivets shall pass through the body of the new plate as before, the area of the new piece not to exceed 24 inches by 24 inches, or 30 inches, in any one direction, the welded edges to be V'd or beveled along the joint prior to welding.

"Where plates of shells and other parts of internally fired boilers subject to tensile strain are reduced in thickness by corrosion not to exceed 25 per cent of the original thickness, they may be reinforced, such reinforcing not to exceed an area of 200 square inches.

"Where calking edges and laps have been reinforced, local inspectors shall require the rivets to be cut out and redriven if they find by inspection that it is necessary.

"No welding shall be allowed in cracks in the shell plates or other plates subject to tensile strain.

"Cracks extending through rivet holes in single-riveted or double-riveted seams in stayed surfaces of back connections of any boilers or side sheets of legs or bottoms of fire-box boilers which are stayed surfaces may be welded up to a length of 6 feet exclusive of rivet holes.

"Where cracks extend through rivet holes in stayed surfaces, the piece extending from the rivet to the edge of the lap may be removed where convenient to do so, and the place where the piece has been removed may be replaced by being built up and reinforced by either of these processes.

"Where leaks develop around staybolts and the staybolts are otherwise intact, the nuts may be removed from the ends of the staybolts, and the staybolts may be welded into the shell by welding a beveled collar or ring aroung the staybolt. The width and depth of such collar shall equal one-half of the diameter of the staybolt. In all such cases of applying welding rings or collars around staybolts, the material shall be hammered while in a glowing state as it is applied.

"In all cases where metal is deposited on stayed surfaces, the operator shall hammer, when practicable, the deposited metal while it is in a glowing state.

. . . .

"Cracks in wrought-iron or wrought-steel headers, and cracks or sand holes in cast-steel, semisteel, ferrosteel, malleable-iron or cast-iron headers, manifolds, crosses, tees, and ells may be repaired by welding cracks or flowing metal into sand holes. Such repaired material other than headers and manifolds shall be subjected to a hydrostatic test of three and one-half times the working pressure after such repairs are made. Reinforcing by building up of any of the above-mentioned articles other than headers shall not be allowed.

"When crown-bar bolts have deteriorated or wasted away at top of combustion chamber under the crown bars, such deterioration not to exceed 25 per cent of the original diameter of the bolt, such bolts may be built up or reinforced by any process of autogenous welding.

"Where tube sheets of boilers have deteriorated not to exceed 25 per cent of their original thickness, or where cracks have developed in tube sheets, the same may be reinforced and repaired by any process of autogenous welding, and the beading on the end of tubes may be welded to the tube sheets by the same process."

CORRESPONDENCE

Contributions to the Correspondence Departments of The Journal by members of The American Society of Mechanical Engineers are solicited by the Publication Committee. Contributions particularly welcomed are suggestions on Society Affairs, discussions of papers published in The Journal, or brief articles of current interest to mechanical engineers.

The Logic of Inspection

To the Editor:

Referring to the paper on The Logic of Inspection, presented by Mr. A. L. De Leeuw at the Annual Meeting, I would say there are very few, if there are any, engineers who do not believe that inspection is the logical and final operation on any manufactured product. The question is, What relation should inspection have to the various machining operations; what form and type of gages should be used; and what manufacturing tolerances are to be permitted?

We will take a concrete example. Suppose it is necessary to manufacture a 3-in. American high-explosive shell. The conditions regarding the manufacture of this product are very clearly set forth in the Government specifications, and tolerances have also been established by the Ordnance Department. A complete outline of the proper methods of manufacture has also been given. The question for the manufacturer to decide is how he can best adapt his own equipment to the production of this particular product, what gages are necessary, and what are the most particular requirements which must be met.

It might be stated that the requirements for a high-explosive shell comprise several points, the more important ones being that the bore must be concentric with the external circumference within very definite limits, the shell prior to loading must be of a certain weight within definite limits, and the shape must conform to Government specifications.

Now, regarding the shape of a high-explosive shell, it might be stated that in order for it to follow the predetermined parabolic curve, the center of gravity of the shell must be in the right place. It is therefore evident that the shape of the shell must be such as to keep it in proper balance when in flight. The only parts of the shell that bear in the bore of the gun are that portion near the base of the ogive, and the rotating band. All other portions of the shell are free and do not contact with the bore. Hence, here are two points which must receive careful attention.

Regarding concentricity, as far as I know, no tolerances are given for this in the original U. S. specifications. The only complete specifications regarding tolerances and location of the center of gravity are the French, and they hold this one point to be more particular than any other. A shell which is not concentric, or, in other words, is out of balance, will not shoot accurately, and a shell in which the center of gravity is so placed

that it does not follow a predetermined curve will not shoot accurately. These questions which have to do with design are beyond the scope of the mechanical engineer and are up to the ballistic expert. The manufacturer, however, must meet the specifications as set down by these ballistic experts.

As an instance to show the importance of weight, it might be stated that when certain Canadian plants started to manufacture shells for the British Government they experienced great difficulty at first in producing shells which would pass the inspectors, owing to a misunderstanding regarding the requirements that had to be met. The shells were made within the desired tolerances for size as called for by the government specifications, but the weight of these shells was overlooked, and hence a large majority were rejected by the inspectors because of being short on the point of weight. It was found that when a shell was made to the minimum limits for diameter and length, it was below the minimum weight, and hence could not be accepted. Experience soon demonstrated to the Canadian manufacturers that the weight of the shell was just as important as any of the other requirements, and as a natural outcome of the difficulty, the shells were made to the tolerances called for by the government specifications, leaving the rear end of the shell longer than necessary. After the shell was completely machined, the base end was faced off until the desired weight was obtained. Points such as this proved to be of valuable assistance to the Canadian manufacturers in enabling them to meet their contracts.

While it is not my endeavor to discuss the subject fully, it is advisable, however, to state that gaging of the shell is no doubt the one operation that requires the most careful attention. Gages have been designed for shells that were not directly adapted to the work required of them, with the result that much work has been spoiled. One of the fundamental points regarding gaging is that the work should be located in the gage from the same point that it is located from when being machined, otherwise tolerances on the product cannot be set with any degree of certainty, and it is impossible to obtain interchangeable manufacture.

A point in connection with the paper presented by Mr. De Leeuw which was out of place, was his reference to the specification dealing with leather belting. This specification had nothing whatsoever to do with the inspection of leather belting, but what it did set forth was the process by which leather belting could be made in order to meet Government specifications, and as such would be of valuable assistance to any manufacturer engaged in this work who had not previously engaged in this particular line of manufacture.

The American Society of Mechanical Engineers can surely be of great assistance to our Government, but in order to do so it is necessary to get down to concrete cases rather than be satisfied with generalities. It is to be hoped that future papers presented before the Machine Shop Section of the A. S. M. E. will contain concrete and definite information on this interesting and important subject.

DOUGLAS T. HAMILTON.

Brooklyn, N. Y.

TO THE EDITOR:

In the first paragraph of his letter Mr. Douglas T. Hamilton says: "The question is, What relation should inspection have to the various machining operations; what form and type of gages should be used, and what manufacturing tolerances are to be permitted?" I fully realize that it was entirely out of the scope of the desired discussion to answer such questions as given above except in a very general way, and I attempted to bring out the necessity of careful consideration of such and other questions. I did not confine myself to the inspection of shells or ammunition because there is no essential difference between the rules which should govern the inspection of such materials and those for any other manufactured product.

That it is possible to give tolerances on the dimensions of a shell which conflict with the tolerances in regard to the weight of a shell shows conclusively that logic is required not merely to determine that there should be inspection, but also that specifications, limits, tolerances, etc., should be given in a logical manner.

Elsewhere Mr. Hamilton says: "Another point in connection with Mr. De Leeuw's paper, which appeared out of place, was his reference to the specification dealing with leather belting. This specification had nothing whatsoever to do with the inspection of leather belting, but what it did set forth was the process by which leather belting could be made in order to meet Government specifications, and as such would be of valuable assistance to any manufacturer engaged in this work who had not previously engaged in this particular line of manufacture." This last quotation shows quite clearly that Mr. Hamilton did not get the drift of what I said. The instance quoted in regard to specifications of leather belting were most decidedly taken from the specifications of users of leather belting; which means that belting not coming up to these specifications would be rejected by the user. I have copies of these specifications in my possession, and I would say that they were not written by the Government, but by some of the largest private concerns in this country. They were by no means information given by the user to some future belt maker, but instructions to an existing belt maker as to what he would have to furnish. The specifications were of such a nature that there was only one thing to do, and that was to take the word of the maker that he had followed the instructions, for the finished product would not show in any way that the specifications had been met. How Mr. Hamilton got the idea that these were Government specifications, and that they were made for the purpose of giving assistance to some future manufacturer, is more than I can tell.

Whether the papers presented before the Machine Shop Session of the A.S.M.E. at the last meeting were the papers most needed at the present time I do not care to discuss, but I feel that if the meeting had followed the lines of Mr. Hamilton's discussion, and had tried to consider in detail every feature of every piece of ordnance or ammunition which this Government may require, this meeting, starting Thursday afternoon, December 5, 1917, would probably have adjourned some Thursday afternoon in 1970! As to my share in the meeting, I merely tried to emphasize the necessity of logical inspection in order to make inspection not only profitable, but even possible.

A. L. DE LEEUW.

Plainfield, N. J.

Topographic surveys and mapping in relation to present military activities were discussed at a recent "patriotic" meeting of the American Institute of Mining Engineers by David White of the U. S. Geological Survey. There are 38 parties of topographers in the field, and the survey is now covering—on a scale of 1 mile to the inch—between 100,000 and 200,000 square miles per month. The survey has now one hundred men wearing the uniform of the United States.

SOCIETY AFFAIRS

A Record of the Current Activities of the Society, Its Members, Council, Committees, Sections and Student Branches; and an Account of Professional Affairs of Interest to the Membership

PROGRESS in the world has been through vicarious sacrifice, and the supreme benefit of this war, besides the attainment of opportunity for the self-determination of peoples great and small, is that of purification through the suffering caused by the war. It is essential that the suffering be for the good of others in order that one may benefit by the suffering.

One of the finest women I know, who has two sons at the front, and who has always, so far as one could observe, lived a life of service for others, recently told me that she is hoping that on the return of her boys she will be worthy to receive them.

We are constantly hearing of the failure to recognize the engineer in this war—that it is an engineering war; and President Taft, in his address before the Society at the Annual Meeting, said: "Now you engineers, all, constitute one of the two professions that are indispensable to the country in the carrying on of the struggle to which the people of the United States are about to devote themselves, yours and the medical profession; you as the constructors of all the material and all the equipment of which so much is needed now in modern warfare to make effective the work of our boys at the front, and the medical profession to furnish, so far as may be, the aid in restoring to the ranks those whom the fortunes of war disable."

Credit and recognition will be in the proportion that we unselfishly devote ourselves and make the sacrifices. It becomes increasingly difficult to receive with patience letters from members doubting the benefit that they obtain from the Society. It does not occur to them that membership in the Society is an opportunity to render greater service through an organization than could be rendered individually.

The Society is increasing its activities rapidly. The Presi-

THE SPRING MEETING AT WORCESTER

The following announcement regarding the convention to be held in Worcester, Mass., June 4 to 7, made by the Committee on Meetings and the Worcester Local Committee, evidences the intention of the committees to make this another war convention. Every member within reasonable distance of Worcester should make it his business to be present.

TENTATIVE PROGRAM

TUESDAY, JUNE 4

Afternoon: (Hotel Bancroft)
Registering of Members and Guests at Society Headquarters

Evening: (Hotel Bancroft)
Address of Welcome, followed by Reception and Dance

WEDNESDAY, JUNE 5

NEW ENGLAND DAY

Morning: (Worcester Polytechnic Institute)
Business Meeting
First New England Session, with opening address by Mr. Charles Washburn on the Industries of Worcester. Buffet lunch served at the Institute. During the morning and afternoon sessions it is proposed also to discuss the Textile Industry in Relation to the War; the Shipbuilding Industry; and the Manufacture of Small Arms and Gun Carriages, with reference to these industries as developed in New England

Afternoon: (Hotel Bancroft)
Second New England Session
General Session with technical papers
Industrial Safety and Workmen's Compensation Session

Evening: (Hotel Bancroft)
General War Session. The general theme of this

Evening: (Hotel Bancroft) Continued
evening session will be How the Engineering Societies Can Assist in the Procurement Program of the Government. Some major topics to be discussed are: Ordnance and Ships for the Navy Department; Munitions for the Army; Aircraft Material; Merchant Ships; Training of Labor, etc.

THURSDAY, JUNE 6

Morning: (Worcester Polytechnic Institute)
General Session with technical papers
Fuel Session
Public Relations Session

Afternoon: (Norton Company's Plant)
Luncheon
Inspection of the Norton Company's community housing and garden projects

Evening: (Worcester Country Club)
Dinner
Illustrated Lecture

FRIDAY, JUNE 7

Morning: Automobile Trip to Camp Devens, via Clinton Dam
Lunch at Camp Devens

Afternoon: Auto Trip to Concord, Lexington and return via the Wayside Inn
Afternoon tea at the Wayside Inn

[illegible] were [illegible] in Washington, to approve, [illegible] the applications by one of the Departments, of suggestions made by the Society at its Annual Meeting.

One of the problems of the war is that of developing the necessary skilled labor, and it was suggested by one of the boards in Washington that this could be accomplished by converting the schools of higher technical education into trade schools, and for a period of five months, commencing May 1, to absolutely stop all higher technical education. Our Council strenuously protested. We are pleased to report that the imminence of such a drastic action as shutting down the schools of higher technical education has, for the present, disappeared; and that the consideration of the whole subject is now in the hands of the Committee on Education and Special Training, the membership of which is made up from leading officers of the Army in its several bureaus, civilian representatives of the U. S. Bureau of Education, the engineering colleges, trade schools, corporation schools, and the Vocational Board; and a committee of this Society has been appointed, of which Prof. R. H. Fernald is chairman, consisting of Mr. F. A. Geier, Prof. Arthur L. Williston, Dean Herman Schneider, and Dr. C. R. Mann. It is the intention of this committee to assist the Government in the development of the nation's resources for the training of men without curtailing the steady flow of professional men. Recent addresses by the Secretaries of the Navy and of War have emphasized the necessity of maintaining at the highest rate the production of technically trained men, and they have appealed to the parents of the boys of the nation to send their sons to technical colleges.

Our Committee on Engineering Resources, of which Mr. George J. Foran is chairman, has lost, through the demands for personal service at Washington, Major J. H. Barr and Mr. A. D. Blake, and these vacancies have been filled by the appointment of Mr. Herman Greul and Mr. F. H. Colvin. The other members of the committee are Mr. Henry C. Meyer, Jr., and Prof. C. M. Allen, of Worcester. A most remarkable achievement has been made, and a special report on this will appear next month. This service is not only for the purpose of furnishing specialists for all demands of the Government, but to furnish specialists to the industries both during the period of the war and afterward.

The Committee on Gages, also a result of a suggestion of our Semi-Annual Meeting, has secured a substantial beginning of the movement to have departments of the Government have their gages certified in one place, namely, the Bureau of Standards, in distinction from having independent sources of authority with obvious possible differences, causing lack of interchangeability of completed parts.

The Committee on Fuel Conservation, of which Professor Breckenridge is chairman, has been very active, and, through Mr. David Moffat Myers, of the committee, who has, by virtue of the committee's activity, been invited by Dr. Garfield to be on his personal staff as technical adviser, is getting out a series of brochures on fuel conservation. Mr. F. R. Low, Editor of *Power*, and speaking for the McGraw-Hill Company, has tendered the patriotic services of members of the editorial staffs of the several publications of that company.

We have also furnished the Fuel Administrator, through Mr. Myers, with the names of our prominent members familiar with fuel economy in each of the states of the Union, and it is the Fuel Administrator's expectation to inform the state fuel administrators of the names of these experts, with the suggestion that the state fuel administrators avail themselves of technical advice.

It is evident from the way matters are managed throughout the United States, that the engineer is not yet the obvious man to do engineering work. By virtue of the fact that members of the other professions, particularly of the legal profession, have apparently made greater efforts to render public service, they are more frequently called to public office. Therefore, when and even before the invitation comes to any engineer to render service, it should be expected that it will be at personal sacrifice. Such sacrifice should be made as a means of advancing our country's cause, and the standing of one's profession.

There is one activity which the Society might well undertake: namely, that of conserving those industries which have been dislocated, and, in some cases, actually put out of business by the war—as a type, the jewelry industry. There is a vast industry, with numerous skilled workers, especially fitted for certain classes of work. There seems to be no agency yet developed in the Government for foreseeing such disaster and arranging in advance that the organizations of these so-called non-essential industries shall be held together by the placing in these industries of Government work and which can be performed with comparatively slight readjustment.

At the Spring Meeting in Cincinnati the convention voted that it was the duty of all patriotic citizens to exchange data so that there would be the freest opportunity for all manufacturers to undertake work. The committee appointed at that time has suffered through the loss of some of its members in active service in the war, and at the last Council meeting a new committee was appointed, and it is hoped that they will be able to take up in addition to the technical features of such a work the broader conservation of industries as a stabilizing element of the nation so essential while at war.

The Secretary could enumerate numerous undertakings which the Society could take up with advantage, and solicits the membership to offer their services to serve on committees and make the sacrifices of time and money to carry out this service for the profession and for their country.

CALVIN W. RICE,
Secretary.

Nominations for Officers of the Am.Soc.M.E.

FOR ELECTION IN DECEMBER 1918

The Constitution of the Society in C 47 provides among the Annual Committees:

> "A Nominating Committee appointed by the President."

It further provides in C 48:

A "Special Nominating Committee: Twenty or more persons entitled to vote may constitute themselves a Special Nominating Committee, with the same powers as the Annual Nominating Committee."

The procedure in the nominations for office is provided in the following By-Laws:

B 27 A Nominating Committee of five members, not members of the Council, shall be appointed before February first of each year by the President. The Secretary shall publish the names of this Committee in the March issue of THE JOURNAL together with a request to the voting membership of the Society that they recommend to the Committee the names of eligible persons for the elective offices to be filled at the next election. This Committee shall deliver to the Secretary in writing between the first and the fifteenth of June the names of its nominees for the various elective offices next falling vacant under the Constitution, together with the written con-

sent of each nominee. The names of the nominees for the various offices proposed by this Committee shall be published by the Secretary under the names of the Committee in the July issue of THE JOURNAL.

B 28 A special Nominating Committee, if organized, shall on or before October fifteenth, present to the Secretary the names of its nominees for the elective offices next falling vacant under the Constitution, together with the written consent of each nominee. The names of the nominees for the various offices proposed by this Committee shall be published by the Secretary under the names of this Committee in the November issue of THE JOURNAL.

There are to be elected in December next

A President to hold office for one year

Three Vice-Presidents to hold office for two years

Three Managers to hold office for three years

A Treasurer to hold office for one year

The President, Charles T. Main, has appointed the following Nominating Committee for these officers:

George R. Wadleigh, of St. Louis, Mo.

William P. Caine, of Ensley, Ala.

C. F. Hirshfeld, of Detroit, Mich.

L. P. Breckenridge, of New Haven, Conn.

Thomas E. Durban, of Erie, Pa.

These names were selected by the following Sections, grouped geographically, and accepted by the President:

GROUP 1 Minnesota, Los Angeles, St. Louis and San Francisco

GROUP 2 Atlanta, Baltimore, Birmingham, Cincinnati and New Orleans

GROUP 3 Chicago, Detroit, Indianapolis and Milwaukee

GROUP 4 Boston, Connecticut, New York and Worcester

GROUP 5 Buffalo, Erie, Philadelphia and Ontario

This Nominating Committee is to meet at the Spring Meeting of the Society in Worcester, Mass., June 4 to 7, and would be pleased to receive suggestions from the membership.

Under the terms of By-Laws B 27 and B 28 the voting membership are requested to send the Nominating Committee or Committees, in care of the Secretary, 29 West 39th Street, New York, N. Y., their recommendations of names for any or all of the elective offices to be filled at the next election.

These recommendations should be sent in early and not later than June 1.

Engineers in Government Service

THE engineering societies have during the past few months supplied to various Government departments, in response to their individual requests, several thousands of names of engineers from which men have been selected to fill a great variety of positions in uniformed and civilian service for the Army and Navy and other branches of the Government's activities in connection with the war, as well as for indirect service for manufacturers and contractors engaged in war work. This service is about to be turned over to the Engineering Council, which will hereafter conduct the work through its American Engineering Service Committee.

To meet the demands the American Engineering Service Committee will assemble in its offices in the Engineering Societies Building the extensive lists and detailed information collated by the societies. The contribution from our Society is the card index compiled by the Committee on Engineering Resources, Mr. George J. Foran, Chairman, from the Personal Classification Sheets sent in by the members.

The American Engineering Service Committee desires to take this opportunity of calling attention to the fact that if these lists are to be maintained in the most useful condition to the Government and to the Engineering Council, the committee should receive promptly information concerning each engineer who has *gone into any kind of Government service*, direct or indirect, so that a record may be made on his cards in the committee's office. Members of this Society to whom this request applies are urged to send at once, if they have not already done so, their names, present addresses and occupations in the Government service, with a brief statement as to whether or not they are available for other service. This notification should be made to the Secretary, Mr. Calvin W. Rice, who will forward the information to the American Engineering Service Committee.

Certification of Gages

THE following letter will interest those who coöperated in the steps inaugurated by the Society at its Spring Meeting in Cincinnati, May 1917, to bring about the certification of gages. These steps were reported in the January issue of THE JOURNAL under the heading: Public Meeting of Gage Committee. The negotiations of the Society with the Government in the consummation of this important work were of the most pleasant character, and the Society deems it a special privilege to have been of service in the matter.

NAVY DEPARTMENT

BUREAU OF CONSTRUCTION AND REPAIR

WASHINGTON, D. C.

TO THE COMMANDANTS AND INDUSTRIAL MANAGERS OF NAVY YARDS AND NAVAL STATIONS, SUPERINTENDING CONSTRUCTORS, ETC.

Subject: Standardization of Gages

1 The Bureau of Construction and Repair designates the Bureau of Standards of the Department of Commerce, Washington, D. C., as the place at which all master and reference gages and standards of measurements are to be certified. This is intended to include all such master and reference gages and standards of measurement as are used for the work coming under the cognizance of the Bureau, both in manufacturing and inspecting.

2 All master and reference gages and standards of measurement used by private manufacturers in carrying out contracts for the Bureau, where certification is called for by the contract, shall be certified by the Bureau of Standards.

3 Where contracts are entered into which require the certification of gages, the following clause should be included in the contract:

> The master and reference gages and standards of measurements, with which are to be compared the gages and measuring instruments used in carrying out this contract, are to be certified by the Bureau of Standards of the Department of Commerce, Washington, D. C.

4 The designation of the Bureau of Standards as indicated above, and the adoption of the clause to be included in contracts where applicable, have been made on the recommendation of the Joint Committee appointed by The American Society of Mechanical Engineers and the Society of Automotive Engineers, with the view of the standardization of practice of the various Departments and Bureaus of the Government.

TAYLOR.

The 1918 issue of the Year Book of the Society is now off the press and will be issued at an early date.

OUR LOCAL SECTIONS ORGANIZATION: 1917-


Oscar Elsas
Atlanta


W. W. Varney
Baltimore


J. H. Klinck
Birmingham


H. C. Ashton
Boston


H. E. Harris
Bridgeport


Forrest E. Cardullo
Buffalo


A. D. Bailey
Chicago


G. W. Galbraith
Cincinnati


P. B. Sargent
Connecticut


J. F. Wadsworth
Erie


G. W. Bissell
Detroit


B. M. Hansen
Hartford

CHAIRMEN OF LOCAL COMMITTEES

1918

W. H. Insley
Indianapolis

F. G. Pease
Los Angeles

C. K. Decherd
Meriden

H. L. Brink
Minnesota

W. M. White
Milwaukee

H. L. Hutson
New Orleans

J. H. Norris
New York

R. W. Angus
Ontario

L. F. Moody
Philadelphia

B. F. Raber
San Francisco

R. L. Radcliffe
St. Louis

G. I. Rockwood
Worcester

Appeal from Navy Department

THE Navy is still in urgent need of binoculars, field glasses, spy glasses and telescopes. The submarine has so changed naval warfare that more "Eyes" are needed on every ship, in order that a constant and efficient lookout may be maintained. Sextants and chronometers are also urgently required. Heretofore, the United States has been obliged to rely almost entirely upon foreign countries for its supply of such articles. These channels of supply are now closed, and as no stock is on hand in this country to meet the present emergency, it has become necessary to appeal to the patriotism of private owners, to furnish "Eyes for the Navy."

Several weeks ago an appeal was made through the daily press, resulting in the receipt of over 3000 glasses of various kinds, the great majority of which has proven satisfactory for naval use. This number, however, is wholly insufficient, and the Navy needs many thousands more. May I, therefore, ask your cooperation with the Navy, to impress upon your members by announcing the following salient features in connection with the Navy's call:

All articles should be securely tagged giving the name and address of the donor, and forwarded by mail or express to the Hon. Franklin D. Roosevelt, Assistant Secretary of the Navy, care of Naval Observatory, Washington, D. C., so that they may be acknowledged by him.

Articles not suitable for naval use will be returned to the sender. Those accepted will be keyed, so that the name and address of the donor will be permanently recorded at the Navy Department, and every effort will be made to return them, with added historic interest, at the termination of the war. It is, of course, impossible to guarantee them against damage or loss.

FRANKLIN D. ROOSEVELT,
Assistant Secretary of the Navy.

Navy Department, Washington, D. C.

AMONG THE LOCAL SECTIONS

SOME few months ago the Committee on Local Sections discussed ways and means for coördinating the work of the Sections with that of the Meetings and Publications Committees of the Society, with a view to developing the contributions from the Sections to the general meetings and to the publications. As the outcome the Sections Committee suggested to each Section the desirability of appointing sub-committees on papers and on research, to devote special attention to the securing of local papers for Sections which would be available for publication by the Society and to the collection of data regarding local research work in the educational institutions and the industries. To date nine Sections have responded by the appointment of these special sub-committees: Atlanta, Baltimore, Birmingham, Boston, Philadelphia, Los Angeles, New Orleans, St. Louis and San Francisco. As soon as all the Sections are heard from, the full personnel of these sub-committees will be published in THE JOURNAL.

In giving out this suggestion to the Executive Committees, the Committee on Sections realized, of course, that some Sections would probably not find it feasible to secure the results desired in just this way, in which case it left it is a matter for the Executive Committee itself to decide on what plan shall be followed. The main object desired, however, is that each Section shall contribute its share, through the general meetings and the publications of the parent Society, to the benefit of all the other Sections and of the membership generally. One of the mainstays of success of the Society is this idea of mutual service, and our organization is very fortunate in that we have a goodly number of members who derive genuine pleasure from giving a little more than they receive.

SECTION MEETINGS

BUFFALO

[illegible]. At a meeting of the Buffalo Engineering Society and the Buffalo Section of the Society of Automobile Engineers, C. C. Carpenter, Chief Chemist of the United States Light & Heat Co., of Niagara Falls, presented a paper on Electric Storage Batteries, in which he described the construction of the battery, the care it should receive, and the service to be expected of it. He demonstrated by means of diagrams the effect of extremely hot and cold weather on the efficiency of the battery.

February 13. At the fifth general meeting of the Engineering Society of Buffalo, J. E. Freeman, engineer of the Technical Division, Portland Cement Association, delivered an illustrated lecture on Concrete Boats. Mr. Freeman gave a general review of the progress in concrete-boat building from its earliest inception, described some of the interesting work under way at the present time, and discussed various problems entering into the application of reinforced concrete to such construction. He closed with an exhibition of motion pictures, showing concrete boats, both small and large.

February 19. Chairman F. E. Cardullo gave a talk on A Discussion of Manual and Technical Training.

E. B. NEIL,
Section Secretary.

BALTIMORE

January 10. At a joint meeting held under the auspices of the Baltimore Section, the Engineers' Club and the various associations of stationary engineers to discuss the subject of fuel saving, Charles H. Bromley, Mem.Am.Soc.M.E., delivered the main address on How to Get the Most Out of Coal. The speaker advocated the payment of a bonus as an inducement to firemen to do their best work and the employment of labor-union methods for engineers and firemen to enforce their demands.

Other addresses were made by prominent representatives from each of the associations.

January 29. Mr. Henry Adams, Mem.Am.Soc.M.E., presented a paper entitled Some Engineering Experiences, in which he discussed the development of heating and ventilating equipment, with particular reference to its application to public buildings. He traced the progress from the crude rule-of-thumb methods of the original builders of this equipment to the present.

A business meeting followed, at which a number of sub-committees were appointed. Among these was a committee to offer the services of the members of the Baltimore Section of the Society to the Fuel Administrator of Maryland, to assist in suggesting ways and means to improve the efficiency of burning coal.

A. G. CHRISTIE,
Section Secretary.

BOSTON

January 22. A reception-smoker was tendered to President Charles T. Main, preceded by a dinner at which many old-time friends and associates of Mr. Main were present. Short addresses were made by Professor Whipple, of the Boston Society of Civil Engineers, Mr. John R. Freeman, Past-President, Am.Soc.M.E., and Messrs. Desmond Fitzgerald, Lionel S. Marks, Dugald C. Jackson, H. S. Hale and Calvin W. Rice.

Mr. W. H. Balch, War Correspondent of the Boston *Evening Transcript*, gave a stirring address on Engineering the End of the War.

February 5. The Boston Section joined with the Boston A.I. E.E. Section at the Massachusetts Institute of Technology in a meeting at which a paper on The Modern Trend of Education was given by Prof. Walter I. Schlichter, of Columbia University. Among the prominent educators who discussed the paper were Professor Franklin, of Lehigh University; Professor Brozel, of Yale University, and Professor Clifford, of Massachusetts Institute of Technology. The special problems in training for the Army and Navy, as well as for the mercantile marine, munition factories and other industries directly concerned in the prosecution of the war, were covered. Reference was particularly made to the utilization of existing technical schools in New England for the production of a large number of trained men for this purpose.

W. G. STARKWEATHER,
Section Secretary.

CONNECTICUT SECTION

Hartford Branch

February 12. Chairman B. M. W. Hanson gave an interesting talk on The Functioning and Production of Automatic Fire Arms, in which he explained the composition and working qualities of the Vickers machine gun produced at the Colt's Patent Fire Arms Manufacturing Company. He described the method of insuring interchangeability of parts. He also described the method of ascertaining that the limits for tolerances were not so great as to interfere with the functioning of the gun, which method is understood to be new as far as gun manufacture is concerned. Three models are made, one accurately to maximum limits, one accurately to minimum limits and the third to mean dimensions. The parts of these three models are mixed together, and then picked out again indiscriminately to assemble a gun. This gun is tested in every conceivable manner, and it is easily determined whether the results for tolerance are too great in any particular case.

Mr. Hanson was assisted by Mr. Fred T. Moore, the ballistic expert of the Colt Company, who gave an interesting explanation of the functioning of the Vickers gun.

S. F. JETER,
Section Secretary.

CONNECTICUT SECTION

Meriden Branch

January 17. Professor L. P. Breckenridge, Mem.Am.Soc.M.E., delivered a talk on Coal Conservation. As a result of an invitation extended to the factory owners and the engineers and firemen of the town, there were over 250 persons present. It was a meeting which proved that the Branch could be of valuable service to the community.

February 14. Sixty persons attended the meeting on this date, at which Mr. C. E. Rigby, Engineer for the Blackstone Mutual Fire Insurance Company, gave an illustrated lecture on Fire Protection in Manufacturing Plants.

CHARLES N. FLAGG,
Section Secretary.

LOS ANGELES

February 7. Mr. L. D. Gilbert, Mem.Am.Soc.M.E., delivered an illustrated lecture on The Practical Side of Portland Cement Manufacture, in which he described fully the construction and operation of the South-Western Portland Cement Company's plant located at Victorville, Cal.

T. J. ROYER,
Section Secretary.

MILWAUKEE

January 16. Mr. Walter Alexander, Superintendent of Motive Power for the C. M. & St. P. Ry. Co., gave an illustrated lecture on Electric Locomotives on this railroad.

February 13. Mr. E. S. H. Baars, of the Vilter Manufacturing Co., gave an illustrated talk on Cold Accumulators and Their Application to the Refrigerating Industry.

An illustrated address on The Refrigerating Equipments at the United States Army Cantonments was given by Messrs. Alex H. Luedicke and Fred Goes, also of the Vilter Company.

FRED H. DORNER,
Section Secretary.

NEW ORLEANS

January 12. The A.S.M.E. Section participated in an enjoyable smoker held in connection with the Annual Meeting of the Louisiana Engineering Society.

February 11. By invitation, the New Orleans Section participated in the meeting of the Louisiana Engineering Society, at which a paper on Some Notes on Wireless Telegraphy was read by Prof. P. E. Lehde.

E. W. CARR,
Section Secretary.

ONTARIO

January 29. At a meeting held at Toronto, Mr. F. B. Ward, of the John Inglis Company, gave an address on The Influence of Munition Manufacture and Other War Work on Machine Shop Practice. Several prominent members of the Section took part in the discussion.

CHESTER B. HAMILTON, JR.
Section Secretary.

PHILADELPHIA

February 26. Mr. Carl G. Barth, Mem.Am.Soc.M.E., appeared in a somewhat novel rôle, with a paper on the Income Tax, in which, by a thorough mathematical analysis of the Federal Income Tax Law represented graphically in several ways, he clearly set forth the defects of this law. Mr. Barth showed conclusively that if the rates imposed on incomes up to about $10,000 and above $40,000 are at all fair, then the rates imposed between these two limits are decidedly too high, as recognized and partially corrected in the recent amendment offered by Senator Smoot. He also showed that an exemption for any income, however small, is a mathematical absurdity. Theoretically every income should be taxed, but if this is done consistently a tax too small to make it worth while to collect it is yielded. There must therefore be a natural exemption for incomes below a certain point, as provided by the recent legislation.

It is always a matter of interest to note the applications by engineers of some of their principles to the broader problems of life, and, strange to say, it is by such studies that the engineer often receives a greater public recognition. Taylor's work, for instance, is best known in its psychological aspects. Mr. Barth's discussion of the income tax calls to mind that Mr. Hugo Bilgram, another of our prominent Philadelphia engineers, and a man who is usually associated with machine construction, has devoted many years of study to problems of economics, especially causes of and cures for panics.

JOHN P. MUDD,
Section Secretary.

PROVIDENCE

January 2. Mr. Frederick J. Hoxie, Mem.Am.Soc.M.E., delivered an illustrated lecture on the Causes of Rot in Timber.

February 20. An illustrated lecture on Water Power Development in New England was given by Henry I. Harriman, of Chace & Harriman, Boston. Mr. Harriman was largely instrumental in the development of the Connecticut River Power Company and of the New England Power Company, and is therefore well qualified to discuss this subject. Some of the largest hydroelectric plants in the six states east of the Hudson and also in some of the western states were described fully, and the various types of construction used in developing and utilizing water power were illustrated.

Several other meetings were held during the month by the various sections of the Providence Engineering Society.

JAMES A. HALL,
Correspondent.

ST. LOUIS

February 8. Mr. C. B. Lord, Mem.Am.Soc.M.E., delivered a lecture on the Manufacture and Use of Ammunition as Adapted to Present-Day Warfare. Through the courtesy of the Wagner Electric & Manufacturing Company, he exhibited a number of samples of explosives and shells, and described the methods of

their manufacture, as well as their use in the present war. Mr. Lord's talk also covered fully the manufacture and use of large guns, submarines, torpedoes and depth bombs.

E. H. TENNEY,
Section Secretary.

Student Branch Meetings

BUCKNELL UNIVERSITY

February 4. Following a business meeting, Mr. Fred Bauman gave an interesting talk on The Efficiency Engineer.

H. R. PARS,
Branch Secretary.

LEHIGH UNIVERSITY

February 7. A paper on Recent Developments in Artillery was given by J. W. Hogg, '18, in which he described the French low-power and the German high-power guns.

Mr. Boyd E. Keifer, '18, presented a paper on Modern Milling Machine Cutters, in which he described the new form of milling cutter which has been found very successful by the Bethlehem Steel Company. Instead of using the old form with radial teeth the new type has underent teeth; the tooth profile does not pass through the center of the cutter but back of it. The old form pushes the metal down, while the new type actually cuts it. The new type removes 67 per cent more metal and runs 75 per cent faster than the old type.

N. DMYTROW, JR.,
Branch Secretary.

OHIO STATE UNIVERSITY

January 15. The following officers were elected: Paul Bucher, chairman; H. R. Ansel, vice-chairman; F. E. Smyser, secretary; C. L. Smith, treasurer, and A. A. Casey, sergeant-at-arms. Mr. R. L. Dickinson, Industrial Service Secretary of the Columbus Y.M.C.A., gave a talk on the work being done by the engineer and manufacturer among aliens in Columbus. The Secretary presented a report of the Conference of Student Branches at the Annual Meeting.

F. E. SMYSER,
Branch Secretary.

GEORGIA AGRICULTURAL COLLEGE

January 23. Following a short business meeting the following papers were presented: The Hydraulic Ram, by E. W. Dye; Impulse and Reaction Turbines, by George Carpenter; Hydraulic Engines, by Professor Graf; and Types of Rams, by Professor Goldman.

VEAL K. FORD,
Branch Secretary, pro tem.

PENNSYLVANIA STATE COLLEGE

January 22. The following officers for the second semester were elected: F. R. Hoffman, chairman; Mr. Smith, vice-chairman; H. C. Wright, secretary.

Following a short talk by Professor Wood, each member present was presented with a copy of the thesis by H. R. Hammond and C. W. Holmberg which was awarded the Student Prize at the Annual Meeting of the A.S.M.E.

The following resolutions were passed regarding the death of H. R. Hammond, one of the authors of the thesis.

WHEREAS, In the untimely death of H. R. Hammond of the class of 1916, we have lost an active and faithful member of our society, be it

RESOLVED, That we express our highest appreciation of his unselfish and active services in the interests of our society while in college, and especially to record the honor which has come to our local branch because of the work of merit which was recently presented by Messrs. Hammond and Holmberg and which won the coveted prize for the best paper submitted by members of the Student Branches throughout the country, and which was later read at the Annual Meeting of the A.S.M.E. Also be it resolved, as a further mark of our esteem for his excellent character, that these resolutions be spread upon the minutes of the society and a copy be sent to members of his immediate family.

HAROLD C. WRIGHT,
Branch Secretary.

PURDUE UNIVERSITY

January 16. Mr. J. E. Hannum, instructor in mechanical engineering, gave a talk on The Mechanical Features of the Submarine. The two types of undersea vessels, the submarine and the submersible or modern U-boat, were described and their design and construction explained by means of sketches.

CLAUDE S. KEGERREIS,
Branch Secretary.

STEVENS INSTITUTE OF TECHNOLOGY

February 7. Prof. R. M. Anderson, successor to Dr. Alexander C. Humphreys as Honorary Chairman of the Branch, gave an interesting talk on The Future of the Society. Following the talk the Inspection Trip Committee reported that trips had been arranged to visit the Cooper Hewitt and the Colgate Works.

The proposed new constitution for the Stevens Engineering Society was submitted to those present for consideration and will be considered at the next meeting.

LINCOLN V. AQUADRO,
Branch Secretary.

THROOP COLLEGE OF TECHNOLOGY

February 1. At a joint meeting of the Student Branches of the A.S.M.E. and A.I.E.E., Prof. H. Adams delivered a lecture on Engineering in China. Professor Adams lived in China for a number of years and was therefore well qualified to speak on the subject.

RETLA ALTER,
Branch Secretary.

TUFTS COLLEGE

January 23. Mr. M. W. Hogdon, '18, gave an illustrated talk on Aviation and Aeroplanes, in which he described the methods of training aviators in this country and in Europe. He also spoke of the tactics employed by skilled airmen in battling with a foe, the causes of accidents, and the great strides made in increasing the safety of flying.

CHRISTOPHER L. SMITH,
Branch Secretary.

UNIVERSITY OF CALIFORNIA

February 11. A business meeting was held, at which the following officers were elected: F. C. Holman, chairman; E. K. Schulze, vice-chairman; L. M. K. Boelter, secretary, and H. L. Reich, treasurer.

LLEWELLYN BOELTER,
Branch Secretary.

UNIVERSITY OF CINCINNATI

February 1. Mr. E. W. Roberts, a Cincinnati aeroplane expert, delivered an illustrated lecture on The History of Flight, describing in detail one of the early types of balloons and other flying contrivances. One of the first English aeroplanes (built by Hiram Maxim) the speaker assisted in building, and he told many interesting facts about its construction, comparing it with the more modern machines.

C. L. KOEHLER,
Branch Secretary.

UNIVERSITY OF COLORADO

February 7. At a meeting of the combined branches, an interesting talk was given on Explosives by Mr. Skinner, General Manager of the Western Chemical Works. A division of the R.O.T.C. has been organized at the University and practically every member of the Branch has joined.

H. O. CROFT,
Branch Secretary.

UNIVERSITY OF ILLINOIS

In the early part of the college year the Student Branch, representing the Mechanical Engineering Department, gave a very instructive Mechanical Engineering Show.

At the second meeting of the Branch, Mr. Godeke, instructor in mechanical engineering, delivered a lecture on Equipment of the Power Laboratory. Opportunities in connection with the Student Branch were discussed by Mr. Radebaugh.

The subject of the November meeting was Airplane Engines, the speaker being Capt. L. Simpson of the School of Military Aeronautics.

At the December Meeting, Mr. B. S. Day, instructor in the power laboratory, spoke on Our Laboratory, Old and New. The Branch also held a smoker during the month which was well attended.

J. J. Kalivoda,
Branch Secretary.

UNIVERSITY OF MISSOURI

January 15. A paper was presented by L. N. Thompson on Recent Developments in the Design of Aeroplane Engines.

J. W. Baldwin,
Branch Secretary.

UNIVERSITY OF NEBRASKA

February 5. The Diesel Engine was the subject of the meeting and was discussed in a paper by Mr. F. W. Rabe, who spent some time in Germany before the war and had inspected several of the Diesel factories. In addition to bringing out the advantages and disadvantages of the Diesel engine, Mr. Rabe also spoke about the life of the inventor and the many obstacles he encountered in selling his patents.

Professor Seaton brought out a fact of interest that the Germans have perfected a Diesel engine actually light enough to be of practical use as a prime mover for aeroplanes.

W. L. Millar,
Branch Secretary.

UNIVERSITY OF OKLAHOMA

January 15. At a joint meeting of the A.I.E.E. and A.S.M.E. Branches the following papers were presented: The Election, by Professor Tappen; Large Types of Steam Boilers, by Professor Helmrick—of especial interest since the speaker had recently returned from Detroit where the largest boiler of today is located; Some Large Power Plants in New York, by Dean Felgar; and Frequencies, by L. B. Holland.

Paul B. Stockwell,
Branch Secretary.

UNIVERSITY OF WASHINGTON

The university is coöperating with the Government by having a Reserve Officers' Training Corps in which underclassmen receive eight hours of training a week with upperclassmen as officers and members of the faculty as instructors, the latter being in the R.O.T.C. An A.U.S. Naval Training Station is located on the campus with an enrollment of about a thousand and a course for marine operating engineers under the direction of the U. S. Shipping Board is given by the mechanical engineering faculty to men from all over the West and Southwest. Over a thousand men from the University of Washington are now in the service, and a good share from the engineering school are now in various branches of the Engineering Corps and other branches of service.

January 17. The meeting was held to discuss plans for a smoker. It was also voted to procure a service flag for the Mechanical Engineering Department at the University.

February 6. Wooden Ship Building and Development, and the Use of the Semi-Diesel Engine in Wooden Ships was the subject on which Mr. R. M. Dyer, Mem.Am.Soc.M.E., gave a most interesting talk. The Diesel Engine was also discussed by Mr. J. M. Royal, Jun.Am.Soc.M.E.

Mr. Anderson, of The American Blower Company, made an address on the Value of a College Education.

H. B. Sallee,
Corresponding Secretary.

UNIVERSITY OF WISCONSIN

January 24. The following were elected officers for the second semester: George Moore, chairman; Glenn Warren, vice-chairman; W. Mantonya, secretary, and K. Seelback, treasurer. An amendment was made to the Student Branch Constitution whereby a fine would be imposed upon the members for absence from a meeting.

K. G. Shiels,
Branch Secretary.

VIRGINIA POLYTECHNIC INSTITUTE

January 24. The meeting was devoted entirely to business matters, including planning the conduct of future meetings and the election of C. H. Driskill as chairman, to succeed Mr. Kearsley.

E. W. Digges,
Branch Secretary.

WORCESTER POLYTECHNIC INSTITUTE

January 11. At the Joint Meeting of the Student Engineering Societies, held under the auspices of the Civil Engineering Society, S. G. Webb, engineer with the Gypsum Industry Association, gave an interesting and valuable talk on the Use of Gypsum in Building Construction. He first explained what gypsum was from the chemist's viewpoint, calling attention to its commonly used name in the arts of plaster of paris and in its use in agriculture under the name of plaster, and then described the sources from which it is procured, its manufacture and finally its use in the building trades. Interesting points brought out were the adaptability of this material to construction of all sorts, its great fire-resisting qualities, its low sound-transmitting quality and its use as a heat-insulating material.

February 6. The resignation of Chairman R. C. Lewis was accepted, owing to his enlistment in aviation work. Mr. Chenoweth Housum, Engineer for the Jefferies-Norton Company, gave a talk on Some Large Gas-Engine Installations, reviewing the merits of the two- and four-cycle types of gas engines. The fuels used in large gas engines such as natural gas, coke-oven gas, blast-furnace gas and producer gas were considered in detail and problems to be overcome in using these fuels were cited. The advantages gained by the use of gas engines over steam engines for blowing in steel mills and blast-furnace work were also touched upon.

H. P. Fairfield,
Branch Secretary.

The Association of Eleventh Engineers (Ry.) has been formed to promote the welfare of the 11th Engineers (Ry.), U. S. A.

This regiment is the one which was recruited entirely by the Military Engineering Committee of the Engineering Societies. The regiment was in the fighting at Cambrai, where it gained the prompt praise of both British and French generals, and earned the name of "The Fighting Engineers."

The Association will be glad to receive from engineers, contributions for carrying on its manifold aims and activities, all of which center to the underlying purpose of service to the men of the 11th Engineers. Mr. J. Waldo Smith, Mem.Am.Soc.M.E., is chairman of the Finance Committee and Mr. Robert Lynn Cox is treasurer, to whom contributions should be sent at the Metropolitan Life Building, No. 1 Madison Ave., New York City.

Sir John Wolfe Wolfe-Barry, one who, by his most varied ability, wide experience, sound judgment and untiring energy, represented the highest traditions of the engineering profession, died on January 22 in his eighty-second year. Sir John will perhaps best be remembered by the engineering societies in this country for his valuable work in connection with the British Engineering Standards Committee. This work inspired the standardization movement among the engineering societies here, which led to the establishment of the American Engineering Standards Committee. This committee now aspires to do the same valuable work for American engineering that the British committee has done for British practice.

Those members of the Society who are interested in this standards work would do well to refer to Sir John's lecture on The Standardization of Engineering Materials and Its Influence Upon the Prosperity of the Country, delivered as the James Forrest Lecture before the Institution of Civil Engineers in 1917, and published in London *Engineering*, vol. ciii, p. 432. His lecture contains a great mass of valuable and interesting information.

NINTH ROLL OF HONOR

MEMBERS of the Society can note with pride how our Roll of Honor is steadily lengthening—this in spite of the fact that the everyday work of a large number of the members is a patriotic service in itself. The call to arms appears to be irresistible and the response unhesitating:

ALEXANDER, W. P., Captain, Inspection Division, Ordnance Department, United States Army.

ALLEN, HENRY A., Colonel Commanding 108th Engineers, 33rd Division, Camp Logan, Houston, Tex.

ANDERSON, F. C., Captain, Engineers' Reserve Corps, Metuchen, N. J.

ATTERBURY, W. W., Brigadier-General, Director General of Transportation, American Expeditionary Forces, France.

BARTON, RAYMOND L., First Lieutenant, Ordnance Officers' Reserve Corps, United States Army.

BEEN, PAUL, Corporal, 9th Engineer Train, Courchesne Bridge, El Paso, Tex.

BERGES, ARTHUR H., Sergeant, First Battalion Headquarters, 23rd Engineers, American Expeditionary Forces, France.

BEVIN, SYDNEY, Captain, Ordnance Officers' Reserve Corps, Detached Service.

BLUMENFELD, R., Lieutenant, Ordnance Officers' Reserve Corps, Production Section, Carriage Division, Washington, D. C.

BORNHORST, A. H., First Lieutenant, Signal Officers' Reserve Corps.

BOOTHMAN, DALE M., First Lieutenant, Ordnance Officers' Reserve Corps, Engineering Bureau, Trench Warfare Branch, Washington, D. C.

BORDEN, JOHN M., Second Lieutenant, Ordnance Officers' Reserve Corps.

BREEDLOVE, L. B., First Lieutenant, Ordnance Officers' Reserve Corps, United States Army.

BRYAN, MARCUS K., Lieutenant, Ordnance Officers' Reserve Corps.

CHURCH, F. O., First Lieutenant, Company B, 26th Engineers, American Expeditionary Forces, France.

CLARKE, LEON L., American Expeditionary Forces, France.

COOLEY, M. E., Lieutenant Commander, Michigan Naval Brigade, Ann Arbor, Mich.

COOPER, HUGH L., Major, Engineer Officers' Reserve Corps, American Expeditionary Forces, France.

CORY, HARRY THOMAS, Major, Engineer Officers' Reserve Corps (unassigned).

CROSBY, W. W., Lieutenant-Colonel, 104th Engineers, Camp McClellan, Ala.

CULLEN, JAMES W., Signal Corps, United States Army.

DAVIES, T. R., First Lieutenant, Ordnance Officers' Reserve Corps, Carriage Division, Field Artillery Section, Ordnance Department, United States Army.

DAVIS, CALVIN E., Second Lieutenant, Aviation Section, Signal Officers' Reserve Corps.

DUFFY, FRANK J., Major, 103rd Regiment of Engineers, United States Army.

DUVENECK, FRANCIS B., Master Signal Electrician, 322nd Field Signal Battalion, United States Army.

EHRHARDT, JOHN J., Captain, Ordnance Department, United States Army.

EYRE, THOMAS T., Captain Engineers, United States Reserve, Commanding Company E, 113th Engineers, Camp Shelby, Miss.

FLICKINGER, HARRISON W., First Lieutenant, Signal Officers' Reserve Corps, Aviation Section, United States Army.

FOGG, OSCAR H., Captain, Officers' Reserve Corps, United States Army.

FORTNEY, C. P., Captain, Engineers, United States Reserve, Washington, D. C.

FULLER, FLOID M., Lieutenant, Reserve Force, United States Navy.

GARRETT, SEYMOUR S., Captain, Engineer Officers' Reserve Corps (Unattached), American Expeditionary Forces, France.

GATLEY, W. A., First Lieutenant, Ordnance Officers' Reserve Corps, Rock Island Arsenal, Ill.

GIEBEL, ROBERT L., Second Lieutenant, Ordnance Officers' Reserve Corps.

GRAVES, RALPH L., Captain, Field Artillery Section, Carriage Division, Ordnance Department, Ordnance Officers' Reserve Corps, United States Army.

HALL, ROLAND B., JR., Captain, Engineer Officers' Reserve Corps, France.

HAWES, ALEXANDER G., Captain, Ordnance Officers' Reserve Corps, United States Army.

HAYES, WILLIAM PARSONS, Lieutenant, Fleet Naval Reserve, assigned to U. S. S. Niagara.

HILL, REUBEN, Major, Ordnance Officers' Reserve Corps, Office of Chief of Ordnance, Washington, D. C.

HIRSHFELD, CLARENCE F., Major, Ordnance Officers' Reserve Corps, United States Army.

HOFFMAN, ROSCOE C., Captain, Ordnance Officers' Reserve Corps, Motor Equipment Section, Carriage Division, Washington, D. C.

HUNTER, HERBERT C., First Lieutenant, Trench Warfare Branch, Engineering Bureau, Ordnance Officers' Reserve Corps.

LEWIS, GOODRICH Q., Ensign, United States Naval Reserve Force.

LISKOW, B. H., Captain Engineers, United States Reserve.

LOCKARD, JAMES P., Second Lieutenant, 328th Field Artillery, Officers' Reserve Corps, Camp Custer, Battle Creek, Mich.

LORING, ERNEST J., Captain, Ordnance Officers' Reserve Corps, Design Section, Trench Warfare Branch, Gun Division.

LYNE, LEWIS F., JR., First Lieutenant, Ordnance Officers' Reserve Corps, Inspector of Ordnance.

MACARDELL, WESLEY E., Department of Engineers, U. S. Military Academy, West Point, N. Y.

MACEWAN, THOMAS S., Aviation Section, Signal Enlisted Reserve Corps.

MARDAGA, LOUIS, Ensign, United States Naval Reserve Force.

MARTIN, ELMER C., Engineer Officers' Training Camp, 7th Company, Camp Lee, Petersburg, Va.

MAURY, DABNEY H., Major, Engineer Officers' Reserve Corps, Office Cantonment Constructor, Washington, D. C.

MAXFIELD, HOWARD H., Lieutenant, Colonel 19th U. S. Engineers, American Expeditionary Forces, France.

MINICH, HENRY D., First Lieutenant, Ordnance Department, United States Army.

O'CONNELL, JOHN J., Captain, Ordnance Officers' Reserve Corps, United States Army.

PARK, J. FRANK, JR., 12th Engineers, Railway, H. O. Detachment, American Expeditionary Forces, France.

PETERS, CLIFFORD H., Lieutenant, Ordnance Officers' Reserve Corps.

PICCARD, J. E., Captain, United States Army, Corozal, Canal Zone.

POHLE, R. F., First Lieutenant, Production Officer, Ordnance Officers' Reserve Corps.

PULLEN, ROYAL R., First Lieutenant, 364th Infantry, Reserve Corps, Camp Lewis, Wis.

RENTON, J. LEWIS, Captain, Company G, First Regiment Hawaiian Infantry, National Guard, Erva, Hawaii.

REUTER, FRANCIS J. G., First Lieutenant, 7th Coast, Engineer Reserve Officers' Training Camp, United States Reserve.

RIDER, JOSEPH B., 2nd, Company E, 10th Engineers (Forestry), American Expeditionary Forces, France.

RITTER, E. R., First Lieutenant, Ordnance Officers' Reserve Corps.

ROLAND, P. W., Naval Aviation Corps.

RUGG, DANIEL M., 307th Engineers, United States Army.

SAGE, DARROW, Lieutenant, N. M. Y., United States Navy, U. S. S. Missouri.

SANDERS, WALTER C., Lieutenant, Coast Artillery Reserve Corps, United States Army.

SEATON, ROY A., Captain, Ordnance Officers' Reserve Corps, United States Army.

SELLMAN, NILS T., Engineer, Coast Artillery National Guards, United States Army.

SEYBOLD, EUGENE, First Lieutenant, Ordnance Officers' Reserve Corps, Watervliet Arsenal, Watervliet, N. Y.

SHATTUCK, CHARLES H., First Lieutenant, Ordnance Reserve Corps, United States Reserve.

SHUSTER, M. M., Naval Aeronautic Branch, Naval Air Station, Pensacola, Fla.

SLOAN, BEN, Captain, Ordnance Officers' Reserve Corps, Inspector of Ordnance, United States Army.

STRAUSS, JEROME, Lieutenant, Inspector of Ordnance, Ordnance Department, United States Reserve.

SWINBURNE, JAMES G., First Lieutenant, Ordnance Officers' Reserve Corps, United States Army.

UNDERHILL, CHARLES R., Captain, Aviation Section, Signal Reserve Corps.

VEHSLAGE, HAROLD E., First Lieutenant, Procurement Division, Ordnance Department, United States Army.

VOGT, CLARENCE W., First Lieutenant, Ordnance Department, U. S. R., Frankford Arsenal.

WADSWORTH, GEORGE R., Major, Engineer Officers' Reserve Corps, United States Reserve.

WANDEL, CARLTON, First Lieutenant, Ordnance Department, American Expeditionary Forces, France.

WILFERT, GEORGE, Captain, Ordnance Officers' Reserve Corps, United States Army.

WILKINS, CHARLES N., Aviation Section, Signal Enlisted Reserve Corps.

WOODS, SAMUEL H., Captain, Engineering Section, Quartermaster Corps, United States Army.

PERSONALS

In these columns are inserted items concerning members of the Society and their professional activities. Members are always interested in the doings of their fellow-members, and the Society welcomes notes from members and concerning members for insertion in this section. All communications of personal notes should be addressed to the Secretary, and items should be received by March 16 in order to appear in the April issue.

CHANGES OF POSITION

Gilbert G. Weaver, formerly director of the Coöperative Industrial School, York, Pa., has assumed the duties of director of the Dayton Industrial Institute, Dayton, Ohio.

H. Hamilton Weber has left the lubricating division of the Texas Company in New York, and has joined the efficiency department of the Hyatt Roller Bearing Company, of Newark, N. J.

James A. Campbell has resigned his position with the Renfrew Manufacturing Company, Adams, Mass., as mechanical superintendent, and has taken a similar position with Lever Brothers, Cambridge, Mass.

Charles A. Haynes, until recently superintendent of the Mohegan Tube Works, Brooklyn, N. Y., has assumed the duties of production engineer with the British Ministry of Munitions in the United States.

James Brakes, Jr., has resigned his position as power plant inspector for the Western Electric Company, Chicago, Ill., to accept the position of draftsman for the Gamm Bernstein Motor Truck Company, Lima, Ohio.

Martin Newcomer, formerly production manager of the American Player Action Company, New York, has become affiliated with the U. S. Cartridge Company, Lowell, Mass., as engineer in charge of shell waterproofing.

John F. Guthrie, formerly associated with the Arnold Print Works, of North Adams, Mass., in the capacity of mechanical engineer, has accepted a similar position with The Abrasive Company, of Bridesburg, Philadelphia, Pa.

Carl T. Carlson has resigned his position with the Springfield Boiler and Manufacturing Company, of Springfield, Ill., as chief engineer, and has accepted the position of combustion engineer for the City of Gothenburg, Sweden.

Earl B. Morgan has resigned as safety engineer for the Norton Company to take the position of safety engineer with the Liberty Mutual Insurance Company, of Boston, Mass. Mr. Morgan will take up his new duties March 1.

Frederick W. Burger has left the employ of the Delphos Manufacturing Company, Delphos, Ohio, to accept the position of assistant to the superintendent of the experimental department of the International Harvester Corporation, Chicago, Ill.

Harold E. Smock has resigned his position as chief draftsman of the Cohoes Rolling Mill Company, Cohoes, N. Y., subsidiary concern of the Page-Hersey Iron, Tube and Lead Company, of Toronto, Canada, to enter the Ordnance Department at Washington, D. C.

Melvin B. Newcomb is no longer connected with the special engineering department of the Firestone Tire and Rubber Company, Akron, Ohio, having assumed the position of chief draftsman of the hydraulic department of the Wellman Seaver Morgan Company, Cleveland, Ohio.

John H. Romann, until recently works engineer with the American Steel Foundries, Indiana Harbor, Ind., has become associated with the export department of J. T. Ryerson and Son, Chicago, Ill. Mr. Romann will leave for Europe in July as representative of the Ryerson Company for the Latin countries of Europe.

Frederick A. Barnes, for nine years with George S. Rider and Company, consulting engineers, Cleveland, Ohio, and for the past year in charge of the office, has severed his connection with that firm and is at present in Washington, in the quartermaster-general's office, engaged in the design of standardized shops for repairing military trucks.

Oliver M. Davis has left the employ of Swift and Company, with whom he was connected for the past six years, giving up his position of general superintendent of oil mills, Columbia, S. C., to take up work in connection with the Government's program for the building of fabricated ships, with headquarters at the Whitehead and Kales Iron Works, Detroit, Mich.

ANNOUNCEMENTS

M. E. Gould has become associated with the Covert Gear Company, of Lockport, N. Y.

John Calder has been made vice-president and general manager of the Aero Marine Plane and Engine Company, Keyport, N. J.

John B. Matthews has become affiliated with the Moore and Scott Iron Works, Oakland, Cal., in the capacity of engineer.

Joseph Wilcox, Jr., has entered the service of the Fitchburg Grinding Machine Company, Fitchburg, Mass., in the capacity of chief draftsman.

Greetings have been received from the front from our member, **P. G. Welford**, of the Canadian Field Artillery, in the form of an attractive card issued by the Fourth Canadian Division.

Louis Mardaga has entered the naval service in the capacity of Ensign, U. S. N. R. F., and is at present located as assistant naval inspector of ordnance, Alloy Steel Forging Plant, Carnegie, Pa.

John C. Mahoney, formerly connected with the General Electric Company at Atlanta, Ga., as district turbine inspector, has become associated with the Schenectady office of the same company.

Carl G. Barth, consulting management engineer, of Philadelphia, has been given a special commission in the matter of extending costs investigation for the Watertown Arsenal, Watertown Mass.

F. J. Hull, who was associated with the Pangborn Corporation as engineer, about five years ago, and more recently in the employ of the Mott Sand-Blast Company, has returned to the Pangborn Corporation in the capacity of assistant engineer.

Fred V. Hadley has resigned as chief engineer of the American Incandescent Heat Company, Boston, Mass., and has opened an office in Boston, Mass., for general consulting work, specializing in heat-treatment engineering and industrial-furnace design.

Robert L. Hibbard has resigned his position as assistant manager and gas engineer of the Riter-Conley Company, Pittsburgh, Pa., with which firm he was connected for the past 15 years, and has opened engineering offices in the Jenkins Arcade Building, Pittsburgh, Pa.

Joseph Esherick, of Philadelphia, Pa., has become associated with the Baker-Dunbar-Allen Company, which, under Mr. Esherick's personal supervision, will represent the D. Connelly Boiler

[illegible] The [illegible]boro Company, and the [illegible] Instrument Company.

JOHN W. L. BENNETT, after eight years of service with the City of New York, first as deputy commissioner of water supply and later as consulting engineer, announces that he is now associated with Ernest P. Goodrich and A. Pearson Hoover, consulting engineers, with offices at 261 Broadway, New York.

CAPT. CLARENCE W. VOGT was commissioned a First Lieutenant Ordnance Department, U. S. R., June 11, 1917, and was ordered to the Frankford Arsenal at Philadelphia, Pa., August 1. He was promoted to the grade of Captain Ordnance, U. S. N. A. January 22, 1918, and is in charge of the artillery primer shops at the Frankford Arsenal.

CHARLES S. HAMNER and HOWARD P. QUICK, who have been associated for some time in engineering inspection and appraisal work in New York, have taken over the engineering and sales

C. S. FOLLER

management of the Parson Manufacturing Company's system of fuel-burning apparatus and ash ejectors for power plants, ships and factory heating plants, with offices at 165 Broadway, New York.

L. H. BERGMAN, until recently fuel engineer for the Midvale Steel Company, Philadelphia, Pa., and J. W. Lauren, formerly vice-president of the Reynolds Wire Company, Dixon, Ill., have incorporated the American Industrial Engineering Company with offices in the Monadnock Building, Chicago, Ill., and will specialize on wire-mill equipment, pulverized-fuel installations, furnace work and fuel economy.

APPOINTMENTS

WILLIAM PARSONS HAYES has been appointed a Lieutenant in the Fleet Naval Reserve and assigned to the *U. S. S. Niagara*.

DAVID H. RAY has been appointed director of the Laboratory, U. S. Signal Corps School National Army, at the College of the City of New York.

NECROLOGY

WILLIAM L. DIERMAN

William L. Dierman was born on May 19, 1868, in Ghent, Belgium. He was educated in the College of Toulouse, France, and the College of Richmond, in London, England. In 1887 he received the degree of C.E. from Ghent University and in 1888 the degree of E.E. from the Montefiore Institute, Liège, Belgium.

Upon the completion of his engineering course he became associated with the Société Générale Electrique and was located first in Paris and afterward in Lille, France. It was while with the Société that he had charge of the building of tramways in European Russia and the Caucasus.

He was next connected with the Société Eclairage et Transmissions Electriques a Longe Distance, where his duties at first [illegible]

In 1890 he was commissioned by the Belgian Government to make a report on the electric traction of the United States. In 1891 he was made supervising engineer of the electric-traction department of the Compagnie Internationale d'Electricité, Liège. He was the designer of the electric-traction system of the Liège and Herstal Street Railway and of many other minor systems. He was the supervisor of the installation of the electric system in Liège. From 1893 to 1901 he was general manager of the concern of Dierman & Co., Liège, which later became the Société des Applications de l'Electricité in Liège. In 1901 he located in Brussels, where he acted as consulting engineer for the Compagnie Générale de Construction, Paris, Ateliers Rateau Muysen-Malines, and Ateliers de Construction de Blanc Misseron, designing electrical and mechanical plants for these companies.

Since the war he has been purchasing manager in New York for the Eclairage Electrique of Paris. In this connection he directed the purchase of machine tools and machinery for new works in France. He was the Administrateur Delegue for Belgium of his concern. He also maintained a private office as consulting engineer in Brussels.

Mr. Dierman was a member of the Société des Ingénieurs Civils de France. He became a member of the Society in 1915. He died on December 25, 1916.

GEORGE LELAND FALES

George L. Fales was born on May 18, 1878, in Nashua, N. H., and was educated in the grammar and high schools there. His technical education he obtained through self-study.

For two years he was in charge of the power plant of the Bayley Hat Manufacturing Co., Newburyport, Mass. His next position was with the G. R. & I. St. Ry. Co., Georgetown, Mass., as chief engineer of its 1200-hp. power plant. In September 1899 he was made chief mechanical engineer of the Boston Almshouse and Hospitals, Boston, Mass. In 1904 he resigned to take the

W. L. DIERMAN

position of chief engineer and electrician with the Great Northern Portland Cement Co., Marlborough, Mich., where he had charge of the power plant and mill equipment of motors, air compressors, etc. The following year he became connected with the Hudson Portland Cement Co., Hudson, N. Y., as chief engineer and electrician, having charge of the power plant and electric equipment. In February 1906 he was made superintendent of the power department of the Tennessee Copper Co., Copperhill, Tenn., having charge of all power plants of the company, aggregating 10,000 hp. in steam, electric, compressed-air and refrigerating machinery. In 1916, after ten years with the Tennessee Copper Co., he resigned to take the position of chief engineer with the Raritan Copper Works, Perth Amboy, N. J., which position he was holding at the time of his death.

Mr. Fales was a master operating engineer, a member of the Institute of Operating Engineers, and a member also of the National Association of Stationary Engineers. He became an associate-member of the Society in 1914. He died on December 29, 1917.

CHARLES S. FOLLER

Charles S. Foller was born in Buffalo, N. Y., on May 9, 1876. He attended the public schools of that city, and upon being graduated from the high school went to Hobart College, Geneva, N. Y., for a year. He also took special work in Cornell University.

He served an apprenticeship of one year at the machinist's trade with the Lake Shore & Michigan Southern Railway. He was then employed in the drafting room of the Brooks Locomotive Works, Dunkirk, N. Y., afterward accepting a position with the Pittsburgh Locomotive Works as chief draftsman, shortly being advanced to superintendent of frame work in the shops. From 1897 to 1905 he was connected with the designing department of the American Locomotive Co., and at the close of that period was the principal designer of new locomotives of the company. For about a year he was engaged in designing steel cars with the Standard Steel Car Co., Pittsburgh, Pa. For the last twelve years Mr. Foller has been associated with the Union Spring & Manufacturing Co., Pittsburgh, Pa., first as mechanical engineer and then as western sales manager, in charge of the office in St. Louis, Mo. In the summer of 1913 he returned to the headquarters of the company at Pittsburgh as general manager of sales.

Mr. Foller was a member of the Engineers' Society of Western Pennsylvania and the American Society of Testing Materials. He became a member of our Society in 1906. He died in Pittsburgh on December 30, 1917.

EDWARD McKIM HAGAR

Edward M. Hagar was born on June 21, 1873, in Salem, Mass. He was graduated from the Massachusetts Institute of Technology in 1893 with the degree of M.E., and in 1894 received his M.M.E. from Cornell University.

The following year he was employed by the North and West Chicago Street Railroad in their electrical-engineering department. In 1895 he became manager of the Chicago office of the Southwark Foundry & Machine Company, and in 1898 founded the firm of E. M. Hagar & Co., western agents for a number of firms handling engines and machinery. In 1899 he was appointed manager of the cement department of the Illinois Steel Co. In 1904 Mr. Hagar became president of the Universal Portland Cement Co., a subsidiary of the U. S. Steel Corporation, and in 1916 president of the Wright-Martin Aircraft Corporation and the Simplex Automobile Co The following year he was elected president of the American International Steel Corporation.

Mr. Hagar was a member of the American Society of Civil Engineers and of many clubs. He joined our Society in 1895. He died on January 18, 1918.

O. ZELL HOWARD

O. Zell Howard was born in Raleigh, N. C., on December 6, 1876. He was graduated from Lehigh University with the class of 1896, and during the next year was employed in the shops of the Crawford Mfg. Co., Hagerstown, Md.

His drafting-room experience he obtained with the Newport News Shipbuilding and Dry Dock Co., where his work dealt with marine-engine and boiler drafting. His next position was with the Baltimore Smelting and Refining Company on general machine drafting. In 1900 he turned again to marine-engine and boiler drafting with the Maryland Steel Co., Sparrows Point, Md. For about a year he was connected with the Bureau of Construction and Repair, Navy Department, Washington, D. C., on auxiliary machinery, resigning to take the position of mechanical engineer with the American Carbide Lamp Co., Philadelphia, Pa. In 1902 he became an instructor in the department of marine engineering and naval construction in the United States Naval Academy, Annapolis, Md. He assisted the head of the department in preparing textbooks on naval engines and machinery and on mechanical processes. He also assisted in the laying out and the superintending of the erection of experimental turbines and boilers in the Naval Experiment Station at Annapolis, and in making tests on the machinery already erected. For the last three years he has been supervising engineer of the Diamond Match Co.

Mr. Howard was a member of the American Society of Civil Engineers, the American Institute of Electrical Engineers and the Society of Naval Architects and Marine Engineers. He became a member of our Society in 1908. He died on December 20, 1917.

CHARLES D. PARKER

Charles D. Parker was born in 1858 in Worcester, Mass. He was educated in the public schools of that city and later attended Worcester Polytechnic Institute, being graduated with the class of 1879.

His first position was with the Crompton Loom Works at Worcester, where he worked at patternmaking for about six months. For the next year and a half he was in the drafting room, and at that time took charge of the patternmaking and drafting departments.

For the last fifteen years he was mechanical expert of the A.

O. Zell Howard

Burlingame Co., Worcester, Mass., builders of steam engines and sawmill outfits.

Mr. Parker became a member of the Society in 1886. He died on December 7, 1917.

GERALD EDGAR TERWILLIGER

Gerald E. Terwilliger was born on January 9, 1888, in Newark, N. J. He received his early education in the Barringer School, Newark, and entered Stevens Institute of Technology in 1905, from which he was graduated in 1909.

For the next two years he studied law and in 1911 was admitted to the bar of New York State. He specialized in patent law, where his technical training made him very successful. In addition to his legal profession, Mr. Terwilliger was interested in literary work, writing for newspaper and magazine publications. He was the editor of the *Stevens Indicator*, an alumni publication of Stevens Institute.

He became a junior member of the Society in 1910. He died on December 9, 1917.

CANDIDATES FOR MEMBERSHIP

TO BE VOTED ON AFTER APRIL 10

BELOW is the list of candidates who have filed applications since the date of the last issue of THE JOURNAL. These are classified according to the grades for which their ages qualify them, and not with regard to professional qualifications, i.e., the ages of those under the first heading place them under either Member, Associate or Associate-Member, those in the next class under Associate or Associate-Member, those in the third class under Associate-Member or Junior, and those in the fourth under Junior grade only. Applications for change of grading are also posted. Total number of new applications, 134.

The Membership Committee, and in turn the Council, urge the members to scrutinize this list with care and advise the Secretary promptly of any objections to the candidates posted. Any correspondence in this regard is strictly confidential. Unless objection is made to any of the candidates by April 10, and providing satisfactory replies have been received from the required number of references, they will be balloted upon by the Council. Those elected will be notified about May 15.

NOTE. The Council desires to impress upon applicants for membership that under the present national conditions the procedure of election of members may be slower than under normal conditions.

NEW APPLICATIONS

FOR CONSIDERATION AS MEMBER, ASSOCIATE OR ASSOCIATE-MEMBER

California

LIGHT, ARTHUR H., Chief Engineer, American Beet Sugar Co., Oxnard

UDALL, PHILLYS A., Chief Inspector, Holt Manufacturing Co., Stockton

WADE, FRANKLIN S., Supt. of Operation, Southern Counties Gas Co. of Cal., Los Angeles

Connecticut

STYER, OLIVER S., Chief Inspector, Pratt & Cady Co., Inc., Hartford

District of Columbia

FRYER, ROSS L., Consulting Engineer, Washington

GILL, JOSEPH R., Mechanical Supt., U. S. Department of Agriculture, Washington

GOODWIN, PERCY F., Captain, Engineers, U. S. R., Washington

HEINE, GREGOR H., Instructor in M. E., Catholic University, Washington

MARTIN, HARRY T., Captain, Ordnance Reserve Corps, U. S. Army, Washington

Georgia

BUSSEY, HENSON E., District Engineer, General Electric Co., Atlanta

Illinois

ARNOLD, DOUGLASS L., Chief Engineer, International Harvester Corp., Chicago

BRIGGS, WALTER B., District Manager, Shepard Electric Crane & Hoist Co., Chicago

DERROM, DONALD L., Works Manager, Munitions Department, Winslow Bros. Co., Chicago

HENSCHEL, OTTOMAR H., Associate Editor Technical Publishing Co., Chicago

O'CONNOR, JEREMIAH J., Chief Engineer Fenger High School, Chicago

ROBINSON, WILLIAM A., Secretary and General Manager, Charter Gas Engine Co., Sterling

RULE, PERRIN, Superintendent, Iroquois Iron Co., South Chicago

SMITH, WILLIAM P., General Superintendent, The Frost Manufacturing Co., Galesburg

Indiana

SNYDER, LEWIS A., Consulting Engineer, Studebaker Corp., Indianapolis

Iowa

SAYRE, HERBERT A., Coal Operator, Treasurer, Eagle Coal & Mining Co., Des Moines

Kansas

GREENFIELD, BENJAMIN, Engineer, Steam Power Dept., Empire Gas & Fuel Co., El Dorado

Louisiana

COULETTE, JEFFERSON D., Construction Engineer and Plant Superintendent, Gulf Refining Co., and Gypsy Oil Co., Shreveport

Massachusetts

MERRILL, MELDON H., Vice-President, Tennessee Eastern Electric Co., Boston

SAWYER, HARRY S., Assistant Works Manager, Wiley & Russell Division, Greenfield Tap & Die Corp., Greenfield

SKENTELBERY, CHARLES, Marine Superintendent, New England Fuel and Transportation Co., Boston

WILDER, CARL D., Assistant to the Superintendent, Reed Prentice Co., Worcester

Michigan

ERICKSON, JOHN, Electrical and Mechanical Engineer, Engberg's Elec. & Mech. Wks., St. Joseph

LUND, MATTHEW, Vice President and General Manager, Valley City Machine Works, Grand Rapids

Missouri

KOHN, NATHAN, Owner of The R. K. Engineers, St. Louis

NUTTING, FRANK S., Testing Engineer, Busch Sulzer Bros. Diesel Engine Co., St. Louis

New Jersey

BALDWIN, CHARLES M., Assistant Inspector of Machinery, U. S. Navy, B. & W. Company, Bayonne

KERR, HOWARD J., Assistant to General Superintendent, Babcock & Wilcox Co., Bayonne

REESE, LAURITS A., Superintendent, Jobbing & Tool Service Division, Edison Phonograph Works, West Orange

VOLZ, PHILIP, Mechanical Engineer, Forstmann & Huffmann Co., Passaic

New York

ANTHONY, MARC O., Consulting Engineer, A. Kimball Co., New York

BATES, JOHN R., Vice President, Wonham Bates & Goode, Inc., New York

BROWNELL, LOUIS M., Industrial Engineer, C. E. Knoeppel & Co., New York

CRAMER, SIDNEY R., Cost Estimator, American Locomotive Co., New York

DE VOGE, JOHN D., Foreman of Planning Dept., Watervliet Arsenal, Watervliet

DILTS, FRANK B., President, Dilts Machine Works, Inc., Fulton

HUBER, FRED F., Designing Engineer, C. W. Hunt Co., Inc., West New Brighton

ILTIS, JOHN, Designer and Estimator, Guarantee Construction Co., New York

KENNARD, RALPH B., Chief Draftsman, Niagara, Lockport & Ontario Pr. Co., Lyons

KIP, HENRY E., Engineer, Union Carbide Co., Niagara Falls

NOWLAND, BENONI, Superintendent Brass Department, John Thomson Press Co., Long Island City

PROCHAZKA, GUSTAV Z., Scientific Hull Draftsman, Newburgh Shipyards, Inc., Newburgh

SPENCE, PETER C., Mechanical Engineer, Department of Labor, State of New York, New York

TOURNIER, EDWARD J., Chief draftsman, American Ore Reclamation Co., New York

ULMANN, AUGUST, JR., Construction Engineer, Walter Kidde & Co., Inc., New York

WHITE, ELISHA J., General Superintendent, Standard Shipbuilding Corp., Port Richmond, Staten Island

WHITE, JAMES A., Chief Engineer, Harrison Radiator Corp., Lockport

WILLSEA, LOUIS P., President and Treasurer, The Willsea Works, Rochester

North Carolina

CHRISTIAN, CHARLES W., Manager Heating Department, General Fire Extinguisher Co., Charlotte

Ohio

ARTHUR, HARRY G., Machine Designer, Firestone Tire & Rubber Co., Akron

GATES, ROBERT M., Engineer, Thew Automatic Shovel Co., Lorain

HUNTER, JOHN R., Engineer Production, Goodyear Tire & Rubber Co., Akron

LOGEMAN, WILLIAM F., Superintendent The Standard Elec. Tool Co., Cincinnati

MAY, JOHN T. L., Instructor in Mechanical Engineering, Ohio State University, Columbus

YAEGER, HARRY C., Chief M. E., The Dalton Adding Machine Co., Norwood

Pennsylvania

EBERT, GEORGE W., Assistant Superintendent, Pedrick Tool & Machine Co., Philadelphia

LANDRY, JAMES N., Superintendent of Production, Aerial Bomb Div., Marlin-Rockwell Corp., Philadelphia

LEONARD, DAVID E., Chief Inspector, Remington Arms Co., Eddystone

MAGEE, WILLIAM G., Assistant Superintendent, The Baldwin Locomotive Works, Eddystone

MOSES, FRED C., Designing Engineer, Bethlehem Steel Co., Bethlehem

ROBERTSON, WALTER M., Special Representative, Vice-President and General Manager's Dept., Pressed Steel Car Co., Pittsburgh
YINGLING, JOHN C., in Assistant Charge Engineering Department, Iron City Products Co., Pittsburgh

Texas

CLYNE, CECIL B., Sales Engineer, Mine & Smelter Supply Co., El Paso
INGLESH, H. O., Chief Engineer, Southwestern Portland Cement Co., El Paso

Virginia

FULLER, Raymond C., Marine Draftsman, Newport News Shipbuilding & Dry Dock Co., Newport News
VESTAL, FRANK J., Test Engineer, E. I. Du Pont de Nemours & Co., Hopewell Works, City Point

Canada

WEEKS, WILLIAM C., University Club, Vancouver, B. C.

Holland

VAN DIJK, J. W., Manager, Lindeteves Stokvis, New York, India and Holland, Amsterdam

Philippine Islands

ROESLER, BERNHARD K., General Manager of George Whalen & Co., Manila

South America

ONSALDO, PEDOR, Engineer, Chief Director, Compania Industrial de Electricidad, Buenos Aires, Argentina

FOR CONSIDERATION AS ASSOCIATE OR ASSOCIATE-MEMBER

California

PORTER, JAMES W., Assistant to Superintendent, Cowell Portland Cement Co., Cowell

Connecticut

GRAHAM, GEORGE A., Engineer, Naugatuck Chemical Co., Naugatuck

Illinois

LLEWELLYN, PAUL, Works Manager, Interstate Iron & Steel Co., Chicago

Massachusetts

DANIELS, FRED H., Secretary and General Manager, Sanford Riley Stoker Co., Ltd., Worcester
WHITE, PERCIVAL, Automobile Expert, Ordnance Dept., U. S. Army, East Milton

Nebraska

BOWEN, WILLIAM S., In charge Aerological Station, Signal Corps, U. S. Army, Weather Bureau, Fort Omaha

New York

CALHOUN, LEROY V., Assistant Shop Superintendent, Hull Div., Navy Yard, New York
THOMA, ANDREW M., Engineering Department, New York Edison Co., New York

Ohio

ROWELL, JOHN T., Part Owner, Bock Machine Co., Cincinnati

Oklahoma

HEID, J. BENJAMIN, Assistant Mechanical Superintendent, Gosden & Co., Tulsa

England

WHATMORE, ALBERT, Chief Assistant Engineer, The Olympia Oil & Cake Co., Ltd., Selby

FOR CONSIDERATION AS ASSOCIATE-MEMBER OR JUNIOR

Connecticut

BRENNAN, MICHAEL J., Checker of Tool Design, Colts Patent Firearms Mfg. Co., Hartford
HENRICKSEN, HARRY E., Mechanical Engineer, American Graphophone Co., Bridgeport
WOOD, HAROLD J., Draftsman, Remington Arms-U. M. C. Co., Bridgeport

Illinois

CAMERON, WILLIAM E., Maintenance Engineer, Sherwin-Williams Co., Plant No. 2, Kensington
MORGAN, EVERETTE K., General Superintendent, Rockford Drilling Machine Co., Rockford

Massachusetts

SIBLEY, EDWARD W., Mechanical Engineer, Aberthaw Construction Co., Boston

Michigan

SPREEN, CHARLES C., Assistant to Assistant General Manager, Dort Motor Car Co., Flint

New Jersey

CRARY, JAMES H., Inspector of Machinery, Bureau of Steam Engineering, U. S. Navy, and Babcock & Wilcox Co., Bayonne
PERRY, JESSE V., Assistant Superintendent, Spencer Kellogg & Sons, Inc., Shadyside

New York

BRICE, NORMAN E., Mechanical Engineer, The Permutit Co., New York
GARLAND, PHILIP, Mechanical Engineer, Technical Department, The Permutit Co., New York
JONES, WALTER H., Engineering Draftsman, New York Central Railroad Co., New York
MITCHILL, GEORGE L., Chief Inspector, Electric Bond & Share Co., New York

Oklahoma

COLLINS, SAMUEL W., Oil-Drilling Contractor in Oil Fields of Okla., Tulsa
MULLERGREN, ARTHUR L., Secretary and Treasurer, Electrical and Mechanical Engineer, Benham Engineering Co., Oklahoma City

Pennsylvania

TAYMAN, GEORGE S., Mechanical Engineer and Draftsman, Crucible Steel Co., Pittsburgh

FOR CONSIDERATION AS JUNIOR

Connecticut

PAUGH, CHARLES T., Assistant Chief Draftsman, Small Tools Department, Remington Arms & Ammunition Co., Bridgeport

District of Columbia

BOYLES, RALPH R., Draftsman, Ordnance Department, U. S. Naval Gun Factory
FLAD, ALBERT E., Mechanical Draftsman, Engineering Bureau, Ordnance Department
FORD, ARTHUR C., Mechanical Draftsman, U. S. Ordnance, Engineering Bureau
PARKHURST, DOUGLAS L., Mechanical Draftsman, Ordnance Department, War Department

Illinois

MAITRA, KRISHNA M., Special Apprentice, Chicago & North Western Railway, Chicago

Maryland

ADDISON, WALTER W., Chief Draftsman and Assistant to Chief Engineer, Baltimore Tube Co., Inc., Baltimore
MOORE, JOHN H., Production Department, Bartlett Hayward & Co., Baltimore

Massachusetts

KENDALL, GEORGE H., Head of Standards Division, Engineering Department, Norton Co., Worcester
LEVI, ELIJAH, Ship Draftsman, Boston Navy Yard, Hull Division, Boston
WINDLE, ARTHUR E., Cadet in Ground Officers' Training School, Aviation Section, Signal Corps at Massachusetts Institute of Technology, Boston

Michigan

SMITH, JOHN M., Draftsman, The Prescott Co., Menominee

Minnesota

GUNNARSON, CARL A., Assistant Superintendent, Department of Buildings and Grounds, University of Minnesota, Minneapolis
PALMER, LLOYD J., Chief Clerk, Chief Engineer's Office, Northern States Power Co., St. Paul

Missouri

LUBKE, ARTHUR F., Consulting Engineer, St. Louis

New Jersey

GAISSERT, HERMAN O., Mechanical Engineer, Keuffel & Esser Co., Hoboken

New York

BEROLZHEIMER, HENRY, Student in Chemical Engineering, Columbia University, New York
HILL, ERNEST K., Machinist, Thomas Morse Aircraft Corp., Ithaca
PETERSEN, CARL E., Assistant to General Superintendent, Morse Dry Dock & Repair Co., Brooklyn
POLDERMANS, DANIEL, JR., Assistant Secretary and Treasurer, Wonham, Bates & Goode, Inc., New York

Ohio

REHN, OTTO F., Special Apprentice, Buckeye Steel Castings Co., Columbus
HAMILTON, HARRY E., Efficiency Foreman Coke Plant, The Youngstown Sheet & Tube Co., Youngstown

Oklahoma

HIGLEY, Frank R., 1st Lieutenant, Ordnance Department, Infantry School of Arms, Fort Sill

Pennsylvania

LEBAIR, MOREAU S., Assistant to Purchasing Agent, Central Construction & Supply Co., Philadelphia
MURDOCK, ALEXANDER, JR., Engineer, D. L. Taylor Co., Inc., League Island Navy Yard, Philadelphia
TIETZEL, ALBERT M., Designer Coke-Plant Work, Cambria Steel Co., Johnstown
WOLFF, JOHN F., Engineer, The Schwarz Wheel Co., Frankford, Philadelphia

Rhode Island

SMITH, NORMAN H., Draftsman, Potter & Johnston Machine Co., Pawtucket

Virginia

DE KLYN, JOHN, Technical Assistant, National Advisory Committee for Aeronautics, Hampton

Canada

STILES, EDWIN M., Chief Draftsman, Consolidated Mining & Smelting Co., Trail, B. C.

[illegible]

[illegible] Department [illegible] Ottawa

[illegible]TON, W[illegible] G., 4th Year Student [illegible] Faculty of Applied Science, University [illegible] Toronto — Toronto

APPLICATION FOR CHANGE OF GRADING

PROMOTION FROM ASSOCIATE

New Jersey

MOLYNEUX, GEORGE E., Consulting, Development of Inventions, Special Machinery, — Bayonne

PROMOTION FROM ASSOCIATE-MEMBER

Connecticut

SCHAFER, ROBERT H., Mechanical Superintendent, Bridgeport Brass Co., — Bridgeport

SEWARD, HERBERT L., Assistant Professor of Mechanical Engineering, Sheffield Scientific School, Yale University, — New Haven

Indiana

WEBSTER, [illegible] E., Captain, Ordnance Dep[illegible] U. S. Reserves, U. S. Inspector [illegible] Bartlett Hayward Co. — Baltimore

New Jersey

MARLOW, FR[illegible] W., Master Mechanic, Armour & Co. — Jersey City

Hawaii

HIND, ROBERT R., Consulting Sugar House Engineer, H. Hackfeld & Co., Ltd. — Honolulu

PROMOTION FROM JUNIOR

Delaware

ANDERSON, HENRY, JR., Assistant Engineer, E. I. du Pont de Nemours & Co., — Wilmington

District of Columbia

LORD, HAROLD S., 1st Lieutenant Engineer R. C., Purchasing Officer for Engineer Supplies

Massachusetts

WYMAN, DWIGHT M., Mechanical Engineer, Aberthaw Construction Co., — Boston

New York

MAHONEY, JOHN F., Foreman Draftsman, Motive Power Dept., Interboro Rapid Transit Co., — New York

WHITING, RICHARD A., Engineering Department, New York Edison Co., — New York

Pennsylvania

HALDEMAN, PAUL C., Master Mechanic, Lukens Steel Co., — Coatesville

SUMMARY

New Applications	134
Applications for change of grading	
Promotion from Associate	1
Promotion from Associate-Member	8
Promotion from Junior	6
Total	149

EMPLOYMENT BULLETIN

THE SECRETARY considers it a special obligation and pleasant duty to make the office of the Society the medium for assisting members to secure positions, by putting them in touch with special opportunities for which their training and experience qualify them, and for helping anyone desiring engineering services. The Society acts only as a clearing house in these matters.

IN forwarding applications, stamps should be enclosed for transmittal to advertisers; applications of non-members should be accompanied by a letter of reference or introduction from a member, such reference letter to be filed with the Society. Copy for The Journal should be in by the twelfth of the month.

GOVERNMENT REQUESTS

MEN WANTED AT ONCE for Government work in Division of Trade Tests as a Committee on Classification of Personnel in the Army to engage in preparation of data and questions and also outline possible performance tests to be used in carrying out the work in the possible trade ability of men in the camps and cantonments, or some of the work in the new draft. Must be men, if possible, broadly familiar with wide variety of industries and competent to formulate or assist in formulating questions to be used in these matters, correspondence with or visits to individuals or camps nearby, from whom they can obtain original data, or confirmation and testing of data which has been prepared, and otherwise in assisting in the preparation of this material. Subsequently to probably be located in the various camps and cantonments to cooperate with the Army Personnel Officers in the application of data which have been prepared and obtained. 2584.

DRAFTSMEN for Bureau of Ordnance, Navy Department. Graduates in mechanical engineering from a technical school or college of recognized standing and who have had some drafting experience, or men who are competent designers of heavy machinery, engines or shop tools and have had a number of years' drafting room experience. Pay ranges from $4 to $6.88 a day, depending upon the qualifications of the draftsmen. 2585.

MEN for Inspection Division Ordnance Department, with both technical training and shop experience and who are beyond the draft age; those accepted will be commissioned. Also men within draft age who have the required qualifications and are not in the first class will be considered for commissions. 2586.

ONE HUNDRED CANDIDATES for commissions in Ordnance Officers' Reserve Corps required for Trench Warfare Section of Ordnance Department. Men over draft age, physically sound, of good character, with business experience, university training and technical skill particularly needed. Application form will be forwarded by the Society. 2588.

POSITIONS AVAILABLE

SALESMAN, preferably experienced on conveying machinery. Splendid opening with good future for right man. Please give full details of experience, age, salary expected, etc. Location Missouri. Record and applications confidential. 1186-C.

THE WESTERN ELECTRIC CO. has opportunities for physicists, engineers, designers and draftsmen for work of research, development and design related to problems of telephonic, telegraphic and radio-communication, which are matters of public importance. Both temporary and permanent positions are open. Apply by letter, not in person to F. B. Jewett, Chief Engineer, 463 West St., New York City. 2178-C.

MECHANICAL ENGINEER, technical graduate, with several years' experience along general and mechanical lines. One conversant with industrial machine design preferred. Permanent position with large corporation. State age, college, previous experience and salary desired. Location Cleveland. 2023-C.

MECHANICAL DRAFTSMAN. Young college graduate preferred. General industrial mechanical engineering work. Permanent position with large corporation. State age, college, experience if any, and salary desired. Location Cleveland. 2024-C.

SALES MANAGER. Engineer experienced in estimating and selling to hold responsible position in long-established engineering and contracting business of an incorporated company. Possible opportunity to become financially interested. Give age and experience in reply. 017-C.

METALLURGIST of good training and reasonable experience for work along lines of heat treatment, experimentation, machine grinding, tube and steel production and gas producers. Location Ohio. 023-C.

DRAFTSMAN, experienced in flour-mill, grain elevator, power-transmission, elevating and conveying machinery. Location Kansas. 024-C.

DRAFTSMAN - DESIGNER on electrical machinery, etc. Salary $1500 to $1800. Location Bayonne, N. J. 026-C.

ENGINEER AND DRAFTSMAN on designing of marine machinery in a large and long-established corporation. Location near New York. 028-C.

GENERAL SUPERINTENDENT for plant near New York with over 1200 employees. Applicant must have a technical training, a highly developed technique in widely different fields, a keen sense of justice, obvious ability to be a successful executive in a democratic organization, and a thorough appreciation of the importance of making deductions from facts alone. The man chosen for the position will be given opportunity to learn technique and establish himself in the confidence and esteem of the personnel. He will probably not be given full responsibility within a year. Department is one of very large organization and affords opportunity for advancement. 032-C.

MECHANICAL ENGINEER AND MASTER MECHANIC. American preferred, 30 to 50 years of age, for factory employing about 500 people. Well-equipped machine shop for repairs and manufacture of new machinery. Really capable man wanted who has sufficient training and experience to qualify him for his work. Must be a technical graduate, with thorough practical experience; able to handle men; sober, reliable and ambitious. Suitable salary and good future assured to right man. Reply by letter, stating experience and qualifications. Location, N. J. 033-C.

YOUNG MECHANICAL ENGINEER with three or four years' practical experience out of college, for chemical testing of boilers, fans, pumps, etc. Salary depends on man. Apply by letter. Location New York, with occasional trips in the East. 039-C.

DRAFTSMAN for New York office. Man over 30 years of age who is capable of developing suggested ideas in machine tools. Willing to pay $40 per week or more to man of more than average ability. 040-C.

DRAFTSMEN AND DESIGNERS for routine copper- and brass-mill work. Several men who are qualified to accept such a position. Long experience in a copper or brass mill not absolutely essential, but a good mechanical knowledge is. Location Elizabeth, N. J. 042-C.

YOUNG ENGINEER capable of handling boiler tests to determine the most economical operation under various grades of coal and under different station loadings. Should be familiar with boilers, stokers, methods of testing and the working up of the tests. Location Poughkeepsie, N. Y. 044-C.

ELECTRICAL OR MECHANICAL ENGINEERING GRADUATE in works-engineering division. Prefer man with experience along lines of industrial power-house and electrical engineering. Location Connecticut. 045-C.

APPRAISAL ENGINEERS who have the experience and are competent to make appraisal of equipment and machinery for by-product coke-oven plants, chemical plants, bituminous coal mines, etc. Prefer to engage competent parties in Milwaukee or Chicago. 047-C.

YOUNG EFFICIENCY ENGINEER with practical experience in time study, rate setting, piece, premium and bonus systems, as assistant to head of department. Must be able to supervise. Excellent opportunity. Give age, education, previous experience, salary desired, etc. Reply Efficiency Department, P. O. Box 400, Cleveland, Ohio. 052-C.

HIGH-GRADE TECHNICAL SALES ENGINEERS with personality, and experienced in gasoline trucks. Men who are producers, have made big money and who are able to stand prosperity. Experience must cover gasoline truck sales. References must be without question. 054-C.

ASSISTANT TO SUPERINTENDENT of mechanical department, a portion of the time as draftsman. Must be a technical graduate engineer with at least five years' experience in an industrial plant, preferably a glass-manufacturing concern. One having some experience in handling men and who has been successful in getting results in general plant construction, upkeep and maintenance, and also construction and maintenance of machinery, power plants and glass-house furnaces. Location New York State. 056-C.

DRAFTSMAN experienced in glass-house or steel-furnace design and construction; must have several years' experience. Location New York State. 057-C.

DRAFTSMAN experienced in general industrial plant, machinery repair and upkeep. Location New York State. 058-C.

DRAFTSMAN with at least six months' experience in mechanical designing for department of experimental engineering. Must have original ideas and initiative. Salary to start $1200. Location Connecticut. 059-C.

DETROIT SALES REPRESENTATIVE. Capable engineer to handle steam-heating specialties in Michigan. Salary, commission and expenses. State experience fully. 060-C.

ENGINEER skilled in the design of small steam turbines to design an efficient steam turbine of less than 10 hp. Temporary position. Location Pennsylvania. 064-C.

CHIEF ENGINEER to run plant of 2400 boiler hp. situated in New Jersey. Must have had practical experience with Corliss engines, condensing and auxiliary apparatus and methods of securing economical boiler operation. Must be able to control help. Mechanical experience necessary, technical experience desirable. 065-C.

BOILER-ROOM EFFICIENCY MAN. Young man who has tact, a pleasing personality and the perseverance to get the desired results. Should have a general knowledge of power plants and their operation and, if possible, actual experience in the operation of a power plant. Salary commensurate with ability to produce results. Location Rhode Island. 066-C.

HIGH-GRADE MECHANICAL ENGINEERS of construction experience for work on powder and explosive plants for U. S. Government. Apply, stating age, nationality, experience, references and salary desired. Location Delaware. 067-C.

SALES ENGINEER, between 25 and 30, for condenser and cooling plants. State experience, salary expected, and give references. Location Pennsylvania. 072-C.

SALESMAN experienced in high-class Diesel or semi-Diesel fuel-oil engines. Unusual opportunity on a salary and commission basis in desirable territory, covering a superior line of engines. State age, education, experience, etc. Location Illinois. 073-C.

SALES ENGINEER, high-class man, experienced in sale of Diesel or semi-Diesel fuel-oil engines; man of strong personality, capable of organizing and superintending agencies. A very attractive opportunity. Give, in confidence, age, education and experience. Location Illinois. 074-C.

ASSISTANT AND FOLLOW-UP MAN on operation of shell shop. Should be systematic and painstaking and have a general knowledge of mechanical drawings to readily identify parts and keep account of work in the shop. Location New Jersey. 075-C.

GENERAL FOREMAN for factory employing 100 men. Must be competent executive and experienced in manufacture of three-jaw independent chucks. Location Chicago, Ill. 076-C.

MECHANICAL ENGINEER with executive ability, experienced as experimental engineer on woodworking machinery. Salary depends on man. Location Middle West. 077-C.

SUPERINTENDENT in machine shop employing about 100 men. Technically trained man who has had actual experience as superintendent of a machine shop. Product is hand elevating trucks for use in factory transportation. Location Massachusetts. 080-C.

TOOL DRAFTSMEN for engineering department of concern. Brooklyn. Pay to start is $35 a week, with promotion; 48 hours a week. 081-C.

DESIGNER experienced on hydraulic presses and pumps. State experience and past connections. Location Illinois. 082-C.

MECHANICAL DRAFTSMAN for permanent position. Working conditions and prospects good. Location Minnesota. 083-C.

TOOL DESIGNER. High-grade man experienced on heavy automatic screw-machine tools. Must be capable of standardizing tools and records. Write, giving full details as to experience, references and salary expected. 085-C.

SUPERINTENDENT for boiler shop combined with heavy tank and plate works, also making light tank work, stacks, breechings, etc. Desire man of executive ability, organizer and one who can handle foremen and men for highest efficiency. State experience and salary expected, also when available. Location Middle West. 086-C.

DRAFTSMAN who is an experienced designer of railway cars, to design draft gear, journal boxes, etc., and make engineering calculations relative to same. Rate of pay in accordance with the ability of the man and general rate prevailing for such services at the present time. Wanted for a permanent position. Location New York State. 087-C.

STAFF OF 100 BIG MEN wanted by large industrial plant in Alabama engaged in important Government work. Superintendents, assistants, foremen and chief operators are needed. Chemical, electrical, electrochemical, gas, liquid air, refrigerating and mechanical engineers, all with operating experience; college men with technical training, and familiar with cement, power, refrigerating, chemical, sugar-refining and electric plants; operators experienced on mining and milling machinery, crushers, conveyors, compressors, furnaces, kilns, ovens. Competent men will be trained in the processes, paid good salaries during instruction, and given an attractive contract as soon as qualified. State age, nationality and experience. 088-C.

MEN AVAILABLE

SUPERVISING FUEL-EFFICIENCY AND WATER-SOFTENING ENGINEER. Member, under 40, with technical education and 18 years' experience in the construction and operation of steam plants, the handling of all classes of men, the testing and chemical treatment of waters, and in the burning and testing of gas, oil and all grades of anthracite and bituminous coals. Knows how to obtain results. Position must carry full authority and pay not less than $4000. C-54.

CHIEF ENGINEER OR MASTER MECHANIC with thorough technical and practical experience covering construction, operation and upkeep of steel plant. Specialty metallurgical work, heating and melting furnaces. C-55.

SAFETY ENGINEER with six years' thorough technical and practical experience in this capacity with large steel works in Pennsylvania. C-56.

ELECTRICAL ENGINEERING GRADUATE with five years' mechanical experience in design of oil-well tools and machinery including gas engines, compressors, pumping jacks, etc.; also experienced in design of machinery for manufacturing 6-in. shells. Student of Alexander Hamilton Institute. Prefers Government work, but will consider anything paying over $125 per month. C-57.

EXECUTIVE MANAGER. An executive of ability and aggressiveness, a mechanical, technical graduate, at present employed, desires to connect with a manufacturer whose business may need systematizing and building up as to organization and production. Has had a varied experience in different branches of manufacturing, operating industrial plants along lines of scientific management, and is fully conversant with modern methods of manufacturing and marketing products. Only interested in a permanent position offering good possibilities for improvement. C-58.

MECHANICAL ENGINEER, Member, technical graduate with over 20 years' shop and mill experience wishes to locate with large New England concern in executive capacity. An important opening only considered. Now employed. C-59.

MECHANICAL ENGINEER experienced in the design of power plants, industrial plants, heating, ventilating, etc. Has held executive positions and had charge of men. Desires responsible position. C-60.

AVAILABLE FOR GOVERNMENT SERVICE MARCH 1—INDUSTRIAL AND PRODUCTION ENGINEER with 17 years' manufacturing experience in metal-working trades. At present chief of production at plant employing 2600. Practical man, with exceptional experience, who desires to enter Government service. C-61.

STEAM ENGINEER wants position with large power or industrial company; six years' technical training in electrical and mechanical engineering, five years' experience in steam power work; familiar with all types of steam and electrical equipment. Associate member, A. S. M. E. Can furnish the best references. Will be available March 1. C-62.

MECHANICAL-ELECTRICAL ENGINEER, Columbia graduate, at present employed as manager of a very large concern, desires position as sales manager or superintendent. Experienced in internal-combustion engines and foundry and machine-shop practice, gas producers, power installations and marine power plants. Unusual business and technical training. Fully conversant with French, Italian and Spanish. Minimum salary to start $4000. C-63.

MECHANICAL-ELECTRICAL ENGINEER, Cornell graduate, age 32, married, desires executive position in the production or manufacturing department of a progressive concern where initiative and tact, coupled with past training and experience, will be of maximum value toward further advancement; experienced in machine-tool operation, design of labor-saving devices and special and automatic metal-working machinery; systematizing, production engineering, etc.; first-class references as to character and ability. Available on two weeks' notice. C-64.

INSTRUCTOR OR ASSISTANT PROFESSOR OF MECHANICAL ENGINEERING. Technical graduate with shop, drafting-room and teaching experience; can also handle military instruction. Services available at end of present semester. Location preferred Eastern or Middle Western States. C-65.

MANUFACTURING ENGINEER, 33, married, desires permanent responsible position. Thorough, mechanical and efficient production experience with fine machines and sheet metal goods. Present duties deal with labor-saving devices, estimates, investigations, rate and bonus layouts, instructions, etc. Salary $2500. C-66.

MECHANICAL OR WORKS ENGINEER. Technical graduate, age 30, married. Good organizer and executive, experienced in design, construction and maintenance of paper mills and metal-manufacturing plants, etc.; in management of shop, yard, office and drafting room forces. Location Eastern States preferred. C-67.

POWER PLANT ENGINEER with 26 years' experience. Can build and operate. C-68.

MECHANICAL ENGINEER AND SUPERINTENDENT. American, with 14 years' practical and theoretical experience. Specialist in steam, air, gas, oil and water engineering specialties; machine-tools, fixtures and shop equipment; shop maintenance, efficiency, engineering testing and production engineering. Executive who can go into shop and do things. Successfully held positions involving above. At present employed. Salary $3000. C-69.

MECHANICAL ENGINEER desires executive position in organization where small or medium-sized work is manufactured. Fourteen years' practical experience as tool and die maker, tool and automatic-machine designer and chief designer. At present assistant works manager in one of the best tool-manufacturing concerns in the country. Present salary $2500 plus bonus. C-70.

MECHANICAL ENGINEER OR ENGINEER OF CONSTRUCTION. Junior member, age 27, University of Pennsylvania graduate, married, class 4-A Federal draft. Engaged in gas, by-product coke, benzol recovery and power plants, erection and operation. Desires permanent position with growing concern where merit is appreciated. At present employed. Best of references. Salary to start $175. C-71.

CHIEF DRAFTSMAN OR PRODUCTION ENGINEER. Eleven years' experience in general engineering, charge of design of internal-combustion engines, railway cars and equipment, furnaces, plant layouts, installation of machinery, automatic machinery, jigs and tools, production, efficiency and routing. At present in charge of technical and mechanical problems in consulting capacity. Position must be permanent. Location New York City or vicinity. Salary $2200 to $2500. C-72.

INSTRUCTOR OR ASSISTANT PROFESSOR OF INDUSTRIAL ENGINEERING. Junior member, age 26, married, M. E. from prominent Eastern university, is looking for a change where he will have charge of the shopwork and teach subjects in industrial engineering. Has had general mechanical experience and since graduation studied and worked under a pioneer in the teaching of scientific management. For three years has taught shopwork under applied methods of shop management, had charge of the machine shop and taught time study, cost accounting, etc. Would assume new duties about September 1, but is desirous of starting correspondence now with those interested. Prefers to locate in the East. Minimum salary $1600. C-73.

ASSISTANT TO EXECUTIVE OR EXPERIMENTAL ENGINEER. Stevens M. E. graduate, 28, married, finishing present engagement some time in March. Three years' successful experience in executive and experimental work in natural gas, two years in power-plant operation. Possesses energy, initiative, self-confidence and unusual mathematical ability. Desirous of securing a position with large industrial or engineering concern. Position must be permanent and offer a future. Initial salary not a primary consideration. C-74.

DESIGNING ENGINEER, CHIEF DRAFTSMAN OR MECHANICAL EXECUTIVE, age 36, technically qualified; practical and supervising experience and competent to design, develop and standardize mechanical products, particularly machines involving complex mechanism and covering a range of sizes, or to organize or direct a department for such work. Specialized knowledge of design and production of a leading line of high-grade textile machinery and accessories, also valuable experience on steam and hydraulic appliances. Prefers connection with growing concern whose expansion calls for establishment of mechanical-development department, handling problems of product and equipment. Salary $3500. C-75.

EXECUTIVE OR ASSISTANT SUPERINTENDENT, American, technically educated, age 36. Practical mechanic, familiar with design of special machinery, tool, jigs, fixtures, etc., for manufacturing duplicate parts on interchangeable system. Twelve years in drafting room, part of time as chief draftsman; six years' shop experience, one as foreman. Salary $2500. Location preferred Eastern States. C-76.

MECHANICAL ENGINEER, Associate-member, age 34, with 12 years of broad experience in designing and construction of various automatic and special machinery. Practical man with executive ability and thoroughly versed in modern methods of interchangeable manufacturing. At present connected with a large corporation, but desires permanent position with prospects for future advancement. Salary $3000. C-77.

MECHANICAL AND MARINE ENGINEER, age 40, with 15 years' experience in the design and construction of ships and power equipment, engines, boilers and auxiliaries; also experienced along general engineering lines and electricity. Thoroughly competent to handle men and take charge of the design and construction of merchant ships and machinery. Good reasons for wanting to make change. C-78.

MECHANICAL ENGINEER with 10 years' experience in building and tool valuations and field engineering along the lines of mill and power buildings. Now open for engagement. Location Chicago or vicinity. C-79.

SALES ENGINEER. Member, age 34, experienced in the manufacture and selling of iron and steel, wishes position with high-class firm as production or sales engineer. At present employed. C-80.

PLANT ENGINEER. Member, age 39, with 12 years' experience in plant upkeep, designing new buildings and equipment, labor-saving and material-handling devices, repairs to machinery or equipment, power, light, heat and plumbing. At present and for past five years with large metal-working plant. Record of experience and references to those interested. C-81.

TECHNICAL GRADUATE (1904), member A.S.M.E., now employed as mechanical engineer and managing two steam-turbine plants, desires executive position with large manufacturer or public-utility company. Experienced in design, construction and maintenance of high-tension sub-stations, steam plants, piping, buildings, steam and electrical equipments. Best references. Locality Eastern States preferred. C-82.

ENGINEERING SURVEY

A Review of Engineering Progress and Attainment in Mechanical Engineering and Related Fields, Including a Digest of Current Technical Periodicals and Selected Titles of Engineering Articles

Saving Fuel Through Operating Economies in Electric Street Railways

THE Electric Railway War Board has recently made public the report made last December by a committee appointed to investigate the fuel savings possible on the street railways in Washington, D. C.

The report covers partly conditions peculiar to the city of Washington, but also touches upon subjects of general interest to electric street railways.

The report shows that the present system of car stopping at every corner (in some cases because of local regulations, even when there are no passengers to take on or discharge) involves a considerable delay in the operation of the cars and a material increase in the consumption of the coal. The committee recommends, therefore, the use of the skid-stop plan, or stopping at alternate corners, as well as the elimination of stopping at rapid-transit corners and other minor delays in operation.

Another recommendation covers the elimination of the present system of running an unnecessary number of cars to the far end of lines where there is not enough traffic. It is believed that for the Washington railways the elimination of unnecessary mileage would save approximately 3200 tons of coal per year.

Still another recommendation covers the generation of the entire power load for the two lines operating in the city at the most efficient plant of one of these companies. It has been found that because of various existing conditions one plant is able to operate with 1.9 lb. of coal per kw-hr., while the other two plants consume 2.6 lb. and 4.1 lb., respectively. Making suitable allowance for losses in transmission, the saving in coal from shutting down these two latter plants is estimated at 9700 tons per year.

A suggestion which might apply to a good many cities besides Washington, of course with proper modifications to meet local conditions, refers to staggering office hours of Government employees. It seems that there are nearly 50,000 Government-department employees who are dismissed each day at 4.30 p.m. This requires a material increase in the number of cars after 4 p.m., which can in a general way be attributed to the necessity for carrying department employees. Most of these additional cars, it is to be noted, make only two round trips.

If the office hours were staggered so as to begin at 15-min. intervals from 8.30 a.m. to 9.15 a.m. and to close correspondingly from 4.00 p.m. to 4.45 p.m., considerable relief would be obtained in street congestion and a saving effected in coal. It is estimated that on such a basis the rush-hour cars could make three trips instead of two, which would cut down the number of additional cars required for this purpose by a third.

It is interesting to note that while the total consumption of coal on the Washington street railways amounted to about 12,760 tons per month, the recommended savings would reduce this consumption by 25,790 tons per year. (*Electric Railway Journal*, vol. 51, no. 6, February 9, 1918, pp. 267-270)

Reorganization of the Quartermaster General's Office

Reorganization of the staff of the Quartermaster General was completed by Gen. George W. Goethals, Honorary Member Am.Soc.M.E., on January 26, and in addition to a general rearrangement of the administrative boards, it includes the storage and traffic service for the general staff.

In the general scheme of the new organization there are three service bureaus, but the Storage and Traffic Organization, comprising four operative divisions, is largest by an additional bureau called the Distribution Priorities Bureau. The function of this service will be to advise the Director of Storage and Traffic with respect to all matters of priority and distribution and to secure data on which to base the apportionment of the use of storage, transportation and embarkation facilities among the various operating divisions.

The three other bureaus embodied in the new organization are as follows:

The General Administrative Bureau has control of the preparation of data and orders for executive action, verification and approval of estimates and supervision of general administrative procedure in the various offices of the Quartermaster's Corps. It also includes an Information and Statistics Section and a Contract Supervision Section.

The second bureau is the Quartermaster's Supply Control Bureau, which comprises a Requirement Branch, a Distribution Branch (for both domestic and overseas troops), and an Administrative Branch.

The third is the Professional and Planning Staff, which supervises and orders all matters relating to office service, administrative methods, operating methods, industrial research, industrial relations and kindred matters for several operating bureaus.

In the reorganization of the immediate staff of the Quartermaster General several operating divisions have been created, each having its own Procurement Branch and Production Branch.

The above information is taken from the *Engineering News-Record* of Feb. 7, 1918, vol. 80, no. 6, pp. 248-250. The article has two charts, of which the second gives the personnel of the chief division of the Quartermaster's Corps.

U. S. Plans to Use Surplus Northwest Water Power in War

The Government is preparing to use the surplus water power of the Northwest for war industries.

A survey will be the first step. It was ordered last December by the power committee of the Council of National Defense. C. O. Frisbie, of Chicago, president of the Wood Products Co. at Cornell, Wis., and head of the Chippewa Valley Operative Association, was selected for the task, and will begin at once.

The power committee has asked for the following information:

How much power is developed from Government and private dams in Minnesota and Wisconsin?

How much additional power can be obtained by improvement of the present facilities?

How much surplus over the present needs of industries and municipalities can be produced?

How much can the present users of power curtail their consumption?

How much of their supply will present users be willing to divert for Government purposes?

It is believed that the survey will disclose thousands of horsepower readily convertible to industrial users. Chippewa Falls and International Falls are the two points from which most is expected, but a close study will be made of the entire field.

The hope is to obtain coöperation of local industries and municipalities in getting much needed power for new war plants. Failing in this, the Government will not hesitate to commandeer the output, as was done at Niagara Falls last week by President Wilson.

The coal shortage makes it imperative the Government turn more to the use of water power. New factories, especially chemical plants, must be built, and the only hope of operating these at capacity and meeting the other fuel needs of the country is to utilize natural power.

Until Mr. Frisbie has completed his work and made his recommendations to the power committee there will probably be no decision in the disposal of surplus power from the high dam at the Twin Cities. (Minneapolis *Morning Tribune*, December 31, 1917, p. 1)

New Gun Plant of the Tacony Ordnance Corporation

The Tacony Ordnance Corporation is rapidly completing extensive and modern facilities for the production of large-caliber, rough-machined gun forgings. The plant, which will cover approximately 22 acres at Tacony, Philadelphia, will be completed about March 1, 1918. Present plans call for the following buildings: open-hearth and stock yard, forge, heat-treatment, machine-shop, chemical, physical and microscopic laboratory, storehouse, dispensary and administration building.

The open-hearth, which will have a capacity of from 700 to 800 tons of ordnance ingots per week, will operate two 40-ton acid, oil-burning furnaces, with 3½-ton charging machine, cranes, oil-storage tanks, etc. A 2000-ton and a 1000-ton steam-hydraulic forging press, with heating furnaces, etc., will furnish ample forging capacity. In the heat-treatment department there will be three vertical quenching and three car-bottom furnaces with necessary pyrometric control and dipping cranes. The machine shop will house about 50 machine tools, including a number of 48-in. and 36-in. turning and boring lathes, shapers, planers, etc. A small but complete toolroom will be maintained.

The new plant will be devoted exclusively to the production of rough machine forgings for howitzers and guns for the United States Army. About 500 to 600 employees will be required to operate the plant at capacity. J. B. Warren, secretary and manager of the Tacony Steel Co., is president of the Tacony Ordnance Corporation, and George Satterthwaite, formerly general superintendent of the Midvale Steel Co., is vice-president and general manager. (*The Iron Age*, vol. 101, no. 2, January 10, 1918, p. 175)

Softened and Asphalted Paper for Wrapping

A practical substitute for burlap to be used for baling and wrapping purposes was recently put on the market by the Cleveland-Akron Bag Company, Cleveland. Burlap substitutes are now of interest, as available supplies of burlap have had to be diverted for use to such purposes only as cannot be filled by other materials.

Machinery and machinery parts, electric motors and dynamos are wrapped for shipping in burlap; for coils of wire and auto tires narrow strips of burlap are used. Burlap is put to hundreds of such purposes which can, and to save burlap for more essential uses should, be performed by other practical substitutes.

The new substitute, "Saxolin," is made of two pieces of heavy paper combined with an asphalt material, making a waterproof combination. In the manufacturing of this product it is softened and made pliable so that the folding qualities of the paper are retained.

In tensile strength it is said to test equal to burlap used for a like purpose. There are four different weights corresponding to different grades and weights of burlap.

"Saxolin" cannot fill all the purposes of burlap, but in the range that it can supply, it will aid to place the available supply of burlap in the channels most needed. (*Journal of Commerce*, January 3, 1918, p. 17)

Pulverized Coal for Central Railroad of Brazil

The Central Railroad of Brazil recently inaugurated a series of experiments with its new coal-pulverizing plant at Barra do Pirahy, which caused considerable interest and favorable comment in engineering circles, according to the *Commerce Reports*. The plant was furnished by an American firm and installed by one of its engineers. The pulverizer is described as being similar in construction to a cement plant. The coal, freed of its moisture, goes into a hopper and is pulverized so that 80 per cent of it can pass through a 200-mesh screen. It is then passed to the locomotive by means of a conveyor screw and blast, thus bringing the ignitable powder to the mouth of the locomotive furnace, at which point combustion takes place. The first set of experiments were with American coal and were an unqualified success. The experiments were then continued with a mixture and finally with Brazilian coal from the Jacuhy district, until now somewhat problematically useful—"problematically useful" because it is a coal that does not burn economically in the usual lump form. It was, however, believed that, once pulverized, this coal would give good results and would prove to be adaptable to the needs of the railroads. The experiment, as reported, was an unqualified success and was hailed as an auspicious event that represents the solution of one of the most vital national problems in Brazil. (*Power*, vol. 46, no. 24, December 11, 1917, p. 793)

French Method of Tinning Cast-Iron Vessels

A method for tinning cast-iron pots and other utensils for domestic use is offered from a French source, *La Chronique Industrielle*. For household utensils only pure tin should be employed and not tin and lead, as the latter forms poisonous salts with the acids of food products. To insure adhesion of the tin the iron should be treated to remove the carbon, or otherwise it should be polished by mechanical means To remove the carbon, the iron is coated with a layer or oxide of iron or manganese, or else the iron is enclosed in a box with

the oxide and maintained at a high temperature to burn out the carbon. After four to six hours the iron is sufficiently decarbonized to permit the adhesion of the tin. After this procedure the iron is cleaned with dilute sulphuric acid to which is added a small amount of blue vitriol. The iron is then immersed in molten tin, or, if the interior of the vessel is to be coated, molten tin with a little sal ammoniac is vigorously rubbed over the surface. It is preferable to heat the iron before applying the tin. This must be done with care, otherwise the surface will be oxidized and impair the adhesion of the tin (*Mechanical World*, vol. 62, no. 1616, December 21, 1917, p. 337)

Society of Automotive Engineers

At the monthly meeting of the Minneapolis Section held in connection with the Twin City Automobile Show the important problem of burning kerosene in tractor engines was discussed. Professor Mowry of the State Agricultural College took the stand that the increased use of kerosene and heavier fuels is more dependent on engine designers than on carburetor or manifold makers. He quoted figures from tests made at his university on kerosene fuel with hot-spot manifolds. The tests were made with a four-cylinder L-head engine with a removable head and the duration of the test was 1 hr. Water temperatures ranged from 190 to 212 deg.

The tests were made with several types of manifolds and vaporizers and the dilution of the crankcase oil due to the admixture of kerosene in the crankcase varied from 0.1 to 0.7 lb. In some manifold tests it was even impossible to run the engine the full hour, because after about half an hour it stopped through preignition.

W. G. Clark, engineer of the Wilcox, Bennett Carburetor Company, who has just returned from a three months' investigation trip among tractor farmers from Texas to Montana, declared that the situation so far as burning kerosene in tractors is concerned is very serious, due to tractor makers selling tractors that are supposed to burn kerosene satisfactorily, but which fail to do it in the service of the farmers. He claimed that the hot-spot manifold is not a solution of the kerosene problem, because it increases the temperature of the mixture too much and cuts down the volumetric efficiency of the engine so that from a quarter to three-tenths of the engine power is lost.

E. R. Greer, engineer of the Emerson-Brantingham Company, expressed the opinion that the hot-spot manifold to accomplish its object must have some form of heat control. Consideration must be given to the speed of travel of the mixture in the manifold as well as the temperature of the manifold. When there are high gas speeds with open throttle, less heat is needed, but when the throttle is closed, heat must be added to prevent loading up. (Based on the report published in *Automotive Industries*, vol. 38, no. 7, February 14, 1918, p. 380.)

Hydroelectric Development

At the meeting of a special committee of the United States Chamber of Commerce on January 14, 1918, a statement was submitted on behalf of the Engineering Council by Calvert Townley, touching upon the subject of hydroelectric development generally and as a means of replacing steam power plants.

There are two fundamental causes which have militated against the substitution of hydroelectric for steam-electric power. One is economic and permanent, the other is statutory and therefore subject to modification.

The economic reason is the high cost of development due to natural conditions. Hydroelectric plants usually carry much heavier fixed charges than steam-electric plants, partly because in a water development a large share of the initial cost is consumed by expenditures for riparian rights, the dam and other hydraulic installations, transmission, right of way, towers, etc. A further share of the greater first cost of hydroelectric plants is due to the fact that, unlike the steam plant, the hydroelectric plant at the start must largely be built with a view to the future and not the actual market, and therefore for years has to carry excessive overhead. As a result, the projectors of the hydroelectric enterprise must often rely for success on a subsequent increase in their market, and the possibility of an incorrect forecast of the extent of such increase and of the time when it may come, imposes a serious business hazard against water and in favor of steam.

Another element in favor of steam is, that with the growing advancement of the art, both the first cost of machinery per unit of power and the cost of operation in the case of steam prime movers tend to decrease, and there is nothing to indicate that the limit of improvement in the design of steam prime movers has been reached or is even in sight. Further, where fuel oil is available, the Diesel or internal-combustion engine is also coming forward as a competitor of water power.

In fact, many sites which fifteen years ago might have been developed to sell energy in successful competition with steam at its then cost, could not now be so developed. On a concrete example, the report shows that the cost of fuel per unit of installed capacity in a steam-electric plant of average good design may be taken at \$11.50 per year. Under the usual conditions this would mean that a hydroelectric plant would be superior to or at least equal to this steam plant provided the hydroelectric investment per kilowatt capacity exceeded that of the steam plant by not more than \$100. As a matter of fact, many hydroelectric developments exceed this limit considerably, in which case they can be commercially successful only if either they are located in sections where coal is more than normally high, or are operating under more than usually favorable conditions, for example, with a plant factor in excess of the usual 35 per cent.

The conclusion which the report emphasizes is that while under certain conditions water power may commercially compete with steam, the view that it can under all conditions produce power at the lower cost than steam is quite a mistaken one.

The report proceeds to discuss certain legal obstacles in the way of water-power development in the United States, and shows, for example, that the discretionary right given to the Secretary of the Interior to revoke permits for the use of public land necessary for water-power developments, operates against the flow of private capital into such projects.

While the Engineering Council does not consider itself as expert in legal matters, the report points out that after a hydroelectric enterprise has been successfully established it is to everybody's interest that it should continue without interruption and all legal obstacles in the way of its operation should be as far as possible eliminated.

The report further expresses the belief that the benefits afforded the communities served by cheap power and the nation by the conservation of coal are far more valuable than the question of restricting returns to capital. The present emergency has shown how important the substitution of water power for steam power might be in releasing to other uses

the extensive transportation facilities now engaged in carrying coal as well as the corresponding volume of labor now occupied in mining this coal, and in converting it into motive power.

Engineers Control War Industries

Germany had prepared for a six months' war. Her supplies, her armies, her transportation system were all tuned for this period. For the general staff had figured the campaign with such precision that any greater extension of preparation would be a waste of national effort. Only one man in the empire felt that the chance of plans miscarrying was of sufficient importance to provide against. This man, an engineer high in the counsel of the Allgemeine Elektricitäts Gesellschaft, felt that to enter into a project as subject to failure as a military campaign, without a plan whereby every resource of the nation might be concentrated on the effort, was suicidal. But he had to wait for the stalemate of December to obtain the opportunity of putting the whole of the industrial resources of the country on a planning and progress chart basis.

This sidelight on the military situation in Europe at the beginning of 1915 is neither invention nor rumor. It is fact, well vouched for by men of undoubted reliability. Therefore, it should be welcome news to the engineers of America to know that a start in the proper direction has already been made in this country. The Office of the Chief of Ordnance has had for some time a planning division in certain of its own shops, and is now extending this most important work to all the factories making supplies for the office. The Progress Section of the Control Bureau, functioning as a division of the Ordnance office, keeps its mind on the progress of all war orders within its jurisdiction. Under Major Sanford E. Thompson, Mem. Am. Soc.M.E., a corps of men keep in touch with the promises and performances of manufacturers, determine wherein lies the cause of delays and what steps must be taken to keep production up to the schedule of requirements which have been determined as necessary to our full and successful participation in the war.—*Engineering News-Record*, February 14, 1918.

This Month's Abstracts

Special attention is called to a remarkable investigation on measurement of torsional stresses abstracted in the section Mechanics.

As yet we have no means of measuring torsional stresses directly. In members of very simple cross section, for example, circular, we can determine the torsion mathematically with considerable precision, but this is not feasible in the case of members of complicated cross-section, such as, for example, aeroplane struts. Nevertheless, this is a case where measurement of torsion is especially important, as aeroplane members must be both of ample strength to meet possible peak loads, and also of minimum weight—two conditions which require considerable knowledge of the properties of materials used and stresses to which these materials are subjected.

Griffith and Taylor have solved this problem by the so-called soap-film method described in the abstract. It is of interest to note in this connection that the properties of soap films and soap bubbles have recently been investigated in several respects, and there is gradually being built up what one might perhaps call "soap-bubble engineering," in the better sense of the term.

The Pittsburgh Testing Laboratory, Pittsburgh, Pa., is now engaged on a five-year test of coarse aggregates in concrete. The results obtained in the first six months are reported in the section Engineering Materials.

In the same section will be found a discussion of the different rates of loading as affecting the compressive strength of concrete.

In the section Hydraulic Engineering is described the equipment of the White River plant, containing two very large Francis turbines operating under a net head of 440 ft. The most interesting feature of this installation is its system of regulation and protection.

The section Internal-Combustion Engineering contains descriptions of several interesting devices.

The Chapman Engineering Company has developed a gas producer with a floating agitator, so arranged as to continuously stir up the entire surface of the fire bed in the producer.

From an English publication is reproduced a discussion of the time required for exhaust pressure in a two-stroke-cycle engine to fall from its initial value to the atmospheric level. A formula is given which makes it possible to determine the position of the piston for any crank angle.

In an abstract published in THE JOURNAL in January 1914 were described the general features of the Kromhout oil engine. In the present issue a unit is described developing as high as 350 hp. and having some interesting features of governing.

G. E. Stoltz, in an abstract in the section Mechanics, discusses the design of flywheels for rolling mills and shows how a comparatively small flywheel properly located may increase the monthly output of a mill by approximately 10 per cent.

The automatic control and measurement of high temperatures is exhaustively discussed by Richard P. Brown in a paper before the Steel Treating Research Society. Among other things are described instruments for the various temperature measurements and automatic temperature control.

In the section Munitions, particular attention is called to the bibliography on gages and gage making for munition plants, prepared by the Library of the United Engineering Societies. No attempt has been made at making an exhaustive bibliography, the aim being mainly to give a list of papers and articles of particular value to American manufacturers.

A new system of locomotive feedwater heating is described in the section Railroad Engineering. One interesting feature of the heater consists of the agitators contained in each of the tubes, so arranged as to bring each particle of water in contact with the hot tubes and to absorb all the heat possible from the exhaust steam on the outside of the tubes. It appears that the higher the velocity of the cold water passing through the tubes, the more violent the agitation and the greater the amount of heat absorbed by the water.

From British publications an abstract is made of a report submitted to the North-East Coast Institution of Engineers and Shipbuilders on various methods of producing high vacuum.

Soon after the beginning of the war various conditions combined in preventing copies of German technical periodicals from reaching this country. In particular, copies of the *Journal of the German Society of Engineers* ceased to come about the middle of 1915. Arrangements are now being made to secure the back issues, and there is good reason to believe that the Society will have them ere long. In that case some arrangement will be made to make the valuable information contained therein available to the membership of the Society.

REVIEW OF ENGINEERING PERIODICALS

Acoustics

The Doppler Effect, A. E. Watson and G. H. Makey. *Flight*, No. 469 (no. 51, vol. 9), December 20, 1917, pp 1335-1338, 4 figs. Discussion of the Doppler effect and its application to the location of flying machines in the air. According to the Doppler principle, the pitch of a note as heard differs from the true pitch of the note as emitted by the source of the sound in accordance with one or both of the factors, namely, relative movement between the source and the medium of oscillations, and relative movement between the observer and the medium. In the present article is examined only the case in which there is relative movement between the source and the medium. This applies particularly to the case of the observer being stationary in the air or on the ground while the note is coming from an aeroplane moving through the air.

Aeronautics

Airplane Dopes, Gustavus J. Esselen, Jr. *The Journal of Industrial and Engineering Chemistry*, vol. 10, no. 2, February 1, 1918, pp. 135-137.

The Design of Air Turbines, Alexander Klemin and Edward P. Warner. *Aviation and Aeronautical Engineering*, vol. 4, no. 1, February 1, 1918, pp. 19-22, 7 figs.

The 230-H.P. Benz Aero Engine. *Aeronautics*, vol. 13, no. 218 (New Series), December 19, 1917, pp. 476-490, 37 figs.

Theory of Bomb Dropping. *Aviation and Aeronautical Engineering*, vol. 3, no. 12, January 15, 1918, pp. 819-822, 11 figs.

Italian Naval Aircraft. *The Engineer*, vol. 125, no. 3236, January 4, 1918, pp. 6-8, 6 figs.

Standard Aero-Engine Production. *Engineering*, vol. 105, no. 2715, January 4, 1918, pp. 13-14. An editorial discussing the advantages and disadvantages of standardization in the production of aeronautical engines. The writer is inclined to believes that more standardization should be applied in British production.

Testing Machines for Aeroplane Manufacture. *Engineering*, vol. 105, no. 2714, January 4, 1918, pp. 1-4, 14 figs.

Air Engineering

How to Use a Psychrometric Chart. J. I. Lyle. *The Heating and Ventilating Magazine*, vol. 15, no. 1, January 1918, pp. 33-36, 1 fig.

Engineering Materials

Tests of Slag Concrete. A series of tests for the purpose of comparing slag, gravel and stone as the coarse aggregates for concrete is being carried on by the Pittsburgh Testing Laboratory, Pittsburgh, Pa., it being the intention to extend the tests over a period of five years. The tests made up to the end of the first six months have now been made public.

The fine aggregate is sand from the Ohio River, while the coarse aggregates cover nine varieties of slag gathered from plants in various parts of the country, two kinds of gravel, two kinds of limestone, a trap rock and a crushed granite. The proportions were determined by establishing the leanest mixture which would produce a dense concrete when using the coarse aggregate having the highest percentage of voids and then using the mixture for all the materials. This led to the use of proportions of one part cement, two parts sand and four parts of the coarse aggregate. The specimens were kept in molds for 48 hr. and were then stored in damp sand for 35 days, after which followed storage in air. Four short pieces of reinforcing steel were imbedded in each of two cylinders from every batch for the determination of the corrosive tendencies. The results shown in Table 1 were obtained. (*Railway Age*, vol. 64, no. 3, January 18, 1918, pp. 165-166, *e*)

TABLE 1 RESULTS OF COMPRESSION TESTS ON 8-IN. BY 16-IN. SLAG-CONCRETE CYLINDERS

Character of coarse aggregate used	Compressive Strength in Pounds per Square Inch											
	14 days			30 days			60 days			180 days		
	Max.	Min	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
Gravel.	2093	1792	1921	2608	2040	2294	3127	2378	2925	4200	3404	3798
Limestone	1840	1720	1758	2442	1950	2174	3846	3014	3543	5011	3814	4426
Trap rock .	2109	2026	2063	2454	2330	2386	3416	3256	3360	4906	4738	4819
Granite..	2208	1980	2122	2334	2230	2292	3258	2760	3043	4248	4016	4151
Slag No. 1.	2594	2380	2484	3127	2999	3075	3460	3268	3365	4906	4678	4803
Slag No. 2.	1998	1897	1941	2770	2343	2525	3008	2815	2930	3958	3560	3753

Fire Tests of Building Columns, Noeman F. Kimball. *The Armour Engineer*, vol. 10, no. 2, January 1918, pp. 107-116, 2 figs. Description of tests carried out at the Underwriters Laboratories in Chicago for the purpose of determining the ultimate fire resistance of large building columns and the fire-resistive value of various kinds of column protection. No actual results of the tests are reported.

[illegible] CEMENT [illegible] PLASTICS. *Engineering*, vol. [illegible], January 18, 1918, pp. 71-73. To be continued.

[illegible] APPLICATION OF LOAD ON COMPRESSIVE STRENGTH [illegible], D. A. Abrams. A discussion of the different [illegible] loading as affecting the results obtained from pre[illegible] of concrete.

[illegible] the conclusions at which the writer arrives is that for [illegible] mixes (1:5 and 1:3) tested at the age of 28 days, the strength when loaded at 0.15 in. per min. is 14 to 20 per cent higher than when loaded at 0.006 in. per min.

If part of the load is applied at a fast speed and the remainder at a slow speed, the ultimate strength of the concrete is not changed, even though as much as 88 per cent of the total load is applied at the fast speed.

Knowing the approximate strength of the specimen, it will greatly expedite the work of testing and involve no sacrifice in accuracy, if we apply, say, 50 to 75 per cent of the ultimate load at a fast speed before changing to the slow speed.

A machine speed which gives a shortening of the test piece of 0.01 to 0.02 in. per min. per ft. of the length is recommended as a standard rate for compression tests of concrete.

The results show that the mean error of a group of tests

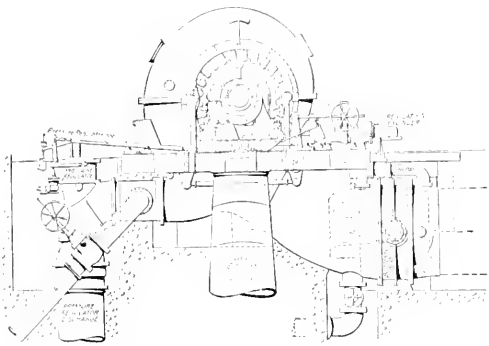


FIG. 1 25,000-HP. FRANCIS TURBINE

made on the same day is considerably lower than that of a set of tests made on different days; while the mean error of the daily average compressive strengths is generally much higher than that of the average tests made on different days. (*Engineering and Cement World*, vol. 12, no. 2, January 15, 1918, pp. 33-36, 2 figs., 4 tables)

GERMAN-MADE BOILER TUBES. When the former German liner *President Grant*, now *U. S. S. President Grant*, was being put through preliminary tests after the necessary repairs, it was found that her boiler tubes were defective. Samples of the tubes taken out were tested at the New York Navy Yard by Prof. William Campbell, who, by the way, did not know where the tubes were obtained.

Standard tests and microphotographs were made, and it was found that the German tubes were even poorer than such American tubes as have been previously rejected by the Navy. Mottling was found, presumably due to segregation of phosphorus, as well as abnormally coarse grain. Phosphorus contents of 0.263 were found, while the sulphur was about the same as in American tubes, or 0.018. Excessive brittleness was also discovered. (*Iron Trade Review*, vol. 62, no. 4, January 24, 1918, p. 271, *e*)

Firing

AUTOMATIC [illegible] CONTROL SAVES MUCH COAL, I. L. Kentish Rankin. *En[illegible] and Cement World*, vol. 12, no. 2, January 15, 1918, pp. 42-44, 1 fig.

Fuel

GAS [illegible] BOILERS, T. M. Hunter. *The Journal of The I[illegible] Electrical Engineers*, vol. 56, no. 270, January 1918, pp. 57-91, 3 figs., 17 tables. A very interesting paper of which an abstract will appear in an early issue. The following subjects are discussed: Calorific value of gas; stability of gas for boiler firing; drying and cleaning; heat transfer; types of boilers, boiler draft, boiler settings; air leakage; radiation and conduction; combustion; practice: gas measurement, boiler control.

NOUVEL APPAREIL DE FRACTIONNEMENT POUR LES PÉTROLES ET AUTRES PRODUITS VOLATILS, M. E. Hildt. *Comptes Rendus Hebdomadaires des Séances de L'Académie des Sciences*, tome 165, no. 23, December 3, 1917, pp. 790-793, 1 fig.

Furnaces

GAS CIRCULATION IN REGENERATOR CHECKERS, A. D. Williams. *The Blast Furnace and Steel Plant*, vol. 6, no. 1, January 1918, pp. 29-33, 7 figs.

NOUVEAU TYPE DE FOUR ÉLECTRIQUE À ACIER SANS ÉLECTRODES. *Journal du Four Électrique et de l'Électrolyse*, 26e Annee, no. 24, December 15, 1917, pp. 325-326.

Hydraulic Engineering

LARGEST HIGH-HEAD FRANCIS TURBINE, Arnold Pfau, Mem. Am.Soc.M.E. Description of the hydroelectric equipment installed in the White River plant of the Puget Sound Traction Light and Power Company near Sumner, Washington. This plant contains two 18,000-hp. Francis turbines operating under a net head of 440 ft., which have developed over 44,000 hp. without any detriment to their efficiency.

In order to prevent excessive variations in speed and voltage of the power system it was necessary to use a very sensitive governor to quickly control the gates of the turbine. The sudden change in the flow of water through the pipe lines and tunnel would cause pressure variations which would not only impair the regulation, but might accelerate to such an extent as to wreck the whole plant.

The following methods of precaution are used:

1 A surge receiver at the end of the tunnel for the purpose of preventing surges set up by the tunnel from materially affecting the pressure in the pipe lines and vice versa.

2 Pressure regulators so combined with the turbines that they permit of a sudden release of the water, which is brought to a stop when the governor closes the gates of the turbines quickly.

3 Air-cushioned tanks which supply hydraulic energy to the turbines when the demand of load is so sudden that the water cannot accelerate in the pipe line sufficiently fast to prevent a serious drop in pressure.

The proper combination of these devices, together with a liberal flywheel effect of the revolving parts of the generators, is said to have made it possible to attain a high accuracy of speed regulation.

The pressure regulator details are shown in Fig. 1. The regulator is directly connected to a branch pipe provided on the lower portion of the spiral casing. It consists of an elbow

with the circular disk valve opening and discharging water downwardly through the plain steel pipe into the tail race. The disk valve is connected to a piston subjected to water pressure controlled by a regulating valve, which in turn is relay operated from a direct connection to the turbine gates. The oil dashpot is so inserted into this connection that the motion of the turbine gates is transmitted to the regulating valve only when the governor closes the former quickly, the slow motion only being completely absorbed in the dashpot. Thus the discharge of the turbine can be quickly switched over from the turbine to the pressure regulator, and there reduced slowly in accordance with the setting of the bypass in the oil dashpot determining the rate of the closing motion.

The governor is installed on a special stand containing the flyballs and the relay of the governing device. The oil pressure is obtained from a central oil-pressure system located in the basement of the plant and is produced in the pumps of a rotary-gear type. The governor has a capacity of about 50,000 ft-lb., and is capable of moving the turbine gates over their full stroke in one second.

In a test the full load of 20,000 hp. was thrown off suddenly, causing the governor to close the gates quickly. The speed did not rise more than 12 per cent above normal, and the maximum pressure rise in the pipe line above normal did not exceed 5.5 per cent as against a guaranteed pressure rise of 15 per cent and a speed rise of 18 per cent. (*Power*, vol. 47, no. 6, February 5, 1918, pp. 174-177, 6 figs., *d*)

Verification of the Bazin Weir Formula by Hydro-Chemical Gaugings, Floyd A. Nagler. *Proceedings of the American Society of Civil Engineers,* vol. 44, no. 1, January 1918, pp. 3-54, 24 figs., 4 tables, 1 plate.

Sur la Détermination des Dimensions les plus Avantageuses des Principaux Éléments d'une Installation de Force Hydraulique, E. Baticle. *Comptes Rendus des Séances de l'Academie des Sciences,* vol. 165, no. 25, December 17, 1917, pp. 995-997.

Internal-Combustion Engineering

Gas Producer with Floating Agitator. In a gas producer recently developed by the Chapman Engineering Company, of Mount Vernon, Ohio, a floating agitator is provided to stir up the fuel bed. The purpose of this device is to prevent the formation of clinkers by destroying blowholes and hot spots in the fuel bed.

It is claimed also that the agitator eliminates hand poking, as well as increases the capacity of the producer and the quality of the gas because of the frequent stirring of the entire surface of the firebed.

The agitator, Fig. 2, is built of heavy seamless tubing, the cross-arms being provided with stirring fingers of high-carbon steel. Cooling water is carried to the end of each finger by an inner tube. If desired, steam can be used for blowing on the fingers. The agitator passes through the fuel bed at the rate of five revolutions per hour. Motor drive is employed, the power being transmitted to a worm and wormwheel running into it.

The vertical or oating movement of the agitator resembles, on a large scale, the combined movement of a Yankee screw-driver. The vertical shaft of the agitator has a spiral driving head, with two large, screwlike spiral flanges that engage in sliding contact with two lugs projecting inwardly from the driving-wheel hub. Under ordinary conditions the wheel with the agitator revolve together, but if an obstruction is encountered, or the agitator becomes submerged too deeply in the surface of the firebed, it automatically screws up at once to a point where the forces are again in balance. (*The Iron Age*, vol. 101, no. 6, February 7, 1918, p. 385, 1 fig., *d*)

Census of Internal-Combustion Engines. The *National Gas Engine Association Bulletin* has just made public data on the 1914 census of internal-combustion engines.

From this census it appears that in 1914 there were 809 establishments which reported the manufacture of engines, of which 243 made steam engines, 549 made internal-combustion engines and 52 made waterwheels, motors and turbines.

As regards internal-combustion engines, the great bulk of the engines produced were rated at having less than 50 hp. and less than 2 per cent as having more than 50 hp. More than nine-tenths of these engines had less than 10 hp. (*N. G. E. A. Bulletin,* vol. 3, no. 7, February 1918, pp. 2-4, *s*)

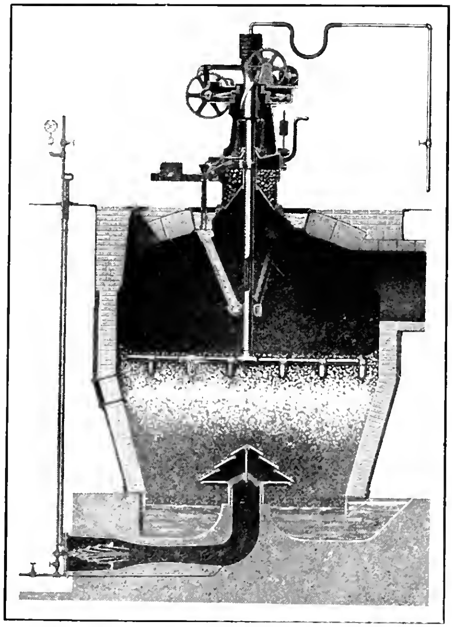


Fig. 2 Gas Producer with Floating Agitator

The Armour Institute of Technology Internal Combustion Engine Engineering Laboratory, Daniel Roesch. *The Armour Engineer,* vol. 10, no. 2, January 1918, pp. 102-106, 6 figs. Description of the new unit-type laboratory at the Armour Institute of Technology.

The Escape of Exhaust Gas in Two-Stroke-Cycle Engines, Guy B. Petter. In a two-stroke-cycle engine it is necessary to know the time required for the exhaust pressure to fall from its initial value to the atmospheric. Engines of the type referred to have inlet and exhaust ports in the cylinder wall which are uncovered by the piston toward the end of its outward stroke. The exhaust ports are given a "lead" so that the exhaust may get away by the time that the air ports open.

The velocity of escape of exhaust gas through the exhaust ports is affected with many uncertainties, and especially with the contraction of the gas by cooling. As, however, we wish

to establish a formula for purposes of comparison only, we assume that the fall of pressure is due entirely to the escape of gas through the exhaust ports at constant velocity.

Let v = constant velocity, in. per sec.
p = pressure (absolute) at the instant t (in seconds) reckoned from the moment of exhaust opening, lb. per sq. in.
V = capacity of cylinder and cylinder head above piston when the exhaust ports begin to open, cu. in.
A = area of exhaust ports open at the instant t, sq. in.
b = total width of exhaust ports, in.
m = engine speed, deg. per sec.
a = crank throw, in.
c = connecting rod length, in.
e = line joining crankshaft center to gudgeon pin, in.

Values with the suffix o are for initial conditions when the exhaust ports begin to open, and valves with the suffix f are for final conditions when atmospheric pressure is reached. It

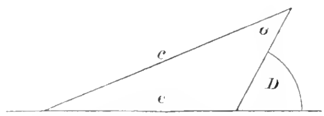


FIG. 3 EXHAUST PORT OPENING DIAGRAM

will be noted that p_f is atmospheric pressure in absolute units.

The total quantity of gas escaping is

$$\frac{p_o - p_f}{p_f} V$$

The quantity of gas escaping in a small interval $\triangle t$ at the instant t is

$$\frac{p}{p_f} vA \triangle t$$

and

$$\frac{p_o - p_f}{p_f} V = \int_{t_o}^{t_f} \frac{p}{p_f} vA\,dt \ldots\ldots\ldots\ldots [1]$$

Assuming from the evidence of the indicator card that the fall of pressure is directly proportional to the time, we write

$$p = p_o - \frac{(p_o - p_f)t}{t_f} \ldots\ldots\ldots\ldots\ldots [2]$$

Also, we may write with sufficient accuracy

$$A = \frac{A_f}{t_f} t \ldots\ldots\ldots\ldots\ldots\ldots\ldots [3]$$

Then we shall have

$$\frac{p_o - p_f}{p_f} V = \int_{t_o}^{t} \frac{p_o t_f - (p_o - p_f)t}{p_f t_f} v \frac{A_f}{t_f} t\,dt \ldots [4]$$

Integrating and applying the limits, we have

$$\frac{p_o - p_f}{p_f} V = vA_f \left[\frac{p_o}{p_f t_f} \cdot \frac{t_f^2}{2} - \frac{p_o - p_f}{p_f t_f^2} \cdot \frac{t_f^3}{3} \right] \ldots [5]$$

or

$$V = \frac{vA_f t_f (p_o + 2p_f)}{6(p_o - p_f)}$$

Consider the triangle in Fig. 3, formed by the crank a, the connecting rod c and the line e from the crankshaft center to the gudgeon pin. Neglecting the obliquity of the connecting rod, the depth of the exhaust-port opening at the instant t is $a(\cos D - \cos D_o)$ where D is the angle of the crank before dead-center position at the instant t, and D_o is the angle at the instant of exhaust-port opening.

Then

$$D_o = D - mt, \text{ or } D = D_o - mt \ldots\ldots\ldots [6]$$

And

$$A_f = ab\left\{\cos(D_o - mt_f) - \cos D_o\right\} \ldots\ldots [7]$$

Therefore

$$V = vabt_f \frac{p_o + 2p_f}{6(p_o - p_f)} \left\{\cos(D_o - mt_f) - \cos D_o\right\} .. [8]$$

From [8] we can compute v if t_f is known or t_f if v is known. The solution for t_f is best found graphically from the intersection of the curves

$$y = \frac{6(p_o - p_f)V}{vabt_f(p_o + 2p_f)} \ldots\ldots\ldots\ldots [9]$$

and

$$y = \cos(D_o - mt_f) - \cos D_o \ldots\ldots\ldots [10]$$

It is not to be supposed that these results will be physically correct, but they will serve for purposes of comparison. A mean value of v under ordinary working conditions can be obtained with the indicator card of any well-designed engine, taking t_f from the card and v from [8]. For the Petter crude-oil engine it is found to be in the region of 1650 ft. per sec. With this value of v it is easy to determine from Equation [8] suitable values for the width and lead of the exhaust ports. The relation

$$e^2 = c^2 - a^2 - 2ae \cos D$$

enables the position of the piston to be found for any crank angle D. (*Engineering*, vol. 105, no. 2714, January 4, 1918, p. 7)

350-B.HP. KROMHOUT MARINE ENGINE. Description of the largest Kromhout marine-type engine yet built. The general principles of construction of these engines were described in THE JOURNAL (January 1914, p. 022).

This engine, built in Amsterdam, Holland, operates on the two-stroke cycle, having four cylinders of 16¾-in. bore by 18¾-in. stroke, and develops its full power at about 240 r.p.m.

Starting and reversing of the engine is effected by means of compressed air. Referring to Fig. 4, the camshaft E is carried on the front of the engine, two cams being fitted for each cylinder to operate the air-starting and reversing valves. In addition, the camshaft has four cams for operating the four feed pumps. This camshaft is operated by the handwheel A by means of which a shaft can be moved in a fore-and-aft direction with the engine either stationary or running, the cams being so arranged that the movement of the shaft with the engine stationary admits compressed air for starting to the cylinder in the best position for commencing the rotation of the engine in the required direction, that is, to go ahead or astern. The engine has no dead center, but will start from any position, either ahead or astern. Air is admitted to the requisite cylinder through the valves G, the jackets of which are water-cooled, and immediately above each valve is mounted a small horizontal cone valve for indicating purposes.

The stroke of the fuel feed pumps and consequently the revolutions of the engine are regulated by the hand wheel D with the shaft operated by this lever being also connected to the governor F, so that the strokes of the fuel feed pumps are adjusted as required by the governor in the event of the load being suddenly taken off for any reason. The hand-wheel D operates a friction clutch used for disconnecting the propeller shaft from the engine when the signal "stop" is telegraphed down from the navigating bridge. The governor

then automatically comes into action and reduces the stroke of the fuel feed pump as necessary, so that the engine runs at about 100 r.p.m., at which speed the cylinder vaporizers remain at the proper temperature to keep the engine running and in definite time.

The governor *F* has several functions. It controls the revolutions per minute of the engine in two ways: first, as described, by reducing the pump stroke. At the same time, however, it throttles the scavenging in order to maintain the required temperature in the combustion chamber. It has also one particular advantage and that is, when the engine at sea is running at normal full speed of 200 r.p.m. and the propeller heaves out of the water, the governor at once prevents any tendency to racing.

The handwheel *J* enables the engineer to adjust the quantity of scavenging air in relation to the engine speed. There are also manual means for regulating the quantity of circulating water per cylinder, safety valves being provided to prevent any damage to the pumps should all four control valves be closed down inadvertently at the same time.

A special receptacle for methylated spirit is provided for the preliminary heating of the lamps: namely, a deep cup with a long handle which can be conveniently filled without danger of spilling, put into position and lit up without any chance of the spirit overflowing if the ship is rolling heavily.

The vaporizing arrangements are such that blow lamps are required for starting purposes only. Once the engine is running it will continue to do so at any revolutions between 100 and 240 for any length of time, and will pick up the full load immediately, even after running at the lowest number of revolutions for several hours. This is achieved simply by the fact that the quantity of scavenging air is always proportionate to the revolutions per minute. The engine requires no water injection.

An auxiliary set is supplied with each unit to drive the air compressor and possibly also the dynamo and bilge and ballast pumps. It is usually constructed on the same principle as the main engine, but without the reversing gear. (*The Engineer*, vol. 125, no. 3237, January 11, 1918, pp. 36-37, 3 figs., *d*)

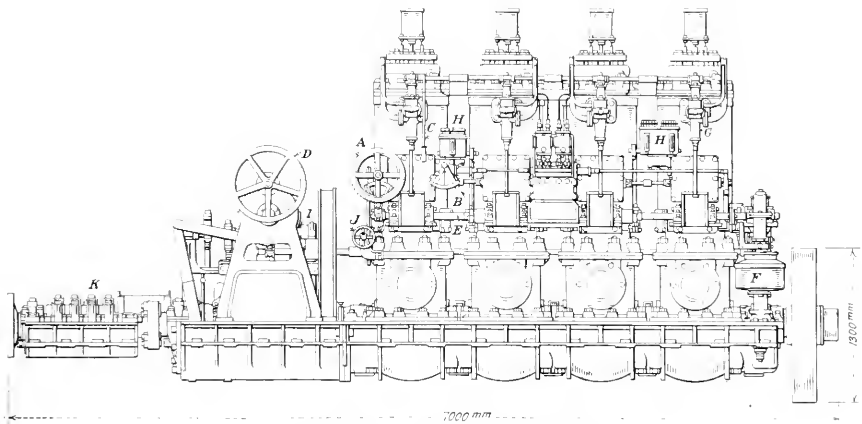


Fig. 4 350-B.Hp. Kromhout Marine Engine

Machine Shop

Tapped Holes. *The Automobile Engineer*, vol. 8, no. 110, January 1918, p. 11.

Generated Gear Teeth, Trevor Rapson. *The Automobile Engineer*, vol. 8, no. 110, January 1918, pp. 2-6.

The Making of Plug and Ring Gages, J. H. Smith. *American Machinist*, vol. 48, no. 5, January 31, 1918, pp. 191-193, 6 figs.

Interchangeability, Tolerances and Finish, J. P. Brophy. *American Machinist*, vol. 48, no. 4, January 24, 1918, pp. 156-157.

Machine Tools

Large Crank Pin Turning Machine. *The Engineer*, vol. 125, no. 3238, January 18, 1918, pp. 50-52, 6 figs.

The Evolution of a High Speed Steel Tool, J. T. Thorne. General discussion of the manufacture of high-speed tool steel, with brief reference to the influence of impurities and heat-treatment. The following statement is of particular interest: "High-speed steel instead of being a tough, inert material, as many people suppose, is rather to be compared to a finely balanced piece of machinery and is swung this way or that by the various influences it undergoes in the process of heat-treating." (*Proceedings of the Steel Treating Research Society*, vol. 1, no. 5, December 1917, pp. 4-19, 12 figs.)

Mechanics

Flywheel Design for Rolling Mills, G. E. Stoltz. The intermittent character of the rolling-mill load makes it necessary to have adequate flywheel capacity to equalize the power requirements and avoid heavy momentary overloads on the driving unit. The use of a proper flywheel effect permits, in certain cases, the installation of driving and generating equipment designed to carry a load of practically a constant character. Better overall economy is obtained, although the friction loss of the flywheel is added.

The writer discusses in brief the theory of flywheels.

The location of the flywheel is of importance. Logically, the flywheel should be placed as near the load as possible, but in some applications, such as sheet mills, this is not feasible as the mill speed is too slow. To properly equalize

the load on an 8-stand mill with the flywheel operating on the mill shaft at 30 r.p.m., a flywheel of 350 tons weight would be required. This is not practical, and on engine-driven mills, even with a comparatively large engine but a moderate-sized wheel, the engine does not fully compensate for lack of flywheel capacity, with the result that the speed drops considerably when peak loads are obtained. With electric drive the motor is usually operating at about 240 r.p.m. and a herringbone-gear unit is provided to obtain the proper mill speed. The flywheel capacity is usually obtained by placing the flywheel at each end of the pinion shaft. By doing this the total weight of the wheels would be 30 tons to provide the same flywheel effect as would be obtained if a 350-ton wheel were placed on the mill shaft. This has the disadvantage of transmitting all the peaks through the gears, but is the practical solution for this type of drive. Where sheet-mill engines have been replaced by motors with adequate flywheel effect, the monthly output may be increased approximately 10 per cent, which is due to the elimination of periods when the mill is slowed down sufficiently to interfere with its operation.

The conditions in the case of a blooming mill were investigated. The mill was of the three-high type, 28-in., operating at 70 r.p.m. Among other things, the writer calls attention

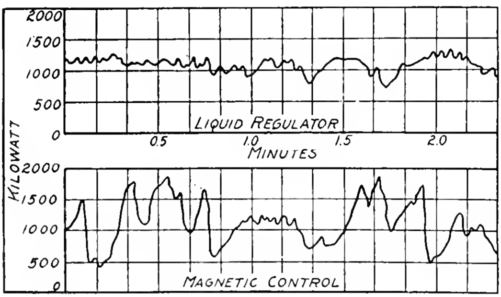


Fig. 5 Comparative Wattmeter Curves on Sheet Mill

to the fact that it is important to take under consideration the type of control used, as some utilize the flywheel effect to a better advantage than others.

From this point of view Fig. 5 is of interest. It refers to a sheet mill and shows the kilowatt input with notching in relays which regulates the amount of grid resistance of the secondary circuit of the motor, while the other curve is taken with the liquid slip regulator in the secondary circuit. The flywheel effect is the same, but the regulator does not come into action until the motor is fully loaded. With grid resistance in the secondary of the motor the flywheel and motor slow down in direct proportion to the load and when full load on the motor is obtained, the flywheel may be operating at 15 per cent slip and any further peak load cannot be absorbed by the flywheel to the same extent as when at its full speed. (*Iron Trade Review*, vol. 62, no. 1, January 24, 1918, pp. 272-274, 3 figs., *pe*)

Solution of Problems of Torsion by the Use of Soap Films, A. A. Griffith and G. I. Taylor. The equations which represent the torsion of an elastic bar of any uniform cross-section are of exactly the same form as those which represent the displacement of a soap film due to a slight pressure acting on its surface, the film being stretched over a hole in a flat plate of the same shape as the cross-section of the bar. Hence, by making appropriate measurements of soap films it may be possible to find the stresses and torsional stiffness of a twisted bar or shaft of any cross-section whatsoever.

Torsional problems are of great importance in aeronautical calculations. Propeller blades, spars, struts, etc., are subject to torsion, and at the same time have to be made of complex sections. It is therefore important to know the torsional stress occurring in them, so as to be able to use the minimum of material. The writers have developed a very simple experimental method for solving these problems.

A hole is cut in a thin plate of the section required to be investigated and a circular hole of a predetermined diameter is cut alongside it. The plate is placed in a box and soap films are stretched across the holes. The films are blown out slightly by reducing the air pressure on one side of them. By making suitable measurements of the shape of the resulting film surfaces it is possible to find the stresses in a bar of the given section in terms of the stresses in a circular bar of the same diameter as the circular hole when the two bars are twisted through the same angle per unit of length. By means of other measurements it is equally easy to find the ratio of the torques which must be applied to the two parts in order to produce the same twist in both.

In order to apply this method, apparatus is required with which three kinds of measurements can be made:

1 Measurements of the inclination of the film to the plane of the plate at any point for the determination of stresses. Optical reflection apparatus is used, the image of an electric-lamp filament being used in the film in such a way that the reflection ray is coincident with the incident ray, so that their common direction gives the inclination of the normal to the surface of the film.

2 Determination of the contour lines of the film. For mapping these lines a steel needle point, moistened with soap solution, is arranged to move about over the plate, its distance therefrom being adjustable by means of a micrometer screw. The point is made to approach the film until the distortion of the image in the latter shows that contact has occurred. This method of mapping contours is referred to here as the "spherometer" method.

3 Comparison of the displaced volumes of the test film and circular standard for finding the corresponding torque ratio. This is done by blowing the films up by running a known volume of water, or preferably soap solution, into the apparatus from a pipette.

The apparatus consists, therefore, of this spherometer for mapping the contour lines and the auto-collimator for determining the inclination of the film, this determination being usually confined to the determination of inclinations at given points on the boundary which are marked by scratches on the plate. For stress measurements the auto-collimator method is better than the contour-line method since it gives the inclination directly, whereas in the other case the inclination can only be found by a graphical determination.

Investigation of torsion problems by the soap-film method was checked by experiments of wooden beams of the same section. In one of these experiments a walnut plank was shaped so that its section was exactly the same as the hole in one of the test planes which represented a section in a propeller blade of fineness ratio 10.55, having its thickest part about one-third of the way from the leading edge. The value of the modulus of rigidity N was found by performing a torsion test on this plank, using the expression for the torque given by a soap-film experiment on the plate which was used in shaping the plank. N was found to be 0.1355×10^6 lb. per

sq. in. Five circular holes were then cut in the plank and their rigidities were measured. The mean value of N found in this way was 0.1387×10^6, or a difference of only 2.3 per cent.

When contour lines have been mapped the torque may be found from them by integration. If the graphical work is carefully done the value found in this way is rather more accurate than the one obtained by the volumetric method. Contours may also be used to find stresses by differentiation, that is, by measuring the distance apart of the neighboring contour lines: but here the comparison is decidedly in favor of the direct process, owing to the difficulties inseparable from graphical differentiation. The contour map is nevertheless a very useful means of showing the general nature of the stress distribution throughout the section in a clear and compact manner. The highly stressed parts show many lines bunched together, while few traverse the regions of low stress, and the direction of the resultant stress is shown by that of the contours at every point of the section. Furthermore, the map solves the torsion problem, not only for the boundary, but also for every section having the same shape as a contour line.

With the aid of simple apparatus of this kind the truth of theorems such as those contained in the following list may be readily demonstrated.

a The stress distribution—and therefore the torque—for any section is independent of the axis of twist. This is easily seen, since the shape of the soap film is completely determined by the boundary and the value of $4S/p$. Hence the torque on a number of bars clamped together at their ends may be found by adding the separate torques which would be necessary to twist each through the same angle. This, as in other cases, applies to torque only. It will be realized that in practice there will be bending stresses which must be taken account of in the usual way.

b Any addition of material to a section must increase the torque, and vice versa, so long as the distribution of material in the original section is unaltered.

c Any cut made in a section, whether it decreases the area or not, must decrease the torque.

d The stress at any point of the boundary of a section is never less than the boundary stress in a circular bar under the same twist, and whose radius is equal to that of the circle inscribed in the section which touches the boundary at the point in question.

More generally, if one section lie entirely inside another so as to touch it at two or more points, the stresses in the inner figure are less than those in the outer one at the points of contact; if the two figures are approximately congruent in the neighborhood of the points of contact, the difference between the stresses is small. The maximum stress in a section is not greater than $2aNr$, where a is the radius of the largest inscribed circle, unless the boundary is concave, that is, reëntrant.

e If a concave part of the boundary approximates to a sharp corner, the stress at this point may be very high, and if the curvature is infinite when the stress is also theoretically infinite, whatever be the situation of the corner with respect to the rest of the section. Actually, of course, if the material is ductile, we can only deduce that the stresses at such a corner are above the elastic limit.

f It is a consequence of (*e*) that it does not necessarily follow that the making of a cut in a section will reduce its strength, whether material is removed or not. As an example of this, one may quote the case of an angle iron in which the internal corner is quite sharp. It is well known in practice that this will often fracture. It may be strengthened, however, by reducing the section, planing out a semicircular groove at the root of the angle iron.

g There can be no discontinuous changes of stress anywhere in a section, excepting only those parts of the boundary where the curvature is infinite—concave or convex sharp corners.

h The maximum stress occurs at or near one of the points of contact of the largest inscribed circle, and not, in general, at the point of the boundary nearest the centroid, as has been hitherto assumed. An exception may occur, if, at some other part of the boundary, the curvature is—algebraically—considerably less; that is, the boundary is more concave than it is at this point.

i If a section which is long compared with its greatest thickness be bent so that its area and the length of its median line are unchanged, its torque will not be greatly changed thereby. For instance, the torsional stiffness of a metal plate is practically unaltered by folding or rolling it up into the form of an L or a split tube. Soap-film experiments show, in fact, that there is a diminution of less than 5 per cent when the inner radius of the boundary is not less than the thickness at the bend.

j The "unstressed fiber," which is situated at the point corresponding with the maximum ordinate of the soap film, is near the center of the largest circle which can be inscribed in the section.

In general, the inscribed circle has a maximum value wherever it touches the boundary at more than two points, and there is usually an unstressed fiber near the center of each of these circles. Between each pair of maximum ordinates on the soap film, however, there is a "minamax" point, which is near the center of the corresponding minimum inscribed circle. This fiber in the bar is also unstressed.

k The "lines of shearing stress" round the unstressed fibers of the first sort are initially ellipses, and round those of the second sort hyperbolas, from which shapes they gradually approximate to that of the boundary. Notions of this sort are useful in practice, because it is possible, with their help, to sketch in the general nature of the lines of shearing stress for any section.

The rest of the paper is devoted to the discussion of approximate formulæ for torques and stresses, and concludes with a mathematical appendix. Those who desire to follow the matter further will do well to refer to the original. (*Engineer*, vol. 124, no. 3234, December 21, 1917, pp. 546-547, 2 figs., eA)

Mechanics

THE LATERAL VIBRATIONS OF BARS OF VARIABLE SECTION, J. W. Nicholson. *Proceedings of the Royal Society*, vol. 93, no. A 654, September 1, 1917, pp. 506-519.

LAMINATED STEEL-SPRING PROPORTIONS, H. H. Kennedy. *American Machinist*, vol. 48, no. 5, January 31, 1918, pp. 182-183.

CIRCULAR-ARC BOW-GIRDER, William Knight. *Engineering*, vol. 105, no. 2716, January 18, 1918, pp. 55-57, 12 figs.

Measurements

THE AUTOMATIC CONTROL AND MEASUREMENT OF HIGH TEMPERATURES, Richard P. Brown. From his experience in this country the writer claims that for industrial service an

instrument actuated by the expansion of nitrogen gas is the most satisfactory for temperature measurement up to 800 deg. fahr.

This instrument consists of a bulb of copper which is inserted in the heat and is connected by capillary tubing to an indicating or recording gage containing a helical expansive spring. The expansion of the gas in the bulb exerts a pressure in the capillary tubing which is conveyed to the spring in the instrument and the pointer attached directly to this spring moves across the scale or chart.

The writer discusses other instruments, such as thermoelectric pyrometers for use in measuring moderate temperatures where the measuring instrument must be placed at a considerable distance, or for measuring temperatures above the range of the gas-expansion instrument.

The writer has developed a new instrument which he calls the Brown heat meter and which is claimed to give greater precision in temperature measurements than is secured with the high resistance millivoltmeter.

In this instrument, in addition to the standard high-resistance millivoltmeter, is used an ordinary dry cell about $1\frac{1}{4}$ in. in diameter by $2\frac{1}{2}$ in. long, and a suitable rheostat to reduce the voltage of the dry cell from approximately $1\frac{1}{2}$ volts to a range from 0 to 60 millivolts, the voltage produced as a maximum by the thermocouples. In the operations adjustments are first made to insure that the voltage developed by the thermocouple is equal to the reduced voltage of the dry cell. Then the voltage of the thermocouple is cut out and the voltage of the dry-cell circuit read by direct deflection, which eliminates the line resistance entirely, just as a potentiometer gives a deflection indicating the actual temperature developed by the thermocouple at the moment of reading the instrument. It does not, however, indicate the fluctuation in temperature of the thermocouple, since it is the voltage from the dry cell that is being read. It is possible, however, to get this reading by connecting the thermocouple to the meter of the dry-cell circuit and noting whether the indications are the same.

The writer also discusses in detail automatic temperature control and the design of a temperature-signaling pyrometer, which latter is an instrument which will automatically signal by lights whether the temperature is too high, correct, or too low in any particular furnace. (*Proceedings of the Steel Treating Research Society*, vol. 1, no. 5, December 1917, pp. 32-35.)

Munitions

Shell Making by Improved Machine and Methods. Description of a method developed in a small machine shop to manufacture shells. A company in Ohio undertook the manufacture of shells for the Belgian army. The orders soon outgrew the capacity of the plant and a small shop was leased in Buffalo. In this latter plant the company manufactured shells of the French type having a longer taper and designed according to metric measurements. This required the improvisation of special machinery. One of the most interesting problems was connected with the process of nosing these French-type shells. The usual process of placing the shell forging centered and rough-machined vertically face down under a hammer or press and swedging it under a die could not be applied in manufacture under French specifications because of the thinness of the metal.

To meet this difficulty R. J. Wehland developed a machine for applying the force perpendicularly to instead of along the axis of the curve. This machine consists essentially of a steam hammer with two dies and a movable carriage which feeds the shell between the dies and rotates it between strokes of the hammer. The lower die is rigid. The upper one is impelled against the shell with a 1-in. stroke at the rate of 125 times per minute.

The shell base is held in the block on the carriage or feeding machine. Rotation is induced by a compressed-air motor working through a small pinion to the large gear which rotates the clamping device by which the shell is held. This rotation is at a constant rate, the entire carriage being moved forward by means of a large handwheel until the nosing attains the form desired.

The hammering is perpendicular to the long axis of the shell, and the only force delivered along the axis of the shell is that forward movement on the table by which the carriage is moved forward by the handwheel when the shell is fed into the dies.

This nosing machine may be used in connection with a forging press, as well as with the steam hammer. (*The Iron Trade Review*, vol. 62, no. 6, February 7, 1918, p. 373, 1 fig., *d*)

Gages and Gage Making for Munition Plants. (Prepared by the Library of the Engineering Societies.)

1913.—Inspection Gages for Remington Gun Parts, 1913. (*Amer. Mach.*, vol. 38, pp. 763-768.) Discusses the life of gages; describes counterbore gage, milling inspection gage and contour gage.

1915.—Machining Shrapnel Shells, 1915. (*Machinery*, vol. 21, pp. 638-639.) Detailed description of gages for British and American shrapnel shells.

1915.—Standardization of B. A. Screws, 1915. (*Mech. Engr.*, vol. 36, pp. 75-76.) Provisional conclusions reached by the Small Screws Sub-Committee of the Engineering Standards Committee, enabling the National Physical Laboratory to issue a list of dimensions which may be of service at the present juncture to persons using the screws and assist in obtaining interchangeable work.

1916.—Abbott, P. W., What's the Matter with Our Methods of Threading? 1916. (*Amer. Mach.*, vol. 44, pp. 173-175.) A study of the various elements entering into the production of good screw threads both internal and external; relates to accuracy in munition and other work.

1916.—Anderson, John R., Adjustable Limit Gage for Munition Parts, 1916. (*Amer. Mach.*, vol. 45, p. 339.) Illustrated description of a "bridge gage."

1916.—Baker, Donald, Manufacturing Parts of Type 80 Time Fuses, 1916. (*Machinery*, vol. 23, p. 297.) Gives details of gages used in testing and manufacturing fuse parts.

1916.—Bogart, F. H., Deceptive Working Limits on Munitions, 1916. (*Amer. Mach.*, vol. 45, pp. 1021-1023.) Analysis of working limits on various parts.

1916.—Booth, W. H., Limit Gage System in Principle and Practice, 1916. (*Mech. Engr.*, vol. 37, pp. 109-112.) Deals with design and materials of limit and screw gages; article written because the widespread interest in munitions has brought the question of limit-gage systems very much to the front.

1916.—Bogart, F. H., Production Gages, 1916. (*Amer. Mach.*, vol. 45, p. 1106.) Discusses their application to munition work.

1916.—Booth, W. H., Limit Gage Principles and Practical Applications, 1916. (*Canadian Machinery*, vol. 15, pp. 285-286, 343, 417-418.) On limit gages for various services, materials, designs, etc.; states that it is of interest in relation to munition work.

1916.—Colvin, Fred H., Caps and Base Plugs for Time Fuse. 1916. (*Amer. Mach.*, vol. 45, pp. 467-471.) Illustrated details of gages used.

1916.—Colvin, Fred H., Making Adapters for British Detonating Fuse. 1916. (*Amer. Mach.*, vol. 44, pp. 239-241.) Illustrated details of gages used for the adapters.

1916.—Colvin, Fred H., Making Copper Rifling Rings, 1916. (*Amer. Mach.*, vol. 44, pp. 678-679.) Shows a simple device for gaging ring used on the base of a shell to make it follow the rifling grooves in a gun.

1916.—Colvin, Fred H., Making Five Million Primers for Cartridge Cases, 1916. (*Amer. Mach.*, vol. 44, pp. 309-315.) Shows illustrated details of gages used.

1916.—Colvin, Fred H., Making the British Time Fuse Mark 80-44, 1916. (*Amer. Mach.*, vol. 45, pp. 367-374, 421-425.) Describes and illustrates tools and gages for making time fuses.

1916.—Colvin, Fred H., Making the Small Parts of the British Time Fuse, 1916. (*Amer. Mach.*, vool. 45, pp. 549-553.) Gages used for different parts of the fuse are shown.

1916.—Colvin, Fred H., Making Top and Bottom Rings for Time Fuses. 1916. (*Amer. Mach.*, vol. 45, p. 513.) Describes a variety of special gages for fuse work.

1916.—Colvin, Fred H., Manufacturing British 8-in. Shells in 4½ Hours, 1916. (*Amer. Mach.*, vol. 44, pp. 749-754, 807-813.) Illustrated details of gages used.

1916.—Colvin, Fred H., Manufacturing 120-mm. Serbian Shells. 1916. (*Amer. Mach.*, vol. 44, pp. 397-403, 453-458.) Details of the gages used, and of turning shells by power to try the gages.

1916.—Darling, H. M., Adjustable Limit Gage for Munitions Parts, 1916. (*Amer. Mach.*, vol. 45, p. 969.) Describes gage for testing straightness of small-size twist drills.

1916.—Darling, Herbert M., Making Accurate Templets (letter), 1916. (*Amer. Mach.*, vol. 44, p. 865.) Method for gaging the form of shells.

1916.—Dowd, A. A., Making Gages for Shrapnel Shells, 1916. (*Iron Trade Review*, vol. 59, pp. 17-20.) Economies for gage manufacture; examples of gages.

1916.—French Screw Gage, 1916. (*The Engineer*, vol. 122, p. 234.) Describes and illustrates a simple form of screw gage devised by M. Marre; relates to the adoption of the S. I. screw thread by the French Minister of War.

1916.—Glazebrook, R. H., Limit Gages, 1916. (*Engrg.*, vol. 102, pp. 224-225, 240-242, 236-238 and 252-254.) Illustrated article subdivided into gages for plain cylindrical work, screw gages, form, and position gages. States that the importance of subject has grown since the commencement of the war.

1916.—Lavender, J. H., Some Notes on Hardening Screw Gages, 1916. (*Engrg.*, vol. 102, p. 631.) Particulars obtained from experimental work extending over a period of six months.

1916.—Hamilton, Douglas T., Gaging and Inspection Methods, 1916. (*Machinery*, vol. 23, pp. 95-118.) The developments of interchangeable manufacture; the limit system and its advantages; difference between allowance, tolerance and limit; probable life of gages, etc.

1916.—Hamilton, Douglas T., Profile and Indicating Gages, 1916. (*Machinery*, vol. 23, pp. 208-219, 302-318.) Description of different types of gages working on the indicating principle which have been used with satisfactory results in the manufacture of munitions.

1916.—Hey, J., Two Gages for Use in Fuse Heads, 1916. (*Machinery*, vol. 8, p. 751.) Illustrated description of gages used in a British factory.

1916.—Loading Primer Bodies, 1916. (*Amer. Mach.*, vol. 45, p. 460.) Final assembling and gaging devices used for primers.

1916.—Manufacture of Mark II Gains for 18 Pdr. H. E. Shells, 1916. (*Canadian Machinery*, vol. 15, p. 277.) Describes gaging device.

1916.—Mawson, Robert, Making Bayonet Scabbards, 1916. (*Amer. Mach.*, vol. 44, p. 292.) Shows tension gage for bayonet scabbard.

1916.—Mawson, Robert, Making 1-lb. Cartridge Cases, 1916. (*Amer. Mach.*, vol. 44, p. 1032.) Illustrated details of gages for testing cartridge cases.

1916.—Mawson, Robert, Making the 18-lb. Cartridge Case, 1916. (*Amer. Mach.*, vol. 45, p. 381.) Shows details of the gages used.

1916.—Mawson, Robert, Making the 4.5-in. Howitzer Cartridge Case, 1916. (*Amer. Mach.*, vol. 45, p. 110.) Shows details of gages.

1916.—Mawson, Robert, Manufacturing the 1-lb. High-Explosive Shell, 1916. (*Amer. Mach.*, vol. 45, p. 158, 202.) Details of gages for screw-machine operations, for outside and inside threads, diameter and thickness of shoulder, length, and final test gage for shell diameters.

1916.—Mawson, Robert, Manufacturing 12-in. Shrapnel, 1916. (*Amer. Mach.*, vol. 44, pp. 537-542, 581-587, 625-630, 675-677.) Gives details of gages used; illustrated.

1916.—Mayoh, F. H., Gages in Modern Manufacturing Practice, 1916. (*Canadian Machinery*, vol. 15, pp. 307-308, 327-328, 364-365.) Illustrations in groups of a number of standard gages; includes gages for testing shrapnel-shell fuse rings.

1916.—Micrometer Limit Gage Attachment, 1916. (*Sci. Amer. Suppl.*, vol. 82, p. 325.) Brief description of "Apollo Mykarms," a small limit-gaging device invented and patented by a British government inspector.

1916.—Moore, J. H., Manufacturing Adapters for 18-lb. High-Explosive Shells, 1916. (*Amer. Mach.*, vol. 44, p. 413.) Illustrated details of gages used.

1916.—Olsen, L. E., Gage for Measuring Shrapnel, 1916. (*Amer. Mach.*, vol. 44, p. 412.) Gage illustrated has many advantages over the common saw-frame style or the vertical standard with pin-dropping device.

1916.—Pusep, Hugo F., Whitworth Thread-Gage Making, 1916. (*Amer. Mach.*, vol. 45, pp. 775-777.) Deals with precision gages for munition factories.

1916.—Screw Gages, 1916. (*The Engineer*, vol. 121, pp. 263-264.) Explains the necessity for accuracy in a gage, the errors which may occur in screws, and methods whereby these errors may be discovered and measured and avoided in future work. Abstract of paper written by the staff of the National Physical Laboratory; states that the screw gage plays a considerable part in munition work.

1916.—Shell-Test Scale, 1916. (*Amer. Mach.*, vol. 45, p. 173.) The purpose of the scale is to immediately indicate whether the shell is under or over the prescribed weight.

1916.—Suverkrop, E. A., Manufacturing British 18-Pounder High-Explosive Shells, 1916. (*Amer. Mach.*, vol. 44, pp. 495-499.) In the final government inspection shells are subjected to a very rigid examination in which all the gages previously employed are again made use of.

1916.—Training That Will Not Be Forgotten (editorial), 1916. (*Amer. Mach.*, vol. 45, p. 435.) Precision gage work on munitions.

1916.—Unification des Filetages, vis Mécanique, France, Adoption du Système International par le Service de L'artil-

lerie, Ministère de la Guerre, 1916. (*Bull. d'Encouragement pour l'Industrie Nationale*, vol. 126, pp. 74-110.) Describes standard for screw threads adopted by the Minister of War of France for use in the artillery service.

1916. United States Munitions, the Springfield Model 1903 Service Rifle, 1916. (*Amer. Mach.*, vol. 45.) General specifications and barrel operations, pp. 635-646, 679-689, 725-734; sequence of operations, including details of gages used. Operations on the barrel and fixed stud, pp. 679-689; illustrations of gages used. Operations on the bolt, pp. 987-994, 1033-1040, 1079-1087; shows sequence of operations and details of the gages. Operations on the receiver, pp. 813-821, 859-866, 901-911, 945-956; includes details of gages; illustrated. Operations on the sleeve, pp. 1123-1131, illustrated details of the gages.

1916. Viall, Ethan, Making 3-in. Russian Shrapnel in a Pump Shop, 1916. (*Amer. Mach.*, vol. 44, pp. 849-850.) Details of Russian shrapnel gages; illustrated.

1916. Wright, M. S., Tolerance System and Metric Conversion Table, 1916. (*Amer. Mach.*, vol. 45, pp. 702-704.) Tables compiled to assist in work necessary on gun construction.

1917. Alford, L. P., ed., Manufacture of Artillery Ammunition, 1917, N. Y., McGraw-Hill Book Co., Inc. Gives illustrated details of gages used.

1917. Baker, Donald A., Gages for Time-Fuse Parts, 1917. (*Machinery*, vol. 23, pp. 1089-1096.) Problems in the manufacture of gages for Russian time fuses and methods by which they were solved.

1917.—Bogart, F. H., Method of Machining the "85" Fuse Body, 1917. (*Amer. Mach.*, vol. 46, pp. 721-723.) Details of machining operations; illustrations of special gages, etc.

1917.—Bogart, F. H., Suggestions Relative to the Manufacture of Parts to Limit, 1917. (*Amer. Mach.*, vol. 46, pp. 667-671.) On the use of limits and limit gages; steps involved; requirements for expressing dimensions; essential and non-essential dimensions; examples of wrong dimensioning, etc., in the production of munition parts.

1917. Brooker, Arthur, Screw Thread Measurement, 1917. (*Engrg.*, vol. 103, pp. 113-118, 139-141, 165-166.) Definitions; method of measurement by microscope micrometer, diametral measurements by floating micrometer, optical projection apparatus, and measurement of pitch by mechanical means. Designed to be useful in manufacturing interchangeable parts in large quantities. (Same in *Mech. Engr.*, vol. 39, pp. 339-343, 353-355, and in *Post Office and Elec. Engrs. Jour.*, vol. 10, pp. 153-170.)

1917. Buckingham, Earle, American Industrial Progress as Revealed by War Orders, 1917. (*Amer. Mach.*, vol. 46, pp. 315-321.) Contrasts American and European manufacturing development and then briefly states the principles underlying interchangeable production.

1917. Chubb, I. W., Producing British Screw gages, 1917. (*Amer. Mach.*, vol. 46, pp. 593-594.) Notes relating to the methods followed by E. G. Wrigley & Co., in making gages for munition purposes.

1917. Cooke, A. G., W. J. Gow and W. G. Tunnicliffe, Manufacture of Gages at the L. C. C. Paddington Technical Institute, 1917. (*Jour. Inst. Mech. Engrs.*, Feb.-March, pp. 45-108.) Workshop details and methods of securing a high degree of mechanical accuracy under conditions of great urgency and without special equipment. Relates to the standardization of munition manufacture. (Abstracts in *Iron Age*, vol. 99, pp. 536-538, and *Model Engr., and Electrician*, vol. 36, p. 115.)

1917. Crompton, R. E. B., Notes on Screw Gages, 1917. (*Automobile Engr.*, vol. 7, pp. 35-37.) States that at the commencement of the war there was no satisfactory system in use for gage making; suggests that whole series of screws from 3-in. down to the tiny screws should follow one law for tolerances, modified only by considerations of the method of manufacture.

1917.—Dilrell, A. G., Ammunition for American Merchantmen, 1917. (*Amer. Mach.*, vol. 46, pp. 617-625.) Description and illustrations of gages for 6-in. shell for the U. S. Navy.

1917.—Erdman, A. W., Limits and Tolerances for the Manufacture of Munitions, 1917. (*Jour. Amer. Soc. Mech. Engrs.*, vol. 39, pp. 382-384.) Discusses some of the practical aspects of limits and tolerances, as customary applied. (Abstracts in *Amer. Mach.*, vol. 47, pp. 73-74; *Iron Trade Rev.*, vol. 60, pp. 1130, 1139-1140.)

1917.—Erdman, A. W., Limits and Tolerances in Munitions Manufacture, 1917. (*Iron Age*, vol. 99, pp. 1137-1138.) On relation of tolerances to weight; thread tolerances; individual judgment of inspectors; machine-tool limitation.

1917.—Forrest, James, Inspection of Munitions, 1917. (*Amer. Mach.*, vol. 47, pp. 763-764.) Inspection of munition work, and an example of gaging with minimum plug.

1917.—Gage Problem in Rifle Manufacture, 1917. (*Iron Age*, vol. 99, pp. 1199-1200.) States that there are not enough tool makers to equip private plants with fixtures.

1917.—How Gages for Big British Shells Are Made, 1917. (*Iron Trade Rev.*, vol. 61, pp. 17-22.) Describes the plant of Dove-Smith & Son at Niagara Falls.

1917.—Hamilton, Douglas T., Gaging and Inspecting Threads, 1917. (*Machinery*, vol. 23, pp. 477-486, 581-586.) Review of question of manufacturing tolerances on various elements of a screw thread as well as other points of importance.

1917.— Iler, William T., National Supervision of Gages, 1917. (*Machinery*, vol. 23, pp. 961-962.) Shows organization of proposed gage department of U. S. Munitions Board.

1917.—Macintyre, J. R., Production of Accurate Thread Gages, 1917. (*Machinery*, vol. 24, pp. 31-32.) Methods used in making thread-cutting and radius-forming tools and an angle-grinding fixture; current practice in the Remington Arms Co.

1917.—Macready, C. A., Elements of Gage Making, 1917. (*Amer. Mach.*, vol. 47, pp. 491-493, 661-664, 1112-1118.) On the principles and methods for recognizing and avoiding errors that have become habitual to gagemakers.

1917.—Masked Tolerances, 1917. (*Amer. Mach.*, vol. 46, pp. 694-695.) Method followed in making French high-explosive shell.

1917.—Modification of the Whitworth Screw Thread (letter), 1917. (*Engrg.*, vol. 103, p. 385.) Discusses proposals of W. C. Unwin, which are stated to be of interest to those manufacturing munitions.

1917.—Moffett, L. W. Toolmaker's Rôle in Wartime, 1917. (*Iron Trade Rev.*, vol. 60, pp. 929-931.) On the necessity of providing gages, jigs and fixtures for mass production.

1917.—Powell, H. J. Bingham, Inspection of Screw Gages for Munitions of War, 1917. (*Amer. Mach.*, vol. 47, pp. 1065-1073.) An attempt to assist screw-gage manufacturers in their work of making gages for munitions of war, which have to be accurate within very low tolerances.

1917.—Powell, H. J. Bingham, Screw Gage Measuring Machine, 1917. (*Amer. Mach.*, vol. 47, pp. 840-842.) Describes machine similar to one used in gage department of the British Ministry of Munitions.

1917.—Pusep, Hugo F., Practical Points in Flat-Gage Mak-

ing, 1917. (*Amer. Mach.*, vol. 47, pp. 369-372.) It has been demonstrated by all concerns engaged in producing war munitions in large quantities that the flat gage is an indispensable tool for taking measurements during the manufacture of primers, fuse bodies, time fuses, rifle parts, etc.

1917.—Screw Thread Measurements: Some of the Accurate Methods Used in Gage Making, 1917. (*Iron Age*, vol. 99, pp. 894-895.) Sketches showing definitions adopted for various portions of screw threads; method of measuring screw threads by microscopic micrometer and principle of the optical projection apparatus; in relation to the needs at the beginning of the war, when British manufacturers were compelled to make interchangeable parts in large quantities.

1917.—Sears, J. E., Manufacture of Screw Gages (letter), 1917. (*Engrg.*, vol. 103, p. 137.) On the work of the National Physical Laboratory since commencement of war; pitch measurement, diameter measurements, optical apparatus, automatic lapping of screw threads.

1917.—Standardization of Screw Threads, 1917. (*Engrg.*, vol. 103, p. 360.) A series of questions accompanied by table and drawing of the Whitworth thread, sent out by the Engineering Standards Committee, in coöperation with the Ministry of Munitions.

1917.—"Sponsel" Gun Barrel Calibrating and Straightening Machine, 1917. (*Amer. Mach.*, vol. 47, p. 744.) Describes a machine used for measuring and straightening the bore of gun barrels, etc.

1917.—Stărr, Adolph, Special Micrometer for Measuring Cartridge Tools, 1917. (*Amer. Mach.*, vol. 46, pp. 651-652.) Illustration of a micrometer designed for measuring drawing punches for brass shells and covers.

1917.—Suverkrop, E. A., Precision Thread Gages, 1917. (*Amer. Mach.*, vol. 47, pp. 265-271.) Details of making precision thread gages from the bar stock to the finished gage, in its relation to the manufacture of munitions.

1917.—United States Common Shrapnel and Common Steel Shells, 3.8, 4.7 and 6 in., 1917. (*Amer. Mach.*, vol. 46, pp. 1113-1118.) Specifications and operation lists for the different projections shown; includes gaging.

1917.—United States Munitions, the Springfield Model 1903 Service Rifle. (*Amer. Mach.*, vol. 46.) Floor plate, floor-plate catch, magazine spring, pp. 415-426; list of operations on parts that go to make up the magazine, illustrated; gages are included. Making the guard, pp. 287-293, 333-338, sequence of operations, including gaging; illustrations. Making the stock, pp. 1031-1041, 1079-1085, 1123-1129; sequence of operations, including gaging; illustrated. Movable stud; front sight and movable base; guard, gear, trigger and floor plate; leaf; slide and cap; draft slides; windage screw and butt plate, butt-plate cap, upper band, lower band, spring and swivel butt plate swivel, pp. 463-469, 551-558, 595-602, 641-647, 685-690, 725-735, 771-779; sequence of operations, including gagings; illustrated. Movable stud, pp. 463-469; includes illustrations of gages. Oiler and thong case, spare parts, container, screw-driver, pp. 947-953; includes illustrations of pages. Operations on the hand guard, pp. 67-73 (vol. 47), 111-118; list of operations and illustrations of gages used. Operations on the sleeve, pp. 19-27; illustrations of gages are given. Safety-lock spindle and plunger, pp. 245-250; small details requiring several interesting operations; some of the fixtures and gages are of special interest; illustrated. Stacking swivel, hand-guard clip, front-sight cover, cleaning rods, pp. 817-823; list of operations and illustrations, including gaging, of small accessories which go to make up the completed rifle. Striker, mainspring and extractor, extractor collar, ejector and ejector pin, pp. 111-119, 153-161; includes illustrations of gages. The bayonet, pp. 197-205 (vol. 47); show gages used in manufacturing the three kinds of bayonets used by the United States; the knife or regular bayonet and the large and small bolo bayonets. The cocking piece, pp. 69-76; illustrations of gages are given.

1917.—United States Munitions, the 3-Inch Common Shrapnel, 1917. (*Amer. Mach.*, vol. 46, pp. 353-377.) Includes illustrations of gages used.

1917.—United States Munitions, the 3-in. Common Steel Shell, 1917. (*Amer. Mach.*, vol. 46, pp. 486-507.) Includes illustrations of gages used.

1917.—United States Munitions, 3 to 6-in. Cartridge Cases, 1917. (*Amer. Mach.*, vol. 46, pp. 881-903.) Includes illustrations of gages.

1917.—Unwin, W. C., Further Notes on Screw Threads, 1917. (*Engrg.*, vol. 103, p. 289.) A comparison of British Standard Fine Threads (B.S.F.) and the International Metric Thread, which is now largely adopted for munition work in Great Britain.

1917.—Unwin, W. C., Suggested Modification of the Whitworth Screw Thread, 1917. (*Engrg.*, vol. 103, pp. 158-159.) Relating to the production of a great quantity of interchangeable mechanical parts for munitions. The advantage of clearance at the roots and crests of screw threads is examined and the effect of such a modification on the dimensions of the thread. (Abstract, Proposed Modification of Whitworth Thread, in *Iron Age*, vol. 99, p. 930.)

1917.—Van Wyck, J. R., Heat Treatment and Temperature Measuring of Shells, 1917. (*Amer. Mach.*, vol. 47, pp. 1087-1090.) Description of a successful method used in the manufacture of two million 3-in. Russian shrapnel shells.

1917.—Whitaker, E. W., Inspection of Gages for Ammunition, 1917. (*Iron Trade Rev.*, vol. 60, pp. 1242-1243.) The author shows the necessity of systematically checking all munition gages.

1918.—Powell, H. J. Bingham, Inspection of Screw Gages for Munitions of War, 1918. (*Jour. Amer. Soc. Mech. Engrs.*, vol. 40, pp. 108-109.) Discusses the question of pitch in screw gages.

1918.—American Society of Mechanical Engineers, Public Meeting of Gage Committee, culminating in a proposal to the Government to coöperate in munitions contracts by requiring certification of gages by Bureau of Standards, 1918. (*Jour. Amer. Soc. Mech. Engrs.*, vol. 40, pp. 70-72.) Recommends that gages be checked against standards under unified supervision.

Making Malleable Cast Iron Rifle Grenades. *The Foundry*, vol. 46, no. 2 (whole no. 306), February 1918, pp. 47-56, 22 figs.

Modern Gun Manufacturing Plant. *The Iron Trade Review*, vol. 62, no. 6, February 7, 1918, pp. 368-372. 15 figs.

Military Engineering, Maj.-Gen. Wm. M. Black. *The Rose Technic*, vol. 27, no. 3, December 1917-January 1918, pp. 72-76.

Smokeless Rifle Powders. *Arms and Explosives*, vol. 25, no. 303, December 1, 1917, pp. 158-160.

Screw-Thread Tolerances for Munitions. *American Machinist*, vol. 48, no. 4, January 24, 1918, pp. 135-136. 3 figs., 4 tables.

Power-Plant Engineering

JOLIET POWER PLANT. Description of the power plant of the Public Service Company of Northern Illinois at Joliet, Ill.

The outstanding feature in the new plant is the high steam pressure used, which is 300 lb. at the turbine and approximately 325 lb. at the boiler, superheated 225 deg., or about 75 lb. higher than common in modern stationary practice.

Because of the density of the steam, extra heavy piping of relatively small diameter is used, all rigid construction being carefully avoided. The lengths of straight runs have been limited, and numerous long-radius bends are employed to provide for expansion.

Individual all-steel horizontal-tube economizers are used, said to be the first of their kind in the country. The construction of these economizers is similar to that of the B. & W. water-tube boiler without the drum. The headers are of rod steel and the tubes, which are 4 in. in diameter and 16 ft. long, of drawn steel 1/4 in. thick. As low temperatures are expected, the tubes are galvanized inside and out to guard against corrosion. The economizer is vertically paneled for three passes, the gases from the boiler entering at the front, and from the third pass rising vertically through the induced-draft fan to the stack. Although at the given rating the fan requires 94 hp., a 150-hp. motor was installed to provide for contingencies and to reduce upkeep to a minimum. Water to the economizer

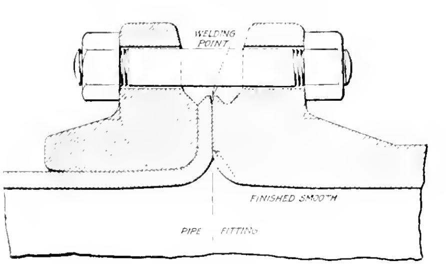


FIG. 6 SPECIAL WELDED JOINT FOR EXTRA HEAVY STEAM PIPING

enters at the bottom of the rear header and passes through 396 four-inch tubes, to leave at the top of the front header.

The economizer is placed above and integral with the boiler, the economizer tubes having a 5-deg. slope. There are no dampers between, so that the gases pass directly from one to the other, the furnace gases flowing from the economizers at such low temperatures as to permit unlined steel stacks.

Outside of the small stoker engines held as reserves for motor drives there is no reciprocating machinery in the station. With little exhaust steam available to heat the feed-water, provision is made to bleed steam under thermostatic control from the fourth stage of the main turbine, where the pressure is sufficient for this purpose. Another feature is to utilize the condenser for drawing boiler make-up from the fresh-water reservoir. The water enters the condenser, and with the air of the condensate pump is passed in the usual way to the heater.

Extra high high-pressure piping is used throughout with fittings of cast or forged steel. On steel pipes above 4 in. in diameter a special welded joint, shown in Fig. 6, is used. The pipe is extended through the flange and is belled out to form the face of the joint. The face is finished smooth and the edge beveled off to form a V-shaped groove to receive the welding metal. On fittings a face boss of extra thickness to form a welding surface similar to that in the pipe flange is provided. The weld is intended only to seal the joint, the bolts through the flange taking this stress. (*Power*, vol. 47, no. 4, January 22, 1918, pp. 108-113, 7 figs., *d*)

POWER PLANT INSTALLATIONS FOR BY-PRODUCT COKE OVEN PLANTS, George B. Evans. *Journal of The Engineers' Club of St. Louis*, vol. 2, no. 6, November-December, 1917, pp. 321-327.

Railroad Engineering

ALL-WOOD AND COMPOSITE HOPPER CARS FOR THE NORFOLK & WESTERN RAILWAY, B. W. Kedel. Description of two recent designs of hopper cars. The Norfolk & Western Railway is just beginning the construction of an order of 2000 hopper cars of 57 1/2 tons capacity, ten of which are being built entirely of wood, including the center sills and bolsters, for demonstrating the possibility of this construction for cars of such capacity. The rest will have steel center sills and steel bolsters with wood-frame construction for the remainder of the car.

The design of the all-wood cars is the result of the unusual steel market. The wood and center-sill members consist of a pair of through 6 by 12-in. sills spaced 15 1/2 in. apart, the bottom being located 2 ft. 6 7/8 in. above the rail, or 5 1/16 in. below the center line of the coupler, about as steel sills are ordinarily located and without the old-style draft chambers. Doweled to the inside of each of these along the bottom edge is a buffing sill of 4 by 8-in. dimension, these being consequently located almost symmetrically with the center line of the coupler and extending from one bolster to the other. Bolted between the main center sills over each truck is a gray-iron casting, which serves as a draft-gear backstop and the center channel tie casting, the center plate being cast integral with it and 4 by 8-in. buffing sills abutting on one of these castings at each end. This casting has shelf portions which underlie the main draft sills and support them independently of the bolts. The casting also has bracket portions which overlie the center sills and to these the sills are also hung by means of vertical bolts. Buffing forces are delivered to the draft by this casting and from it to the end grain of the buffing sills, and the buffing sills, in the same manner, transmit the force directly to the draft gear at the opposite end of the car and on to the next car.

The body of the car is anchored to the main 6 by 6-in. draft sills and these are bolted and doweled at intervals to the buffing sills to take care of the shifting of the body and the lading with respect to the buffing sills. The center plate being integral with the back-stop casting, the force from the inertia of the truck in buffing reacts at one end of the car against the ends of the buffing sills and at the other end of the car directly against the draft gear through this casting. The retarding force of a brake application is transmitted in the same manner.

The bolsters are each composed of two 6 by 20-in. yellow-pine timbers passing over the center sills and beneath the hopper chute, and these rest upon the top surface of the gray-iron center casting.

The design of the composite cars does not represent anything of unusual novelty. It is, however, of interest to note that iron castings are used quite extensively in the framing of these cars, the weight of the car being not much higher, however, than that of a steel car of equal proportions. (The first car turned out weighs 42,300 lb.)

It was contemplated on the steel center-sill cars to use wooden bolsters with the steel center sills, but because of the difficulty of making steel and wood work together with beam construction, steel bolsters are used with steel sills. The deflection of wooden beams is such that the center sills would be greately overstrained over the center plate before the bolster would have its proper load. Also the shrinkage of wood against the constant dimension of the steel would probably cause such variations in the loading at points as to entirely defeat the design. (*Railway Review*, vol. 62, no. 1, January 5, 1918. pp. 13-15, 2 figs., *d*)

Rail Creep. In a paper by Frank Reeves are described some simple experiments having for their purpose an explanation of the so-called creeping of rails. The broad conclusions at which the author arrived are: Creep of rails is due primarily to the deformation of the rail as the wheel passes over it. It may be likened to the movement of dough when rolled under a rolling pin. The more violent the deformation, the greater the creep. That is to say, creep is increased by (*a*) increasing the wheel load, and (*b*) by diminishing the rigidity of the rail, either by reducing its section or using a weaker material.

In a second paper, by Harry Powell Miles, are described briefly the effects which the direction and class of traffic and the alignments and gradients of the line have in producing creeping. The effect which creeping rails have on the constituent of the permanent way and the method of rectifying the positions of the rails after a creep has taken place are described, as well as investigations which the author made for a period of five years on a length of line consisting of 850 track miles of main and branch lines over which various kinds of traffic passed. The results of the investigation are not reported in the article. (*The Railway Gazette*, vol. 28, no. 2, January 11, 1918, pp. 42-45, 6 figs.)

The Effects of Water Scooping on Train Resistances, H. C. Webster. During its passage through the trough the scoop becomes a moving vane and is governed by the same principles as an ordinary turbine, except that the impact in the former case is caused by the collision of the moving scoop against the stationary volume of water and in the latter case by the moving water against the stationary or slowly moving vane.

Assuming that the scoop is moving at a velocity of V ft. per sec., and the area of the delivery pipe is a sq. in., then the resultant reaction of the scoop which constitutes the increased resistance of the train is

$$R = \sqrt{2} \times 62.4aV/144g\sqrt{(V^2/2)}$$

The writer gives the following table for trains moving with velocities between 25 and 60 miles per hour with a equal to 50 sq. in.:

Speed, m.p.h......	25	30	35	40	45	50	55	60
Resistance, lb......	901	1310	1779	2330	2940	3610	4320	5220

The relation between resistance and delivery-pipe area a is shown in the following table (V = 40 miles per hour):

a, sq. in........	35	40	45	50	55	60	65	70
Resistance, lb.....	1631	1860	2100	2320	2560	2800	3040	3260

If these data are plotted as a curve, as the writer does in the original article, a straight line is obtained which shows that in designing the scoop the minimum area is desirable consistent with the volume of water to be lifted over a given length of trough. (*Railway Engineer*, vol. 39, no. 456, January 1918, p. 4, 3 figs., *t*)

Locomotive Feedwater Heating. Description of a new system for preheating the water before it is admitted to the boiler of a locomotive. In this case exhaust steam taken directly from the steam chest or the exhaust passage in the cylinder saddle is used. It is claimed that the amount of exhaust steam taken in this way is not sufficient to interfere materially with the draft of the locomotive, while the feedwater temperature is raised from 150 to 180 deg.

With this system the injector is replaced by a new water pump which was developed for this particular work by the Westinghouse Air Brake Company.

This pump was modeled after a Westinghouse compressor. The steam end is that used on a standard 9½-in. compressor. The water cylinder is 6½ in. in diameter and double-acting. Tests made with this pump have shown that 50 lb. of water are pumped per lb. of steam used for operating the pump.

In the heater illustrated in the original article the exhaust steam from the steam chests is admitted at the top, allowed to circulate around the tubes which contain the feedwater, and passes out through the drain at the bottom. The water from the pump passes through the heater four times before it is delivered to the boiler. This is accomplished by means of walls in the headers at the end of the heater. One of the headers has three chambers formed by a wall extending horizontally across the header at the center and a vertical wall extending up from this wall. The other header has one vertical wall dividing it into two parts.

One of the most important features of this heater is represented by the agitators contained in each of the tubes in the heater. They consist of thin corrugated and spiraled strips of brass and their function is to so agitate the water as it passes through the tubes that every particle of it will come in contact with the hot tubes and absorb all the heat possible from the exhaust steam on the outside of the tubes. This agitation also serves to keep the tubes clean and free from scale. The higher the velocity of the cold water passing through the tubes, the more violent the agitation and the greater the amount of heat absorbed by the water. (*Railway Age*, vol. 64, no. 3, January 18, 1918, pp. 177-179, 3 figs., *d*)

The Creep of Rails, Frank Reeves. *Engineering*, vol. 105, no. 2716, January 18, 1918, p. 66.

Solidification as a Factor in Railway Valuation, H. M. Taylor. Discussion of methods for determining the value of "the hardening down" of a railroad, which means depreciation in the roadbed due to seasoning. The writer believes that it would be possible to arrive at a factor for determining closely the value of solidification by investigating the large companies which have lines long in service and lines newly built. (*Railway Age*, vol. 64, no. 3, January 18, 1918, pp. 176-179, 5 figs.)

Steam Engineering

Air Pumps. A sub-committee appointed by the Council of the North-East Coast Institution of Engineers and Shipbuilders recently presented its report on various methods of producing high vacuum.

This report was based on an investigation carried out at the works of Richardsons, Westgarth & Co., at West Hartlepool, England. The apparatus used in the investigations is of the composite type, such as used in college laboratories. It is shown diagrammatically in Fig. 7.

The tests were made on reciprocating air pumps working all wet, wet and dry, etc., and two steam jets. The pumps were

not used with the condenser, but with the receiver A. Into this receiver continuous streams of air and hot water to represent the condensate could flow at known rates, and it was the duty of the pumps to remove the water and maintain the vacuum in the receiver by withdrawing the air and vapor. As it was found in early tests that the aeration of the water was very irregular, it was decided to standardize it and for this purpose the de-aerator C was installed. It consists of a chamber exhausted by a steam jet to a vacuum of about 24 or 25 in.

The first tests were made with the plant arranged on the "ordinary wet system" with both barrels working. The results are shown at A, B and C in Fig. 8. To study the effect of the reduction in the volume of air, tests were then made

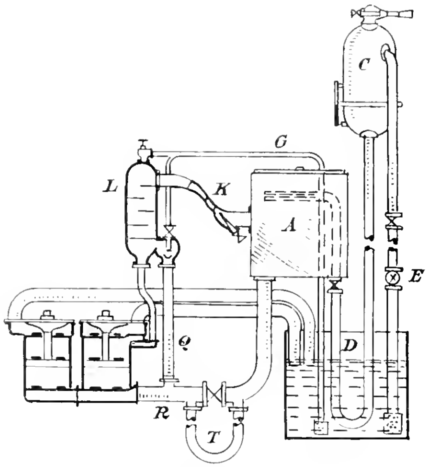


FIG. 7 DIAGRAM OF EXPERIMENTAL APPARATUS

with the single barrel, the results being shown in D. The next experiments were carried out with one barrel working wet and the other dry. The results obtained are shown at E, with cooling water at 50 deg. fahr., and F, cooling water at 70 deg. fahr.

Next "kinetic" combinations were tried out. Fig. 7 shows the connections used for the kinetic twin wet system. Two 1¼-in. steam jets working in parallel were fitted at K. The air withdrawn by these jets from the receiver was discharged into the small receiver and condenser L, the water being directed through the U-pipe T, which acted as a seal, making effective the head obtained by the height of the receiver above the foot valves and so preventing the passage back to the receiver of the air and vapor in pipes Q and R already compressed by the action of the steam jet. The results obtained are shown in G, for 60,000 lb. of condensate per hour, and H, for 10,000 lb. of condensate per hour.

The report states that the advantage obtained by the use of the jet is at once apparent, the vacuum approaching very closely to that ideally obtained in the absence of air, and an important portion of the curve being indistinguishable therefrom.

Two other arrangements of the kinetic system, namely, the kinetic wet and dry, were tried. The jet K, Fig. 7, and its condenser were moved to the left and connected with the barrel on that side and the U-pipe T was dispensed with. The right-hand barrel was run wet and the left-hand barrel dry. The line K, Fig. 8, shows the results obtained.

The tests have shown the greater efficiency of the steam jet. The complete report can be obtained from the Institution and costs half a guinea. (*The Engineer*, vol. 124, no. 3235, December 28, 1917, p. 557, 4 figs., *e*)

AIR PUMPS AND CONDENSERS. A new application of the steam-jet vacuum has recently been suggested by D. B. Morison. An extended investigation brought him to the conclusion that the steam jet is of advantage where the conditions are such that a poor vacuum meets the needs of the case. From his experience it appears that if a 25-in. or 26-in. vacuum will satisfy requirements, it can be obtained more cheaply and maintained more certainly by the use of auxiliary steam jets than in any other way.

A bad vacuum in a condenser, if not due to dirty tubes or hot cooling water, implies that much of the tubing is air-jacketed. In the commercial operation of reciprocating engines it is difficult to prevent air leakage, which impairs the efficiency of the condenser tubing. As the mixture of steam and air passes over the tubes, the steam as it condenses drops away as water, but the air remains behind, jacketing the tube. As a result, the lower rows of tubes in a reciprocating-engine condenser become quite ineffective.

Nevertheless, the lower rows cannot be abolished, because the air pumps can only remove a certain volume of air per minute, depending on their gross piston displacement, and also on the

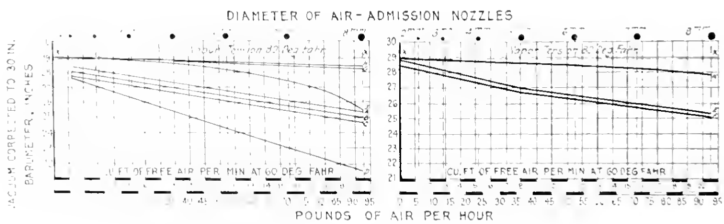


FIG. 8 DATA OF WEST HARTLEPOOL TESTS OF AIR PUMPS

temperature and pressure of the air itself. If the lower tubing be removed, the air will be delivered to the pumps at a higher temperature, and in that case either the piston displacement must be increased or the air must be delivered to the pump at a higher pressure, which means a worse vacuum in the condenser.

Here is to be found the advantage of the steam jet. If steam jets be interposed between the condenser and the pump, these jets which have a great volumetric capacity compress the

air into the pump suctions, so that a large weight of air can be abstracted with a very moderate pump displacement. Hence, the amount of the cooling surface in the condenser can be reduced 20 to 25 per cent, and the air pumps may also be made much smaller.

The experiments referred to in this article are those made by a sub-committee of the North-East Coast Institution of Engineers and Shipbuilders, and are reported in the next abstract. (*Engineering*, vol. 104, no. 2712, December 21, 1917, pp. 664-665, 2 figs., *e*)

Measuring, Purifying and Heating Feed Water, and Feeding Boilers. *Southern Engineer*, vol. 28, no. 5, January 1918, pp. 52-74, 36 figs.

Condensers with Seventy-Foot Water Level Variation, F. R. Brosius. Description of an installation where a type of substructure construction had to be adopted so as to insure a satisfactory supply of condensing water under unfavorable conditions and also support the great weight of the building and equipment on unstable ground. There are five condenser wells, with the intake well 86 ft. deep from the basement floor to the well floor and 60 ft. in inside diameter. Special methods for sinking the three larger wells had to be resorted to. It is of interest to note that part of the weight of the turbine rim rests on these wells. (*Power*, vol. 47, no. 5, January 29, 1918, pp. 142-144.)

The Lubrication of Steam Turbines. *Power*, vol. 47, no. 6, February 5, 1918, pp. 198-201, 3 figs.

Agricultural Tractors, Alan E. L. Chorlton. *Engineering*, vol. 105, no. 2714, January 4, 1918, pp. 7-10, 10 figs. Among other things, the subjects of drawbar pull and road resistance are discussed in detail in a very interesting manner.

Varia

American Research Methods, Charles H. McDowell. *Journal of the Western Society of Engineers*, vol. 22, no. 8, October 1917, pp. 546-564.

An Industrial Achievement of the War, L. P. Alford. *Industrial Management*, vol. 55, no. 2, February 1918, pp. 97-100, 1 chart.

Women in Airplane Production, I. William Chubb. *American Machinist*, vol. 48, no. 6, February 7, 1918, pp. 221-225, 16 figs.

Laws Regulating Women in Shops. *American Machinist*, vol. 48, no. 6, February 7, 1918, pp. 239-240.

Women as Foundry Workers in Germany, K. Abeking. *The Metal Industry*, vol. 11, no. 25, December 21, 1917, pp. 520-523, 4 figs.

Charts

Charts for Drawing Whitworth Hexagonal Nuts. *Mechanical World*, vol. 63, no. 1619, January 11, 1918, p. 15.

Graphic Method of Determining the Amount of Radiation Required, M. William Ehrlich. *Power*, vol. 47, no. 7, February 12, 1918, p. 225.

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Survey.

LIBRARY NOTES AND BOOK REVIEWS

ARTICLES of interest from the Library of the four Founder Societies, selected list of accessions during the month, and reviews of books of special importance prepared by members of the A.S.M.E. and others particularly qualified.

Making the Library Serve Your Purpose

It is only by constant use that one begins to understand and appreciate into what an immense storehouse of knowledge the combined engineering societies' Library has now developed. For although a complete dictionary catalogue by authors and subjects may be available, and in addition many published bibliographies besides those compiled in the Library—all of which are at all times at the disposal of members visiting the Library—it would be a mistake to think that this machinery affords complete access to all the material.

Complete access could only be provided by a systematic index covering the whole of the books and periodicals, and such an index would hardly consist of less than twenty million cards, to approach anything like completeness; but the cost of this work is far beyond the present financial resources of the Library.

It is evident that a dictionary catalogue and bibliographies merely act as principal signposts through the labyrinth of knowledge constituted by the publications. But although no complete index is available, the Library possesses other means to get at what is wanted, i.e., a staff of searchers, who from long experience have learned to dig, and to dig deeply; and it is now a rare thing that a question is presented for elucidation and the inquirer is not satisfied. These searchers, making use of the signposts mentioned, act as guides in the innumerable directions indicated; it is they who finally obtain whatever information may be required.

Members of the engineering societies are at all times welcome in the Library, and welcome also to do their own digging, in which the Library staff will gladly assist them; but they will find that as a rule it is cheaper and much more convenient to have the digging done for them, for an experienced searcher will find a dozen references where an inexperienced man will find one.

Bibliographical work done by the searchers may serve a variety of purposes. It may be used for direct application in business; as a basis for technical papers, books, lectures; as a basis for inventions and patents; as a basis for legal action; or from the standpoint of economic, financial, and other aspects. It is therefore of the utmost importance that

all questions made the object of a search should be stated with the greatest accuracy, for only an intelligent question is likely to elicit an intelligent answer. In the great majority of cases it is unwise to ask the Library for all information on a given subject. In almost every case it is necessary to state limitations, such as: The search is to cover a stated number of years; the information is required for such and such a purpose; patents must be included or excluded, etc.; and this is the more necessary because it is generally in the more difficult questions that the assistance of the Library is required.

In view of the multitudinous ramifications of search work it is hardly possible to apply standardized methods to it, but it may be explained that the usual procedure includes the following steps:

a The inquiry is formulated exactly; if this is impossible, further information is asked of the inquirer.

b A bibliography is made to cover the subject exactly as stated, and is submitted to the inquirer.

c After perusal the inquirer may decide either to examine all the material or to select for further consideration such references as appear to him most suitable.

d In accordance with his decision the Library may be called upon to make photoprints, translations, or abstracts of the material selected, as the case may be.

e On receipt of these the inquirer is in a position to give the final answer to the original question, or he may determine in what further directions the assistance of the Library would be desirable.

Of course, the inquirer is at liberty to close the question at any of the stages enumerated. The Library also will tell the inquirer quite frankly when searching has probably reached the limits of usefulness, and it keeps an exact record of the extent of the searches made, so that any one may be continued at any time without duplication of the work.

An examination of the searches made in the Library would open the eyes of many as to the variety of subjects of inquiry. Although the searches are made under definite instructions from the Director with regard to methods, sometimes a question is received the answer to which lies entirely outside of the recognized routine, and to find an answer to some of these may tax to the utmost the ingenuity of the searchers. The following is an instructive example:

Some time ago a member presented the following question: "About fifteen to twenty years ago the sulphur beds of the island of Saba were worked; find the references."

In a case like this the card catalogues and most of the printed indexes are of little use, for even the encyclopedias dismiss a small place like Saba with a perfunctory note of about five or six lines, stating that it is a small island belonging to the Dutch West Indies, etc. The searcher experiences a vivid realization of the hopeless position of a man standing before a mass of books and not knowing where to attack them.

Reflection shows that the only way to attack such questions is to analyze them and think out a plan leading to the desired information. Thus in the Saba case the population would be very small and, therefore, mining operations of any extent would very likely be reflected in the figures. Again, the ore mined would presumably be exported, and being a poor ore by inference (for otherwise operations would be still going on), it could not stand the freight rate to Holland; it would most likely be shipped to the United States, also on account of geographical location and shipping facilities. Thus we obtain two sets of figures, population and imports to U. S., with which to begin operations. Which of these two sets is more likely to be available, to be more accessible and more accurate? Experience teaches that as a rule population figures are more reliable and more easily accessible, hence these were made the point of attack.

After considerable trouble, sufficient figures were obtained between the years of 1886 and 1913 to construct a curve, showing that a peak occurred about the year 1888. This was followed by a continuous decline, but preceded by rather small variations. Figures before 1886 could not be located, although it would have been interesting to follow out the variations indicated. Assuming that the year 1888, the peak of the reconstructed curve, was the year of the mining operations in question, this would agree fairly with the statement of the inquirer that they took place fifteen to twenty years ago, for in almost every case the time given is understated. The obvious course to follow now was, therefore, to examine the figures giving the imports into the United States for the corresponding period. Naturally, no geographical figures were available for a small place like Saba, the only statistics found including all the Dutch West Indies and Surinam; as for the subject sulphur, it was useless to think of tracing it in the imports.

The tables of imports found, however, proved to be disappointing, for they showed no unusual features; there was no peak corresponding to that of the population, nor was it perhaps reasonable to expect such an indication in view of the complexity of the figures.

According to the population curve it was useless to examine import figures for later years, so it was decided to work backwards at any rate to 1880, for there a decennial table for 1870-80 might be found. So it turned out to be, and the figures for 1875 indicated a fairly large import. What was more remarkable still, this import figure was isolated—it was preceded and followed by entire absence of imports. Although this absence might be satisfactorily explained in various ways, this was a good-enough indication on which to refer to mining magazines of that year in the hope of finding Saba, and so it happened. The article giving the information was found in the *Engineering and Mining Journal* for July 1875, vol. 20, p. 56.

It may be argued that going through the mining magazines at once would have led to the desired result, but in view of the fact that the inquirer was 22 years out in his statement, the fallacy of this is obvious. Besides, searching indexes for a number of years back has its difficulties; one is forcefully reminded of the philosopher's dictum, "Nothing is constant but change."

In the above case the train of thought led to the desired result; it might also have failed, but it is a fair example to show that no pains are spared in the Library to get at the information desired by members. Nor should the charge made by the Library for this class of work deter members from the full benefit of this unique collection of engineering literature, for the rate of $1.50 per hour charged is calculated to cover actual cost, so that no part of it will fall on the finances of the Library.

Inquiries from members are at all times welcome and estimates for work required will be gladly given so far as this is possible. Members who send orders to the Library can always keep control of the work to the extent of specifying the number of hours to be spent on their inquiries.

J. K.

BOOK REVIEWS

Machinery's Encyclopedia. A Work of Reference Covering Practical Mathematics and Mechanics, Machine Design, Machine Construction and Operation, Electrical, Gas, Hydraulic and Steam Power Machinery, Metallurgy and Kindred Subjects in the Engineering Field. Compiled and edited by Erik Oberg and Franklin D. Jones, in collaboration with many prominent mechanical and electrical engineers. The Industrial Press, New York, 1917. In 7 volumes, half-leather, 8x11 in. $36.

In spite of the unquestioned usefulness of encyclopedias of engineering, the English language is, unfortunately, poorly equipped with these summaries of current practice at the time. Such works as Spon's Dictionary of Engineering and Appleton's Cyclopedia of Applied Mechanics had great practical value in their day, as epitomes which saved reference to many individual treatises, but the time that has elapsed since their issuance has made them obsolete and created a need for some successor which would present present knowledge and current practice in concise and authoritative fashion.

The present work is intended to do this for mechanical engineers, especially for those interested in the design, construction and operation of machines and machine tools. To this end particular attention has been given to those processes and methods which the designer and manufacturer of machine tools use and to the best practice in machine-shop operation. The material included has been selected from the standard treatises and from the columns of *Machinery;* supplemented by numerous special signed articles on many phases of the general subject.

The noticeable features of these volumes are the length of the articles on important topics, the liberality with which they are illustrated, and the care that has been taken to include topics that are usually given scant attention. The article on Broaching, to take an example at random, fills 9 pages and contains 17 illustrations. Twenty-two pages are given to a discussion of Assembling. The question of Grinding and Grinding Machines occupies 50 pages, while the article on Autogenous and Electric Welding is 30 pages long. These articles give an idea of the scope of the work: the minor articles, however, are also useful, including as they do much material that usually is hard to find.

The final volume includes a comprehensive index, enabling one to find information not brought out by specific headings in the encyclopedia, and a Guide to Systematic Reading, outlining courses of orderly study on a number of topics, such as Mathematics, Forging Practice and Equipment, Finishing and Protecting Metal Surfaces, etc.

The mechanical construction of the set is good. The type, while small, is clear. The illustrations are reproduced from line drawings and are really illustrative. The pages open flat.

The producers of the work are to be congratulated upon the result of their endeavors. The set will prove of distinct usefulness in any library of engineering.

Harrison W. Craver.

The Principles of Iron Founding. By Richard Moldenke, E.M., Ph.D. McGraw-Hill Book Co., Inc., New York, 1917. First Edition. Cloth, 6x9 in., 517 pp., 45 illustrations. $4

Dr. Moldenke needs no introduction to those familiar with foundry practice, for he is one of the comparatively few men who have had to do with the marked advance of recent years in the art of producing sound castings. He is not only a well-trained technical man, but a successful foundryman as well, having had at different times the management of some of the largest foundries in this country producing gray iron, malleable and steel castings.

His fifteen years of acceptable service as secretary of the American Foundrymen's Association have brought him into close touch with all of the prominent founders of the world and provided the best possible training for writing a book on foundry work.

The author has undertaken to deal more or less completely with all of the principles underlying the processes involved in the art of iron founding.

It is rather unfortunate that there is nothing in the title to indicate that the author has not covered the whole field in his book. Either the title should be changed or this book should be marked Vol. 1, for the author notes that he is now at work on a second volume which will deal more particularly with general foundry practice.

This volume pays especial attention to the metal itself, to melting processes and to mixture making, and leaves nothing to be desired in the way of general information along these lines.

The problem of oxidized iron is given special attention and much new material is presented.

The book together with the promised second volume will unquestionably become the leading reference book on foundry practice and can be safely recommended to those seeking information on foundry work along either historical, scientific or practical lines.

The book should be in the library of all those interested in foundry work, as it is well worth owning. The facts and information which it presents are absolutely reliable and no other foundry book contains so much that is so.

William W. Bird.

Lubricating Engineer's Handbook. A Reference Book of Data, Tables and General Information for the Use of Lubricating Engineers, Oil Salesmen, Operating Engineers, Mill and Power Plant Superintendents, Machinery Designers, etc. By John Rome Battle, B. S. in M. E. J. B. Lippincott Co., Philadelphia, 1916. Cloth, 6 x 9 in., 333 pp., 114 illustrations and 16 pp. of ruled log sheets. $4 net.

Of very real importance are the 26 chapters devoted to the presentation of specific recommendations as to the proper and economic lubrication of air compressors, automobiles, internal-combustion engines, steam engines and turbines, refrigerating machinery, street and railway cars, locomotives, elevators, rolling-mill, textile, flour-milling and electrical machinery, etc. Wire-drawing and cutting-tool lubrication are also dealt with and chapters are given on lubricating oil and grease tests, lubricants and their properties, the cost of lubrication, etc. The book is self-contained, in that all of the mechanical reference data and tables required in working out lubricating problems are included. The author has been the mechanical engineer of a large oil company for many years and writes with the knowledge thus acquired.

Bulletin No. 99 of the University of Illinois Engineering Experiment Station contains the results of a series of experiments on the collapse of short thin tubes, made by Prof. A. P. Carman of the department of physics. The purpose of these tests was to find an equation by the application of which the pressure required to collapse a tube can be calculated when the dimensions of the tube and the elastic properties of the material are known. The bulletin gives a brief summary of earlier experiments on collapsing pressure, such as those of Fairbairn, Stewart and others, together with the formulæ developed by these investigators. Copies of this bulletin may be obtained gratis by addressing the Engineering Experiment Station, Urbana, Ill.

Library Accessions

Agricultural Drainage in Georgia. (Georgia. Geological Survey. Bulletin no. 32). *Atlanta, 1917.* Purchase.

Applied Motion Study. By Frank B. Gilbreth and L. M. Gilbreth. A Collection of Papers on the Efficient Method of Industrial Preparedness. Sturgis and Walton Co., *New York, 1917.* Cloth, 5 x 8 in., 220 pp. 7 pl., 1 diagram. $1.50. Gift of the publisher.

Bibliography of North American Geology for 1916, with subject Index. (U. S. Geological Survey. Bulletin 665). *Washington, 1917.* Purchase.

Biochemical Catalysts in Life and Industry. By Jean Effront. Proteolytic Enzymes. Translated by Samuel C. Prescott, assisted by Charles S. Venable. John Wiley & Sons, Inc., *New York, 1917.* Cloth, 6 x 9 in., 752 pp., $5. Gift of the publisher.

Blast Furnace Breakouts, Explosions, and Slips, and Methods of Prevention. (U. S. Bureau of Mines. Bulletin 130). *Washington, 1917.* Purchase.

Catalogue Studies. 40-D, 1918. Gift of Catalogue Equipment & Supply Company.

Checklist of Indexed Periodicals. Compiled by Alvan W. Clark. H. W. Wilson Co., *White Plains, 1917.* Purchase.

Chemical Analyses of Igneous Rocks Published from 1884-1913, with a Critical Discussion of the Character and Use of Analyses. (U. S. Geological Survey. Professional paper 99). *Washington, 1917.* Purchase.

Compressibility of Natural Gas and Its Constituents, with Analyses of Natural Gas from 31 Cities in the United States. (U. S. Bureau of Mines. Technical paper 158). *Washington, 1917.* Purchase.

Cost Accounting for Oil Producers. (U. S. Bureau of Mines. Bulletin 158). *Washington, 1917.* Purchase.

Descriptions of New Tertiary Mollusca Occurring in New Zealand. (N. Z. Geological Survey. Paleontological Bulletin no. 5). *Wellington, 1917.* Purchase.

Directions for Sampling Coal for Shipment of Delivery. (U. S. Bureau of Mines. Technical paper 133). *Washington, 1917.* Purchase.

Durability of Cement Draintile and Concrete in Alkali Soils. (U. S. Bureau of Standards. Technologic paper no. 95). *Washington, 1917.* Purchase.

Electrical Stimulation of Crops. By L. Birks. Journal of Agriculture, vol. XV, no. 4, Oct. 20, 1917. Gift of L. Birks.

The Eyes of the Army and Navy. By Albert H. Munday. Practical Aviation. Harper & Bros., *New York* (copyright *1917*). Cloth, 5 x 7 in., 226 pp. 19 illus., 4 pl., $1.50. Gift of the publisher.

Everyman's Chemistry. By Ellwood Hendrick. The Chemist's Point of View and His Recent Work Told for the Layman. N. Y. and Lond., Harper & Bros., *New York* (copyright *1917*). Cloth, 5 x 8 in., 374 pp., $2. Gift of the publisher.

Federal Valuation of the Railroads in the United States. Statement prepared by H. C. Phillips, general secretary, of the developments in connection with federal valuation as of Dec. 31, 1917. Gift of Clemens Herschel.

First Report to the Council of the North East Coast Institution of Engineers and Shipbuilders on Certain Methods of Producing Vacuum. By Edwin L. Orde, C. Waldie Cairns and J. Morrow. North East Coast Institution of Engineers and Shipbuilders, *Newcastle-upon Tyne, 1916-1917.* Paper, 9 x 12 in., 34 pp., 16 illus., 1 pl., tab., 10s. 6d. Gift of the publisher.

Florida. Geological Survey. Annual Report. 9th. *Tallahassee, 1917.* Purchase.

The Flyer's Guide. By Captain N. J. Gill. An Elementary Handbook for Aviators. E. P. Dutton & Co., *New York, 1917.* Cloth, 6 x 9 in., 153 pp., 18 illus., 3 pl., $2. Gift of the publishers.

Folding Endurance of Paper. By F. P. Veitch. (Reprinted from *Paper,* May 30, 1917). Gift of Technical Association of Pulp and Paper Industry.

The Foundations of National Prosperity. By Richard T. Ely, Ralph H. Hess, Charles K. Leith and Thomas Nixon Carver. Studies in the Conservation of Permanent National Resources. The Macmillan Co., *New York, 1917.* Cloth, 5 x 8 in., 378 pp., $2. Gift of the publisher.

Fundamentals of Naval Service. By Commander Yates Stirling. Special Chapters by Lieut. Comm. H. C. Mustin, Lieut. Comm. C. S. McDowell and Dr. Ralph Walker McDowell. J. B. Lippincott Co., *Philadelphia* (copyright *1917*). Cloth, 5 x 7 in., 589 pp., 32 illus., 2 pl., 2 diagrams, $2. Gift of the publisher.

Geologic Structure in the Cushing Oil and Gas Field, Oklahoma. (U. S. Geological Survey. Bulletin 658). *Washington, 1917.* Purchase.

Geology and Ore Deposits of the Virgilina District of Virginia and North Carolina. (Virginia Geological Survey. Bulletin no. XIV). *Charlottesville, 1917.* Purchase.

Hydro-Electric Power Stations. By Eric A. Lof and David B. Rushmore. John Wiley & Sons, Inc., *New York, 1917.* Cloth, 6 x 9 in., 822 pp., 407 illus., 2 diagrams, $6. Gift of the publishers.

Industrial Arts Index, 1917. *New York, 1917.* Purchase.

Interior Wiring. By Arthur L. Cook. And Systems for Electric Light and Power Service, a Manual of Practice for Electrical Workers, Contractors, Architects and Schools. John Wiley & Sons, Inc., *New York, 1917.* Flexible cloth, 5 x 7 in., 416 pp., 248 illus., 2 diagrams, $2. Gift of the publishers.

An Introduction to the Study of Landscape Design. By Henry Vincent Hubbard and Theodora Kimball. The Macmillan Co., *New York, 1917.* Cloth 9 x 11 in. 406 pp. 40 illus. 36 pl. $6. Gift of the publisher.

Investigation of Stresses in Digester Shells. By H. O. Keay. (Reprinted from *Paper,* October 3, 1917). Gift of Technical Association of the Pulp and Paper Industry.

Ironmonger Diary, 1918. *London, 1918.* Purchase.

The Kiln Drying of Lumber. By Harry Donald Tiemann. A Practical and Theoretical Treatise. J. B. Lippincott Co., *Philadelphia* and *London* (copyright *1917*). Cloth, 6 x 9 in., 316 pp., 51 illus., 1 diagram, $4. Gift of the publisher.

Lighthouses and Lightships of the United States. By George R. Putnam. New York, and Houghton Mifflin Co., Boston. The Riverside Press, *Cambridge, 1917.* Cloth, 6 x 9 in., 308 pp., 36 pl., $2. Gift of the publishers.

Manganese and Chromium. (California State Mining Bureau. Preliminary Report no. 3). *Sacramento, 1917.* Purchase.

Map of the Oil District, Venango, Crawford and Warren Counties, Penn. *1865,* Purchase.

McGraw Electrical Trade Directory. Central Station Edition. 1917. *New York, 1917.* Purchase.

Meteorology and Aeronautics. (Report 13). *Washington, 1917.* Gift of National Advisory Committee for Aeronautics.

Michigan. Secretary of State. Laws Relating to Construction of Drains. *1917.*
——— Laws Relating to Highways and Bridges. *1917.*
——— Laws Relating to Railroads. *1917.* Gift of Secretary of State.

The Microscope. By Simon Henry Gage. An Introduction to Microscopic Methods and to Histology. 12 ed., rewritten. The Comstock Publishing Co., *Ithaca, 1917.* Cloth, 6 x 9 in., 472 pp., 253 illus., $3. Gift of the publisher.

The Microscopical Examination, Physical Testing and Chemical Analysis of Paper as Conducted in Paper Testing Laboratories. By F. C. Clark. (Reprinted from *Paper,* October 17 and 24, 1917.) Gift of Technical Association of the Pulp and Paper Industry.

Mineral Springs of Alaska. (U. S. Geological Survey. Water Supply Paper 418). *Washington, 1917.* Purchase.

Mineral Springs of Canada. Part I—The Radioactivity of Some Canadian Mineral Springs. (Bulletin no. 16). *Ottawa, 1917.* Purchase.

Mines and Mineral Resources of Portions of California. (Report XIV of the State Mineralogist of California). *Sacramento, 1916.* Purchase.

The Mines Handbook and Copper Handbook. By Walter Harvey Weed. vol. XIII. *New York, 1918.* Purchase.

Moody's Manual. Complete List of Securities Maturing January 1, 1918, to December 31, 1919. vol. V. *New York, 1917.* Purchase.

Moody Manual of Railroads and Corporation Securities, 1918. Railroad Section. *New York, 1918.* Purchase.

New York State. Industrial Commission. Labor Law and Industrial Code with Amendments, Additions and Annotations to July 1, 1917. *Albany, 1917.* Gift of Industrial Commission.

NOTES ON SHIPBUILDING

A Statement of the Primary Requirements for Successfully Building and Launching Vessels, Particularly in the South, One of the Vital Factors of the War

By F. J. French,[1] New Orleans, La.

I HAVE been asked to outline, in as few words as possible, the problems which present themselves to the prospective shipbuilder, rather with a view to promoting discussion on the subject with especial reference to local conditions in the South than with any intent to disseminate uninteresting and unimportant data on the subject of design.

Let us assume first that the shipyard owner is approached by a client who desires a vessel built for his particular service. His requirements will be primarily governed by ships that he already has in service; modified by the recommendations of his marine superintendent and his port engineer as to type of cargo, desired carrying capacity, draft, speed, and indicated horsepower, and further modified by that very misleading factor, "cost per deadweight ton," which is so widely quoted, regardless of speed required.

To illustrate the fallacy of using this unit of cost, take a vessel of 5000 tons deadweight capacity and assume, from data already at hand, a speed of 10 knots with an indicated horsepower of 1500. If the owner desires his ship to make 13 knots instead of 10, it will be found that (as for normal speeds the power varies with the cube of the speed) the required indicated horsepower will be in the neighborhood of 3300, or more than double the original figure, and the power-plant weight and cost will, of course, be in similar proportion.

The primary characteristics having been decided upon, the problem now passes to the builder's naval architect, who correlates all of the factors determined upon by the principles and sends to the estimator the weights, horsepower, etc., who in turn makes an estimate of cost upon which the contract is finally signed. It goes without saying that the estimate takes into full account whether or not the vessel is for bulk oil or molasses, which requires a much higher grade of workmanship than for package freight.

In addition to the particular requirements of the owners, it will also be specified that the ship is to be built to the requirements of either Lloyd's, The American Bureau of Shipping, or some other recognized classification society, and the surveyors of the chosen society will see to it that its requirements are lived up to. It may be pointed out in passing that the rules of the various societies specify, to the thirty-second of an inch, the size and thickness of all members entering into the structure of the ship, as well as the size and type of all fastenings; their rules being based primarily upon the theoretical strains experienced by ships subjected to the action of deep-sea waves, but modified by scores of years of experience covered by comprehensive reports of hundreds of catastrophes at sea, these reports being made by surveyors of the societies who are themselves seafaring men and who have carefully investigated the probable causes, and possible preventive measures, in each particular case.

Let us now assume that all the particulars of the ship to be built have been decided upon, the contract plans completed and the contract signed, and place ourselves in the position of the successful bidder. We find that we have on our hands a contract to furnish all material to construct, launch, power and equip a ship of, for example, 5000 tons deadweight, which is 350 ft. in length by 48 ft. in width by 28 ft. in depth, and has engines of 1500 to 2000 i.hp.

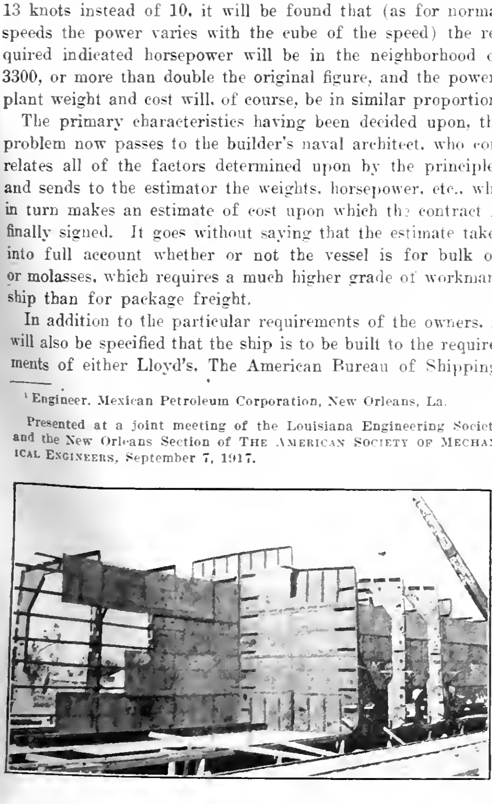
Perhaps, under present conditions, we have not done much more than select our site for building. If this has been done, it goes without saying that a frontage was chosen on as deep and wide a waterway as was compatible with financial and engineering considerations, and also that the site selected is reasonably accessible to a labor market.

The next step is to lay out our building ways to suit the water into which we propose to launch. We have now a choice of two methods of launching, i.e., stern first, or sideways. The stern-first method is universal at all Atlantic Coast yards and wherever the required width and depth of water is obtainable. The side lanching is largely confined to the yards on the Great Lakes and to other plants where for various reasons it is found desirable to build on the banks of a narrow waterway.

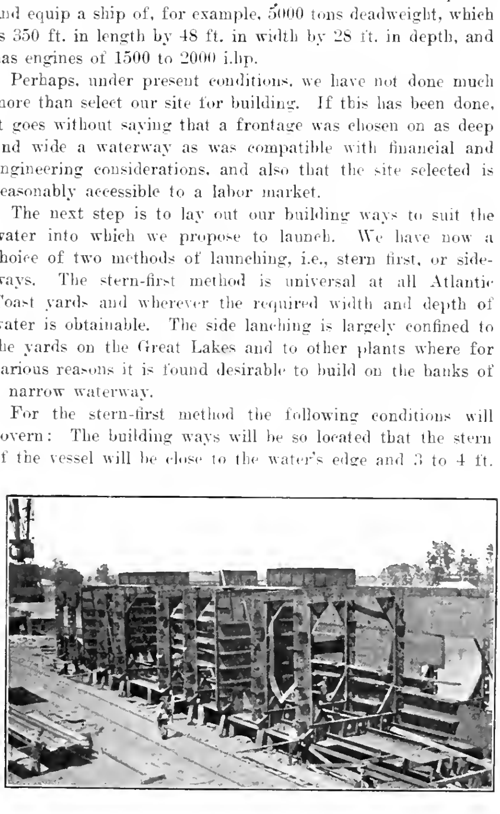
For the stern-first method the following conditions will govern: The building ways will be so located that the stern of the vessel will be close to the water's edge and 3 to 4 ft.

[1] Engineer, Mexican Petroleum Corporation, New Orleans, La.

Presented at a joint meeting of the Louisiana Engineering Society and the New Orleans Section of The American Society of Mechanical Engineers, September 7, 1917.



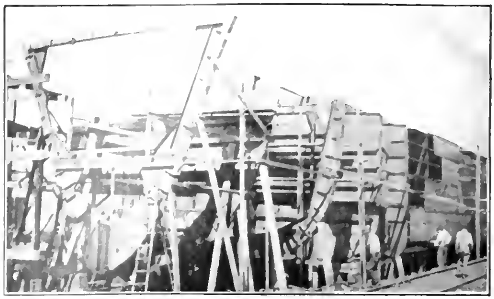
Hull 23, March 31, 1917.



Hull 23, April 6, 1917

Views Showing Progress of Steel Ship Construction at Violet, La.

Hull 23, May 9, 1917



Hull 23. Bow, September 14, 1917

STEEL SHIP CONSTRUCTION AT VIOLET, LA.

above the ground. From this point back they will be given a rise of about five-eighths of an inch per foot, which would put the keel line at the bow of a 350-ft. ship some 21 ft. above water. A yard having a natural easy slope toward the water is therefore desirable as facilitating the construction of the underbody of the ship without the necessity of filling to the desired grade. The building ways consist of a series of blocks spaced about 4 ft. center to center and made up of 12 by 12-in. timbers 5 or 6 ft. long, set transversely and resting on piling.

The launching ways consist of two parts, the standing and the sliding ways, and are parallel to the center line of the ship and about one-third to one-half the half-breadth from it. They are constructed of heavy longitudinal timbers laid on piling and are usually given a camber or round-up of about a foot in their length for the purpose of overcoming the resistance of the water as the vessel nears the end of the ways.

A customary slope is about ½ in. per ft. at the bow of the ship, increasing to ¾ in. per ft. at the submerged end of the ways. This lower end should be 5 or 6 ft. below the surface and should be well supported by clusters of piles as, at the moment before the bow drops off the end, nearly half the weight of the ship bears on this point. The construction outlined is the common practice in tidewater yards and the datum plane taken is that of high tide.

It will at once be seen that we meet insurmountable obstacles when we propose to adapt this method to a river such as the Mississippi, where a variation occurs of twenty or more feet, and this so gradually that months may elapse between two successive periods of high water. If, for example, it has been planned to launch at high water and completion has been delayed for four or five months beyond the schedule, the builder is confronted with the alternatives of waiting for the next high water or flattening the launching ways and extending them some 400 ft. further, a procedure which would not appeal to the yard superintendent very favorably.

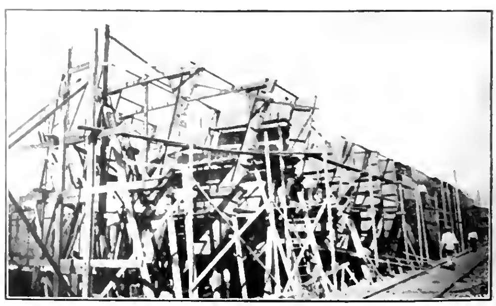
It has been suggested that ships could be built behind the levee, or in a sort of semi-dry-dock with gates, the grade being established midway between high and low water. A little consideration will show the impracticability of this scheme, for both high- and low-water conditions must be met. A levee must surround the building ways in case launching is to be at high water, and for low water nearly the same impractical length of ways would be required, as has been already described.

So far, then, as building on the Mississippi is concerned, it is believed to have been shown that the only practical location is upon a locked canal, and this, of course, involves a side launching. With this method, the keel is laid parallel to the bank, and instead of two sets of ways there are perhaps a dozen or more at right angles to the keel. The construction of the ways is similar to those already described, except that they may either be carried below the water surface (in which case the final camber is much greater than the longitudinal ways) or they may be stopped off short above the surface and the vessel "dumped" off. In either case the launching is a much more delicate proposition than the stern-first method, as all the ways must be released at precisely the same instant, any variance carrying the practical certainty of disaster.

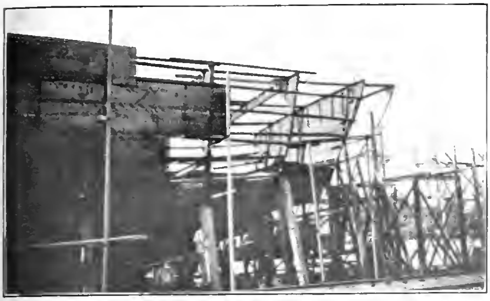
With either type of ways the maximum loading per square foot of sliding surface should not exceed 2½ tons, especially in warm weather, as heavier loading forces out the grease and chars the ways.

The next most important step is the ordering of the structural material, and this is done by the builder's superintendent from the contract plans, which consist of midship section, inboard profile, deck plans, bulkheads, and (if the vessel is to be of steel) the plating model. The latter is accurately made from the line drawing and on it are shown the exact sizes and thicknesses of all shell plates, as well as data concerning seam and butt riveting, doubling plates, longitudinals and transverse frames. All plates are ordered to within ½ in. of the desired size and are so shipped by the mills. Every plate, channel, or angle is inspected and tested at the mill by the surveyor of the registration society and a permanent record made of its characteristics as well as its location in the finished vessel.

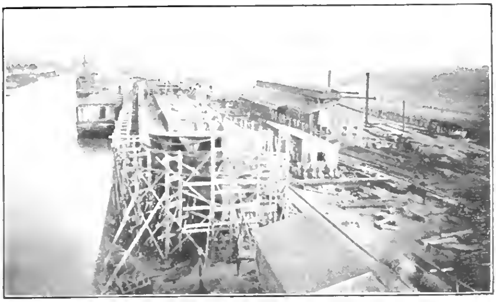
In the interval preceding the delivery of the material the loftsman is busy with his force laying down to full size and fairing the lines of the ship on the mold-loft floor. These



HULL 23, SEPTEMBER 29, 1917



Hull 23, October 1, 1917



Hull 23, December 4, 1917

STEEL SHIP CONSTRUCTION AT VIOLET, LA.

lines are the intersections of vertical transverse, vertical longitudinal, and horizontal planes with the outside shell of the ship, and the three views must be made to agree precisely or the resulting surface will be unfair. In some yards the lines are first drawn and faired to a quarter-inch scale in the drawing room, the offsets or ordinates from this set then laid down and refaired to a one-inch scale on a marble slab, and finally the offsets from the slab laid down and faired to full size on the mold-loft floor.

Methods have been evolved for deriving mathematically the lines of a ship of given characteristics, but as the simplest of these methods involves the use of formulæ with five variables they have not become altogether popular.

From the lines as drawn are now derived the exact contour of each transverse frame, as well as its bevel, the location of plating seams, and the traces of longitudinals and decks.

Templates of thin white pine are made of the frames and on these is shown all the information necessary to enable the shop to fabricate them. These templates then go to the bending floor, and the frames when bent and beveled go to the punch shop and are finally set upon the blocks and tied to the center keel and keelson plates which have preceded them. With the frames secured in place with longitudinals and temporary rib bands, templates are made from the skeleton for each shell plate and these templates applied to their plates which have now arrived from the mills. If the ship is known as a "full" ship and has a considerable percentage of parallel middle body, much of this work may be done in the loft and one template be made to answer for a dozen or more plates.

By intelligently applying the above principle to the original design a great amount of unnecessary labor may be eliminated, not only in the shell, but on bulkheads and decks as well.

The advantages above outlined would not, of course, apply in the same degree to the construction of a wooden vessel, as in this case once the frame templates are out it is largely a case of cut and fit for each timber and plank.

It is only reasonable to believe that by a judicious duplication of parts, by adhering as far as possible in a given yard to a given size and type of ship (as is now done in England), by reducing the number of plates which must be "lifted" from the ship itself, and by the introduction of efficient cost-keeping methods we will be able, when the present abnormal conditions have passed, not only to hold our own but actually to take the lead in this industry.

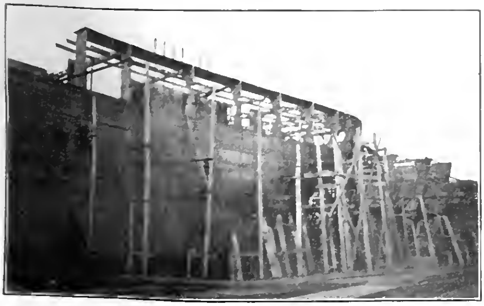
Turning for a moment to the power-plant side of the question, the builder and owner are faced by the necessity of deciding upon exactly the kind of plant desired. Let it be assumed that the indicated horsepower and speed have been determined. The combination of the two will give within reasonable limits the revolutions per minute of the propeller or propellers. There is then the choice of twin or single screws, with either compound or triple-expansion steam engines, turbines with gear reduction, Diesel engines or a turbo-electric system. In the particular case of four rather small vessels now building in the vicinity of New Orleans the advantage was found to lie with the latter system in price, weight and delivery, and that system was therefore adopted.

It is believed that there are very few, if any, shipbuilders in this part of the country who are at present equipped to economically construct marine engines, though it is hoped the opportunity will be afforded by the United States Shipping Board for local shops to become accustomed to this type of work so that they may intelligently and profitably undertake merchant work when the present shipping crisis has passed.

With regard to boilers, there are a number of shops in the immediate vicinity which are entirely competent to undertake the construction of fire-tube marine boilers to meet any requirements. As to type, the only fire-tube boiler in common marine use is the Scotch or wet-back type, in which the combustion chamber is integral with the boiler and is surrounded by water.

Of the water-tube type there are many makes, such as the Babcock and Wilcox, Heine, Sterling, Yarrow, Ward, etc., all of which are manufactured in both land and marine styles.

In direct connection with the choice of engine and boiler arises the question of whether or not it is desirable to superheat the steam, and if so, what type of superheater should be



HULL 23, STERN, NOVEMBER 29, 1917

adopted. With many of the water-tube boilers the superheaters are integral; that is to say, are really an extension of the tube surface. With the Scotch boiler, however, they are usually independent and are placed in the breeching.

In addition to the main power plant there will be required a main condenser with air and circulating pumps, boiler-feed pumps, fire pumps, anchor windlass, steam capstans, refrigerating plants, winches, and possibly a towing engine, as well as evaporators and distillers. These auxiliaries are fairly well standardized, and the purchaser is practically sure of getting what he pays for.

For the valves, pipe and fittings, of which there are thousands of dollars' worth on a ship of any size, some of our local houses are willing to exert themselves to the extent of quoting from a set of piping plans, with bill of material attached. Others prefer apparently not to do so when there is enough business coming their way without any effort on their part.

Having disposed in our allotted few brief words of yard, hull, and power plant, we have nothing left to think of but the arrangement of living quarters, carpenter work, joiner work, ladders and gratings, rigging, plumbing, ventilation, galley and linen stores, boatswain's stores, life boats and davits, carpenter's stores, fire-extinguishing apparatus, running lights, cooking and mess equipment, engine-room telegraphs, bilge and ballast system, and if we are so fortunate or unfortunate as to be building oil tankers, the entire cargo-handling system!

From the local builder's point of view there is one question which eclipses even the difficulty of securing delivery of materials under present conditions, and that is the problem of obtaining, in competition with the large northern yards, labor skilled in the art of shipbuilding. The ship carpenter of the days of the old wooden clipper ships, of whom was written, "Build me strong, O worthy master," is almost as extinct as the dodo bird, while ship fitters, ship smiths, loftsmen and other skilled workers are demanding and receiving wages that would have seemed affluence five years ago. At least one local yard (of which the writer has personal knowledge) is doing remarkable work in the training of colored labor for all except the most responsible positions in these trades, and is achieving excellent results in quality of workmanship.

To summarize briefly, it would appear that success of the southern shipbuilder rests on the following points:

1 Judicious selection of site
2 Rational layout of yard, with due regard to receiving, handling, storing, and routing of material
3 Foresight in design, with a view to standardization of all possible parts and the elimination of special and the use of stock fittings which may be purchased in the open market
4 An efficient cost-keeping system
5 The training of the labor which is locally obtainable and may reasonably be counted upon to remain
6 Promotion of a knowledge of the principles of shipbuilding by the establishment of classes in the public night schools.

[The paper was illustrated by lantern slides and was followed by discussion, in which several members of the Louisiana Engineering Society and of the A.S.M.E. took part.]

THE DEVELOPMENT OF CONCRETE BARGE AND SHIP CONSTRUCTION

By J. E. FREEMAN[1], CHICAGO, ILL.

THE need of ships has become increasingly evident to all, and that their construction in large numbers is a vital part of our war program is thoroughly understood. Judge George Gray, of Wilmington, Del., a member of the War Shipping Committee of the Chamber of Commerce of the United States, said recently in a plea addressed to the shipbuilders of the country: "There is no exaggeration in the statement that the necessity for an adequate production of ships is the most serious matter that now confronts us in this the greatest crisis in our country's history, or in the history of the world. We have entered this war for a just cause, and we must prosecute it with all our might and with all the resources of our country. Otherwise we cannot win it."

But speed is essential in securing tonnage, not only to replace submarine sinkings but to provide the great fleet of vessels to transport and maintain an adequate army in the field and still continue to keep our allies supplied with certain necessities. We need this fleet in the quickest possible time. "Make a bridge of ships to France" is the latest message from General Pershing and his men.

The tonnage of steel and wooden vessels now under construction in countless yards, to which are added ships transferred from coastwise and Great Lakes service, is still short of what is needed. To solve the problem requires the rapid development of all methods of shipbuilding, and it is for this purpose that reinforced concrete is now being considered and utilized to augment the tonnage under construction. The first seagoing vessel of concrete has made successful trial trips and vessels of larger tonnage are under construction both here and abroad.

The concrete-ship construction now under way in this country is of course largely experimental, assisted by experience gained in the design of steel and wooden ships; but there is every indication of ultimate success, and, as has been the case in other applications of concrete to new uses, experience with these first vessels will provide data to improve and clarify present ideas and to develop efficient methods of design and construction. Those who have thus far worked out designs for concrete ships have done so more or less independently, and up to the present time only meager information has been published regarding the data and calculations upon which their designs are based. But recent advices show that the Government is studying the problem, that a Department of Concrete Ship Construction has been formed by the Shipping Board, which is actively engaged in the development of a standard design for a concrete cargo ship of 3500 tons capacity, and drawings and specifications are expected to be ready in March. Provisional contracts have also been let to three companies for a number of 3500-ton vessels, plans and specifications for which must be approved by the Shipping Board. This has already been described in the technical press.

This present discussion of concrete ships and barges therefore must of necessity be rather general, presenting a brief review of progress in concrete-boat building from its earliest

[1] Portland Cement Association.

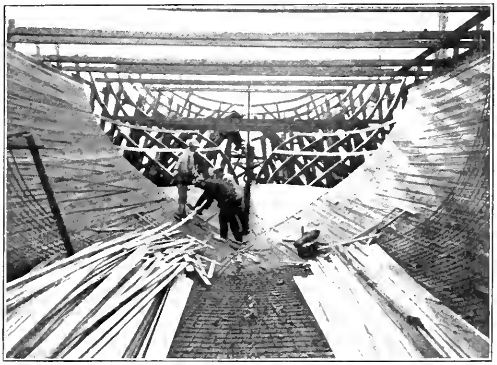
Abstract of paper presented at a meeting of the Engineering Society of Buffalo, February 13, 1918.

inception, describing some of the interesting work under way at the present time, and calling attention to the various problems entering into the application of reinforced concrete to such construction.

Singularly enough, boat building furnished one of the first uses of what would today be called reinforced concrete—a rowboat was built of this material in 1849, by M. Lambot, of Carces, France. This instance thus marked the starting point not only of concrete-boat building, but also of modern reinforced-concrete construction. This boat created considerable interest when exhibited by its builder at the World's Fair in Paris in 1855, and it was still apparently in excellent condition as late as 1903. Records are lacking, however, of any further development in France, until 1900, when a gravel barge 50 ft. long, 13 ft. wide and 3 ft. deep was built on the River Lozere.

In 1899 Carlo Gabellini, of Rome, began the construction of concrete barges and scows in Italy, and in 1905 a 150-ton barge was constructed for the city of Civita Vecchia. Later another barge was built for the use of the Italian Navy at Spezia; before acceptance, this barge was put to the severe test of being driven against piling and afterward being rammed by a steel tugboat. Up to 1912 about eighty vessels had been constructed by the Gabellini concern.

Center to Stern of Reinforced-Concrete Boat Under Construction at Redwood City, Cal.



Construction of Concrete Cargo Steamer at Barcelona, Spain

Beginning as early as 1887 small concrete barges of 11 tons capacity were built successfully by the Fabrieck van Cement-Ijzer Werken, in Holland, followed later by larger craft of 55 tons capacity with a cellular construction formed by longitudinal and transverse partitions or bulkheads and reported as making the boat practically unsinkable.

In Germany a 220-ton concrete freighter was built in 1909. The major portion of the hull had parallel sides, but was so shaped that the lines were fairly good and the water resistance was decreased below that of a rectangular barge. This vessel also had watertight bulkheads. It is reported that since 1914 Germany has built numerous concrete barges and some concrete ships.

In 1912 a reinforced-concrete scow or pontoon was built by the Yorkshire Hennebique Contracting Co., Ltd., of Leeds, England, for maintenance work on the Manchester Ship Canal, in accordance with the requirements of the canal company's engineers. The craft is 100 ft. by 28 ft. by. 8 ft. 6 in. deep from main deck to keel, drawing about 6 ft. 6 in. when loaded to capacity (about 224 tons). It carries centrifugal pumps, steam winches, engines, boiler and coal supply. The hull consists of a series of watertight compartments, so designed that if the exterior shell were destroyed the body of the hull would still remain afloat. The compartment containing the boiler plant has a 4-in. floor and heavy beams supporting coal bunkers and boiler, but otherwise the general construction is light; the outer skin of the hull is only 3 in. thick. All watertight compartments were carefully tested by filling them with water. The scow has been in almost constant service since construction with small expense for repairs.

In 1910 the building of concrete barges was undertaken on this side of the Atlantic. On the Welland Canal an 80-ft. barge of 200 tons capacity, called the *Pioneer*, was built for maintenance work. Design and construction were carried out under the supervision of J. L. Weller, St. Catharines, Ont., engineer in charge of the canal work. The barge has a beam of 24 ft. and depth of 7 ft., with rounded bow and a square stern. The hull was divided into eight compartments by longitudinal and cross bulkheads, double hatchways at stern and openings through the cross bulkheads giving access to all parts. The deck, bottom, sides and bulkheads are $2\frac{1}{2}$ in. thick, reinforced in two directions with $\frac{1}{4}$-in. steel wire and strengthened by the bulkheads and by beams and posts of reinforced concrete about 6 by 8 in. in size. Two 6 by 8-in. oak timbers serve as fenders. The barge draws 2 ft. 8 in. light (130 tons displacement), and when loaded to capacity has a draft of 6 ft.

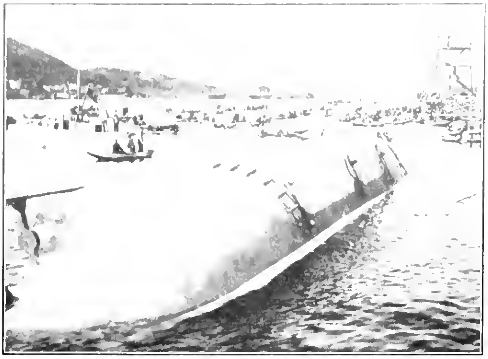
This barge has been in almost constant service since construction with practically no maintenance charges and is still in excellent condition. At times she has been loaded with 10-ton carloads of rubble stone dumped from a height of 12 to 15 ft. directly on to the $2\frac{1}{2}$ in. deck, the full load starting at one end.

On the Panama Canal three concrete barges 64 ft. long, 24 ft. beam and 5 ft. 8 in. deep were built in 1910 to carry dredging pumps, forming part of a plant used for hydraulic excavation at the site of the Miraflores locks. They were launched in the spring and summer of that year. Reinforced concrete was used because it was impossible to obtain skilled labor and suitable material for the construction of steel or wood barges within the time required. The walls and bottom were made $2\frac{1}{2}$ in. thick—two 3-in. bulkheads extending from bow to stern, making three compartments. Longitudinal beams at top and bottom of bulkheads and side walls, with posts at 10 ft. intervals, cross-connected at posts by beams with knee braces, comprised the general framing plan. The shell was a 1:2 mortar plastered on the steel skeleton of rods and mesh. Interior

members were 1:2:4 concrete cast in forms. The draft was 3 ft. 5 in. with a total load of about 140 tons.

Following this work, in 1913 and 1916 a number of reinforced-concrete pontoons were built at Panama to serve as landing stages for boats up to 65 ft. in length, and have been in regular use since. These pontoons are 120 ft. long, 28 ft. wide and 8 ft. deep.

Oscar F. Lackey, when harbor engineer of Baltimore, developed a system of construction which was first used in 1909 to build a landing stage for small boats, and then in 1912



LAUNCHING A 200-TON CONCRETE LIGHTER AT PORSGRUND, NORWAY, JULY, 1917

was applied to building a 500 ton concrete gravel scow for the Arundel Sand and Gravel Company of that city.

This latter craft has a length of 113 ft., a breadth of 29 ft. and a depth of 10 ft. 6 in. Four longitudinal bulkheads and five cross bulkheads divide it into twenty watertight compartments. The shell and deck are supported by a series of vertical and horizontal beams, the slabs varying from 3 in. to 5 in. in thickness, reinforced with plain bars running in both directions. The hull was built between forms and a very rich concrete mixture was used, with coarse aggregate of about $\frac{1}{2}$-in. maximum size. With the intention of facilitating towing, the sides were rounded on about a 6-ft. radius and worked into sloping ends which were carried back much further than in the ordinary scow. Light, the scow draws 4 ft. 3 in., and when loaded to its capacity has 1 ft. freeboard.

This scow has been in daily use ever since construction, is perfectly watertight and has withstood the roughest kind of handling. It has required no pumping out.

The full rounded sides and ends developed some undesirable features under load in a high sea or strong wind and in berthing. Consequently, in two other scows that were built in 1913 and 1915, respectively, a design more along the lines of the ordinary wood scow was utilized. These later scows were also cheaper to construct, form work being less expensive and placing of reinforcement easier. In the second of these scows five longitudinal and five cross bulkheads were used, and a combination of bars and expanded metal used for reinforcement. In the third scow an intermediate deck was introduced. The difficulties found in towing the first scow were eliminated and the draft reduced to 3 ft. 10 in. This was slightly in excess of a timber scow of the same capacity, but the concrete scow towed as easily when new, according to Mr. Lackey, and more easily than the other after a few months' service because of the lack of formation on the bottom.

One of these scows is used by the Raymond Concrete Pile Co., at Baltimore, a letter from which company last July stated that it had been very satisfactory in every respect and there had not been a dollar's worth of repairs since the scow was placed in commission.

Considering that these scows are watertight, do not require scraping, calking or painting, or maintenance other than repairs to the wooden-fender system, and crediting the cost of time that would otherwise be lost in making such repairs, the concrete scow becomes a decidedly interesting proposition.

England and France have recognized the utility of barges and self-propelled lighters of concrete. Last spring an English periodical mentioned a French company formed for the purpose of building seagoing concrete lighters; later pictures were shown of concrete boats under construction on the Paris Ship Canal. The Under Secretary for Sea Transportation and Merchant Marine in France was recently quoted as saying that very interesting experiments had been made with two concrete lighters in service. This has doubtless led to the building of more craft near Bordeaux, also several twin-screw vessels at Ivry-on-Seine, recent press photographs of which give a general idea though details are lacking. An English paper reports orders on hand from the French Government for several hundred concrete barges. Several English firms have begun the building of motor-driven barges of concrete, and more recently a concrete shipbuilding company has arranged for a yard at Dundee, Scotland.

James Pollock & Sons Company, a London firm of naval

LAUNCHING A 200-TON CONCRETE LIGHTER AT PORSGRUND, NORWAY, JULY, 1917

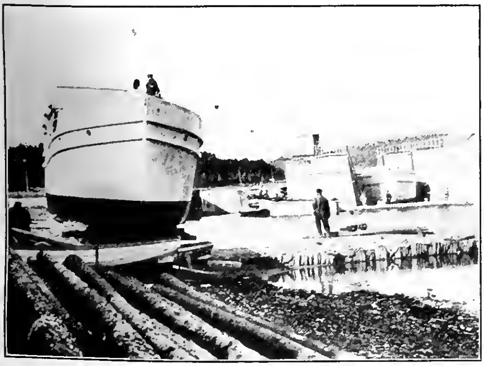
architects and engineers, has drawn plans for a fleet of small coasting vessels of reinforced concrete, the first vessel laid down having a length of 92 ft., beam 19 ft. and depth 10 ft. Power is obtained from a 120-hp. oil motor. In coasting vessels which need not make over 8 miles per hour, the use of straight lines would not necessarily be a handicap, and these concrete vessels have therefore been designed with such lines wherever possible to reduce form work, simplify bending, placing of reinforcement, etc. This firm is now drawing plans for larger vessels of 500 to 1500 tons cargo capacity.

A letter just received from a former Chicago engineer, now in England, advises that he has recently designed a number of barges and seagoing vessels of reinforced concrete and is at present interested in the building of ten such seagoing barges of 1000 tons capacity. A recent statement by the First

Lord of the Admiralty that ferro-concrete barges up to 1000 tons were being built in Great Britain possibly refers to this same work.

A Spanish reinforced-concrete cargo boat will be launched shortly by a corporation known as Works and Pavements, of Barcelona, the first firm in Spain to engage in the construction of concrete ships. The length of the first vessel is about 110 ft., beam 23 ft. and depth 11½ ft. Power will be supplied by a 120-hp. Diesel engine, and in addition sails will be fitted to the vessel. The company plans to construct during 1918 a gross tonnage of 40,000 in standard ships of 300, 500 and 1000 tons each, while ground has been acquired to permit later the construction of thirty boats at a time, some of which are planned to be of 6000 tons capacity. This company uses a mixture of 650 kg. of cement to 1 cu. m. (1:2½) of inert materials (gravel and sand of three sizes) so as to obtain, in its own words, "a dense, impermeable mixture that will permit also constructing the thinnest permissible section with a view to reducing maximum weight and thus obtaining the greatest possibilities in the way of speed." The concrete is considered to develop a compressive strength of 271 kg. per sq. cm. (approximately 3800 lb. per sq. in.) in 90 days, and a working strength of 76 kg. (approximately 1100 lb. per sq. in.) has been adopted.

Yet this work in shipbuilding is not entirely new, for Norwegian and Danish firms have already built and launched several concrete ships and self-propelled lighters of 200 tons capacity and now have larger craft under construction. The Fougner Steel-concrete Shipbuilding Company, one of the first in the field, has a plant at Moss, established in 1916. Following successful experiments made by Mr. Nic. K. Fougner with a 50-ton concrete lighter at Manila in 1914, the company has built some eighteen or twenty reinforced-concrete lighters and tow boats. These lighters have capacities of 100 to 200 tons, the later types having more the barge shape. Some are in use along the Norwegian coast and others have been bought by the Norwegian Navy. A loading test recently reported of a 64-ft. 100-ton lighter over an unsupported length of 40 ft. showed a deflection of about 0.6 in. under a uniform



Launching the 200-Ton Seagoing Concrete Motorship *Namsenfjord* at Moss, Norway, July, 1917. Concrete Floating Drydock in Background

load of 16 tons, in addition to the weight of the lighter itself which was 58 tons. The surface is reported to have shown no sign of cracking or indications of flaws.

The structure consisted mainly of keelson and ribs of reinforced concrete with a thin shell of concrete plastered on expanded metal or cast around rods, and this method of construction has been applied to the first sea-going concrete ship, the *Namsenfjord*. This vessel was launched last summer, was given a high rating by Lloyd's and is now in service for coastwise traffic. The vessel has a cargo capacity of 200 tons on 9½-ft. draft and is driven by a Bolinder crude-oil engine of 80 hp. at a speed of about 7½ knots. The length is 84 ft., beam 24 ft., molded depth 11½ ft. Larger ships of 600 to 1600 tons are now building, but their general design is much the same as that of the *Namsenfjord*, briefly described as follows:

There is a keelson of reinforced concrete with cross frames every 4 ft., the frames being continuous along sides and bottom and tied to the keel by the rod reinforcing. Particular attention is paid to continuity of reinforcement for these frames, and knee braces are provided at corners of the hull. The skin is 3 in. thick, reinforced with mesh and having a longitudinal beam at the outer corners of the hull. Concrete-filled pipes are used for center posts at intervals. The hull is divided into watertight compartments by transverse bulkheads of concrete reinforced with metal lath. The cabin is of wood and wood fenders are provided.

In building the hull, the bottom is cast in forms up to the top of the longitudinal hull beam previously mentioned. For the side of this size vessel the reinforcement and metal lath is set up for the total height and concrete deposited between the two sets of lath which act as a form; the outside and inside surfaces are then plastered. For larger boats this procedure is altered, using shorter heights of lath or casting the main frames in forms. Care is taken to make the construction continuous however, so that no joints are left in surfaces exposed to water.

In the earlier craft 1:1½:2 or 1:1½:2½ concrete was used with ½-in. maximum size aggregates, but later developments showed a 1:2 mixture with ¼-in. material worked better around the reinforcement.

The company has a contract for a 4000-ton ore carrier 254 by 40 by 19½ ft., equipped with two 300-hp. Diesel engines, and only awaits authorization by the Norwegian Marine Registry before proceeding with the construction. It has also constructed for a Christiania firm of yacht builders a floating drydock of concrete—the first of its kind—with a lifting capacity of about 100 tons, which suggests another field for development in the present emergency. The dock is 80 ft. long, 38 ft. wide and 20 ft. high, with a sill 4½ ft. thick and side walls 6½ ft. wide at the bottom. There are nine watertight compartments. The dock accommodates a vessel 75 ft. by 25 ft. and is equipped with an electrically operated centrifugal pump by means of which a 100-ton load can be lifted from the water in one hour. The Fougner Company is reported to have plans for larger docks up to 15,000 tons capacity.

The ships built according to the Fougner system have a ratio of dead weight to displacement from 12 to 15 per cent less than for steel ships, that is, their displacement is more for the same cargo-carrying capacity. [By dead weight is meant the cargo-carrying capacity expressed in tons, usually in terms of long tons (2240 lb). The displacement of a ship is the weight of water she displaces, and covers the weight of the ship itself plus the dead weight.]

The Fougner Company has established an American branch in New York, and is reported to have a contract with the Shipping Board for several 3500-ton ships contingent upon the success of the first vessel. It is stated that the Ferro-Concrete Shipbuilding Corporation, of New York, and the Liberty Shipbuilding Company, of Boston, also have similar contracts.

Another Norwegian company actively engaged in concrete-boat building is the Porsgrund Cement Construction Works, at Porsgrund. After the construction of a bridge pontoon in 1913, experiments were begun with a view to simplifying the form work and construction methods, as a result of which it was determined to build the boats upside down and launch them in that position. Following successful experiments with a 9 ft. model, a 200-ton barge was built and launched last summer. The barge has a length of 98½ ft., beam 19½ ft. and molded depth of from 9 ft. at center to about 10½ ft. at bow and stern. It will be equipped with a 70-hp. motor. Other lighters are in process of construction having capacities of 600 to 1000 tons. The general design follows that of a framed steel ship. The righting of the boat took about 20 minutes, an ingenious arrangement of inner airtight compartments making the craft practically self-righting.

The principle may be briefly described as follows: The inner mold is divided into compartments; when the vessel enters the water the air gradually escapes from the middle and upper two compartments through vent pipes, and the vessel losing buoyancy gradually sinks to a point of maximum submergence. The lower side compartments never being flooded, the vessel is in a state of unstable equilibrium, the center of gravity being considerably higher than the center of buoyancy. If the vessel now heels slightly to one side or the other, a couple is formed, the moment of which tends to turn the vessel on a longitudinal axis until the vessel is righted and floats in correct position. The flooded compartments are then pumped out and the molds removed to be used again for a similar vessel.

Progress in concrete shipbuilding has been made in Denmark also: one firm is reported to have several types from 300 to 1000 tons dead weight approved and classified by the Bureau Veritas for overseas service. The work has even developed so far that official rules have been laid down for design applying to the construction of flat-bottomed vessels of reinforced concrete.

At Montreal, Canada, the construction of a 126-ft. ship of about 350 tons capacity was started early in September, 1917, by the Atlas Construction Company, Ltd., and the vessel launched in November. This ship has a beam of 22½ ft. and a depth of 12½ ft. The ribs are of structural steel encased in concrete and spaced about 27 in. apart, the steel sections being 5 in. deep at the top and 14 in. at the base. Before the plans were prepared by C. M. Morssen, president of the company, and Prof. Ernest Brown, of McGill University, tests on model ship beams were made to ascertain the resistance of concrete to some of the strains encountered in ship design. The shell is of reinforced concrete varying from 3½ to 5 in. in thickness, approximately 50 tons of reinforcing steel being used in construction. The concrete is reported to be practically a mortar, about 1:1½:3, with small gravel. It was placed between forms, construction being carried on as continuously as possible. The vessel is of the single-screw type capable of about 8 knots.

The concrete vessel to which probably the greatest interest attaches at present is a 336-ft. single-screw cargo steamship of about 5000 tons capacity being built at Redwood City, near San Francisco, by the San Francisco Shipbuilding Company. The ship has a beam of 41½ ft. and a molded depth of 30 ft., with a designed load draft of 24 ft. She is to be fitted with Scotch boilers and triple-expansion engines of 1750 hp., giving a speed of 10 knots. Fuel-oil tankage is provided sufficient for 30 days' steaming.

The hull is divided into nine watertight compartments by concrete bulkheads. The frames or ribs of the hull are spaced about 4 ft. apart and there are also interior columns for the support of the two decks. The shell is reported to be about 5 in. thick at the bottom, decreasing to 4 in. at the deck, which is about 3½ in. thick. In addition to the diagonal-rod reinforcement in the shell, wire fabric is placed ¾ in. from the outside surface.

According to recent reports concrete is now being deposited in the forms, using a 1:1½:2 mixture with ¾-in. maximum size coarse aggregate and carefully graded sand. During the placing of the concrete the outsides of the forms are hammered to thoroughly consolidate the concrete and produce a dense surface. After stripping the forms the hull is to be sand-blasted and given a coating of gunite, later finished by rubbing.[1]

Although several firms in New York City have been developing plans for barges, the first construction work of this character was begun by the Louis L. Brown Company last October on a 700-ton deck scow of length 112 ft., beam 33 ft., depth 10 ft. and light draft 3 ft. 4 in.

The frame of the barge consists of reinforced-concrete members supporting a thin concrete shell reinforced with wire mesh. Rail, bulkheads, and deckhouse are of concrete; wooden fenders will be used. Concrete is placed by means of a cement gun.

Construction of a 500-ton scow will be started shortly at Vancouver, B. C., the plans having been prepared by the Taylor Engineering Company, of that city. This has an overall length of 107 ft., beam 32 ft., and depth 9½ ft. It will draw 3½ ft. light and 8½ ft. when loaded to capacity. The truss method of framing is of interest. The same company is now designing a 1200-ton well-deck scow. A New Orleans sand and gravel company is now building a deck barge 130 by 30 by 7½ ft. deep, of about 550 tons dead weight.

A joint committee of the American Concrete Institute and the Portland Cement Association has been investigating this subject in a preliminary way. It recently prepared a report covering points to be considered in designing concrete vessels and submitted a tentative design for a 2000-ton seagoing barge of the following dimensions:

Length	227 ft. 6 in.
Length between perpendiculars	220 ft. 0 in.
Beam	42 ft. 0 in.
Depth	23 ft. 0 in.
Loaded draft	18 ft. 0 in.

The displacement was estimated to be 3675 tons on an 18-ft. draft. The vessel is divided into five compartments by transverse bulkheads, the three center compartments being for cargo and the other two for tank and ballast.

In designing, the criterion followed was a steel ship designed according to Lloyd's rules, and practically equivalent strength provided in reinforced concrete. A concrete of 1:1:2 mixture with carefully selected sand and selected gravel (about ½-in. size) was decided upon and considered to develop an ultimate crushing strength of at least 3000 lb. per sq. in., allowing a maximum stress in concrete of 1000 lb. per sq. in.

The spacing of the frames is 4 ft. and the thickness of shell 4 in. on the sides and 5 in. on the bottom. Two lines of reinforcement are provided. The deck is 3 in. between hatches and along the lines of the hatches and 5 in. thick outside these lines.

[1] Since this was written, word has been received that the hull has been completed and the vessel successfully launched.

An estimate of quantities gave the following:

Concrete	731 cu. yd.
Steel	482,000 lb.
Flooring for hold	30,000 ft. B.M.
Oak timber (fender rail, etc.)	15,000 ft. B.M.

The total weight of the ship was estimated to be 1647 tons and the carrying capacity 2028 tons for 18-ft. draft. The cost of the hull per ton dead weight was estimated at $63; the best available figures indicated a cost of steel hull of the same character of $90 to $120 per ton and up; cost of wooden hull of $70 to $100.

A few paragraphs from the report of the joint committee are given below and may be of interest in regard to points connected with the design and construction of concrete vessels.

"It is apparent that the efficiency of a ship as a cargo carrier depends upon the relationship between dead weight and displacement. Expressed in terms of per cent, in the average cargo ship built of steel, the dead weight is from 70 to 75 per cent of the displacement—taking into account as weight of ship all spars, fittings, deck houses, anchors and chains, auxiliary engines and tanks, but not boilers, engines or coal. In a wooden ship, the dead weight is from 60 to 65 per cent of the displacement. It is quite evident that from the difference in weight of materials, it will be difficult to design a ship of concrete that will give a relationship between dead weight and displacement approaching that of steel. However, if ships are to be built of concrete for commercial use, the weight of the ship must be such as to provide a reasonable dead weight or cargo capacity for the displacement.

"The stresses in the transverse members of a ship are, in still water, functions of the draft and the stiffness, and may be computed by mathematical processes, although the computations are long and laborious. When the material is reinforced concrete the problem becomes much more complicated. Experience has shown, however, that numerous elements other than draft affect the transverse strength of a ship, such as the effect of rolling in a sea way, impact with docks or other ships, and stresses incident to going into drydock. The transverse members of cargo ships of today are, therefore, not designed to withstand computed stresses, but are designed in accordance with various rules which embody the result of long experience in the construction and use of ships. It should be noted in this connection that granting of insurance depends on compliance with these rules."

"Steel ships are of two different types, (*a*) framed ships, in which transverse ribs or frames are spaced from 18 to 24 in. on centers, the plating being riveted to these ribs without intermediate longitudinal members, excepting in the bottom; and (*b*) longitudinally framed ships (Isherwood), in which heavy frames are spaced from 10 to 15 ft. on centers, with intermediate longitudinals to which the plating is riveted."

"From a comparison with the ordinary steel-ship design, it would appear to be not difficult to design transverse members of reinforced concrete of equivalent strength to steel members—the question of strength only being considered."

"A ship must be able to meet conditions which are unlike any to which land structures are subject.

"In determining the longitudinal strength of a ship, it is customary to assume two conditions. Under the first condition, the ship is assumed to be suspended between two wave crests, the length between crests being equal to the length of the ship between perpendiculars, the height of the wave being equal to one-twentieth of that length. In this case, the ship as a whole is acting as a simple beam supported at the ends. This condition is termed 'sagging.' Under the second condition, the ship is assumed to be supported amidships on one crest of the same wave. Under this condition, the ship as a whole acts as a cantilever. This condition is termed 'hogging.' It is apparent, therefore, that when a ship is riding the waves both the deck and the bottom of the ship will be required to withstand tensile and compressive stresses alternately—the maximum tensile stress following the maximum compressive stress at very short intervals. In a steel ship the entire cross-sectional area of the midship section acts to resist these stresses, taking into account, in determining the moment of inertia, all of the continuous members, such as continuous scantlings and deck, side and bottom plates. In the concrete ship equivalent strength must be provided. In the case of the concrete ship, however, only the steel reinforcement can be relied upon to take tensile stresses. The concrete, assisted by the steel, will take the compressive stresses."

"There is an almost unanimous opinion among naval architects and seafaring men generally that a concrete ship will be so inelastic that she will tear herself to pieces in a sea. While it is doubtless true that in a concrete ship there will not be the same readjustment of stresses as in a steel ship when subject to the action of a heavy sea, experience with reinforced-concrete structures generally has shown that such structures have considerable elasticity, and there is ample reason for the hope that reinforced concrete will prove a suitable material for shipbuilding purposes."

One of the questions in concrete shipbuilding concerns the possible effects of sea water on concrete. Recent investigations by the Bureau of Standards, as reported by Messrs. Wig and Ferguson, throw new light on this subject and point out remedies. The results of their investigations tend to show that inferior concrete, or concrete of which the surface skin has been impaired, suffers serious effects when in contact with sea water, and that great care in the mixing, placing, and finishing of the concrete is needed for durable construction. There is every reason to feel assured that the care needed in the selection and proportioning of materials and in mixing and placing and finishing concrete for concrete shipbuilding will provide the proper remedy.

Another aspect is the protection afforded the reinforcing steel by the concrete, and in this connection the investigations of the Bureau of Standards show that portland cement itself is durable in sea water, which suggests that the rich mixture of concrete used in concrete ships, if properly deposited around the reinforcing steel, will provide the requisite protective coating.

Besides the work now under way which has been mentioned, plans are nearing completion for the construction of other vessels on the Gulf and Southern Atlantic coasts, so that in the course of six months there should be much more detailed information available on the subject. The art of concrete shipbuilding might be said to hold the position occupied by reinforced concrete fifteen years ago, but the knowledge gained during these years is helping to solve the present problems, and we may be sure of a rapid development in this hitherto unrealized field.

In the report of the Canadian Department of Marine and Fisheries for last year, recently made public, the opinion is expressed that no form of industry has a brighter opening in the Dominion than shipbuilding, and it has in fact already made a rapid and substantial start.

Ships to the value of $60,000,000 to be constructed in the Canadian yards this year are reported to be already under contract. Included in this amount are orders for vessels amounting to $25,000,000, placed on behalf of the Admiralty through the Imperial Munitions Board; 100 others are under construction at plants in various cities throughout the Dominion, as well as certain craft regarding which information cannot be given. In this situation of the shipbuilding industry, necessitated by the demand for tonnage to meet war conditions, the British Controller of Shipping, the British Admiralty, the Imperial Munitions Board, and two departments of the Canadian Government have had a part. (*Journal of Commerce*, March 14, 1918, p. 5.)

THE WAR'S EFFECT ON MERCHANT SHIPBUILDING

By HOMER L. FERGUSON,[1] NEWPORT NEWS, VA.

In a military sense, this war is narrowed down to the question as to whether the German submarines can sink the English ships and those of the Allies at such a rate as to force peace upon Great Britain, ourselves and the other Allies before the Germans are sufficiently thrashed on land to recognize that fact. When the submarine campaign was started in February, 1917, the German Minister of the Navy promised his people that in August of that year England would be brought to her knees. The rate of sinking for a time increased until it became probably three or four times the rate of building.

There have been two schools of thought regarding the proper method of meeting the German submarine campaign. One school has held that only by the production of the maximum number of ships in the shortest space of time, until the production of new vessels should more than equal the destruction of vessels in being, would the question be answered. The other school has held that there were vessels in plenty to feed England and to carry our troops to France and to feed them, and that the proper method to meet this menace was to build a large number of submarine chasers, destroyers and other vessels of war to go after the submarine itself.

The exponent in an official way of the theory of building the maximum number of ships is, of course, the United States Shipping Board, with the Emergency Fleet Corporation as the largest individual owner and builder of merchant ships anywhere, either at this time or at any other time in the history of the world. All of the shipbuilders have had their new ships commandeered by the Shipping Board, and these ships are now being pushed to completion under the direction of the Shipping Board. In addition to the ships under construction at the time the Shipping Board took over all these vessels on August 3 last, the Shipping Board has placed contracts for 200 to 300 additional steel ships and for about 200 wooden and composite ships. The English have built ships at a very rapid rate during the past six months, but prior to that time their capacity had fallen off woefully. The figures of British shipbuilders are that in normal years their capacity in tons was about two million. In 1915 they built only 700,000 tons. In 1916 only 550,000 tons. In the first six months of 1917 they built 500,000 and by the end of 1917 they will have built during this year almost two million tons, or practically their normal tonnage.

In comparison, it is interesting to look at our record, which is mostly to be made in the future. The largest tonnage ever built by us in any year prior to 1917 was in 1908, when we built 615,000 tons. In 1917, or at the end of the fiscal year of 1916-17, on July 1, the total tonnage turned out in merchant ships in this country was close to 800,000 tons. Of course, we expect this to be bettered very much, and except for labor difficulties the production would have been very much greater; but it is a far cry from 800,000 or 1,000,000 tons of ships a year to a prospective 2,500,000 to 5,000,000 tons of ships a year, and especially when we consider that the best the first shipbuilding country of the world ever did in any one year was only 3,000,000 tons.

Now as to the methods of turning out such an enormous tonnage in a short time. The standardized ship was first thought of by Noah. It certainly would have been had he built a second ark. Every other shipbuilder has thought what a joyful thing it would be if he could only build two or three or four ships just alike. If the war does nothing else for shipbuilding, it will at least demonstrate that the individual tastes of individual owners need not be met in every instance. Building a ship is somewhat like building a house, and I dare say even the ladies present will agree with me that none of them has ever seen a house built which they would not change here and there—certainly in closet space if nothing else; and it is very much so with ships. Ships are not built alike for the reason that ships are built by units and tens instead of by thousands. And what applies to the automobile industry or hat industry, or any other industry where the units are small and the aggregate number is very large, is not possible where you are building a thing that is worth half a million or a million or more. It is certainly not possible under ordinary circumstances with a very scattered ownership. But with a single ownership, like the Emergency Fleet Corporation, it becomes possible for the owner to specify that all ships shall be alike, and thus we have standard ships!

There is an idea extant that if a ship is called "fabricated" or "standardized" it becomes rather easy to build. It does become easier to build, but it is not any easier to drive a rivet in a fabricated ship than in a common ship, and the 7500-ton fabricated ship will have about 650,000 rivets and some riveters must do a considerable amount of work to drive those rivets in that ship the same as in any other ship. The most onerous work in building a ship is in the driving of the rivets; and if any concern is going to build one ship a week it must drive 650,000 rivets a week. When we consider that the best rivet drive is by the Union Iron Works, where they drive 250,000 rivets a week, and the next best by the three largest shipyards on this coast is about 200,000 rivets each per week, the problem of driving 650,000 rivets a week assumes a rather difficult aspect to the casual observer.

The fabricated ship has the center of the stage at the present time. In England a standardized ship was adopted which is very much like a fabricated ship, and they are being turned out at a rapid rate. The first ships have already been completed and are now on the sea. The fabricated ship, like the English standard ship, has the disadvantage of low speed, and at the same time it has the advantage of a large carrying capacity. The records of submarine sinkings, such as have been gathered, indicate that speed is probably the safest defense against the submarine. The number of very slow ships sunk is very great in proportion to the number attacked. Probably 90 per cent of the slow ships are sunk when attacked by a submarine. As the speed becomes greater the immunity of the ship from torpedo attack becomes greater—not only because she presents a more difficult target, but also because the vessel may run away from the submarine in darkness or in daylight if she has a greater speed than the submarine has on the surface, and also because the vessel may be maneuvered much more quickly.

One of the most gratifying things about submarine warfare is that the torpedoes are not making as great speed as in the early days of the war. The speed of the torpedo has undoubtedly become much decreased. Just why we do not know, although it is probably due to the absence of tungsten and

[1] President, Newport News Shipbuilding and Dry Dock Company.
Abstract of address delivered at a joint meeting of the Engineers' Club of Philadelphia and the Philadelphia Section of The American Society of Mechanical Engineers, October 16, 1917.

manganese and some other ingredients now so difficult to obtain in Germany. Vessels of 16 or 17 knots have actually dodged the torpedoes.

The vessel of 16 or 17 knots is also needed to carry soldiers. We are shipping all our soldiers to Europe in vessels of 14 knots or over because it is thought to be too hazardous to ship them in the slower vessels. We have at the present time in this country enough vessels in commission to ship soldiers to Europe at the rate of not more than one million a year. That includes all vessels of 14 knots or over. But by building a large ship, as well as a speedy ship, an additional factor of safety is obtained, which may be illustrated by stating that a torpedo will blow just as big a hole in a little ship as in a big ship. When a small, short ship has a large hole in it, a relatively larger proportion of its length is open to the sea. When a similar hole is blown into a long ship, a very much smaller proportion of that vessel is open to the sea. So that it is perfectly possible to design, and practical, indeed, to design a ship 500 or 600 ft. long, so subdivided that it will take two, and probably three, torpedoes of the German variety and still stay afloat.

The design, however, must be of such character that when the compartments are flooded the ship will still remain upright. The requirements of passengers who go to sea are such that the ordinary passenger ship shall have a very small metacentric height. But with a small metacentric height the rolling of the vessel is very easy, so that the passengers are not made ill with the motion of the ship as easily as they would be if there were a large metacentric height and the ship rolled quickly and with a jerk. Ordinary passenger ships are modeled with a small metacentric height, and three-fourths of them, when bilged or torpedoed, will probably turn over before sinking.

A great deal of talk was heard years ago, when the *Titanic* went down, about making ships safe. The *Titanic* was probably the safest ship that ever crossed the ocean, with the exception of the *Olympic*. The *Empress of Ireland*, the *Lusitania* and the whole host of passenger ships of which we have any record have turned over as they went down, and they probably righted after they went down. In designing a ship that will be safe against submarine attack, not only must the question of subdivision be taken care of so as to limit the length of the vessel that may possibly be damaged by a torpedo, but also the stability, so that when torpedoed the vessel will remain in an upright position and will be able to get into port.

The larger type of ship which will probably be built before the war is over by a number of concerns in a position to undertake this work will be designed with a high speed for troop transport, with a close subdivision to make the ship safe, and with a large amount of stability so that the vessel will also be safe against turning over.

The war so far has developed three distinct types of vessels: the standardized or fabricated ship, such as both England and the United States have adopted; the large troop transport which has been described; and, in addition, the submarine chaser.

Besides these three types there has been a very definite attempt to rejuvenate what some of us have considered a dead industry. I do not know whether many wooden ships are being built around Philadelphia, and I would not like to criticize the wooden-ship builders; but I should like to see a few. We have a few of the older wooden-ship builders left, but the building of a wooden vessel to my mind is so much more difficult than the building of a steel vessel, and requires so much higher skill than does the building of a steel vessel, that I wonder how one can ever expect to build them.

I do not believe that a 288-ft. wooden ship built in a lumber yard, either South, West or North, and necessarily by men who are not expert ship carpenters, will ever relieve any great distress on the other side of the water caused by lack of fuel or food. On the other hand, these wooden vessels may be used in our own trade at home. My chief regret is that they are not made shorter, because when such ships are over 200 ft. long it is rather difficult to hold the ends up. If we can get more vessels by building wooden ships, let us build them, but it is unfortunate that the type was settled before many professional wooden-ship builders were on the job. The wooden-ship builders, of course, have taken a good many men from the steel-ship yards, and have lessened production to just that extent; but, on the other hand, they will add a very considerable tonnage, now that practically all our large coastwise ships are either going abroad or are in the way of being commandeered for foreign service, so that the wooden ship will serve a useful purpose.

The standard ship probably offers the best opportunity for a large increase in our tonnage. The standard ship has been built on the Great Lakes for years. Shipbuilding there has become largely a manufacturing operation for the reason that the ships themselves simply form a part of the manufacturer's business of carrying iron ore from Lake Superior down through the Canal to the eastern points, where it is shipped to the steel furnaces. The loading and unloading of the ore permitted the standardization of docks, hatches, and so on, and the method of construction became standardized because the work which the ship did was standardized. Many ask why we do not build ships just as they do on the Lakes, and the answer is that we do not do the same work that they do. On the coast, with the coal trade, there has been some effort toward standardization. With the standardized ship the main benefit is not in the hull of the vessel, or in the fabrication of the vessel in the steel mill. The main benefit is that the machinery and the outfit, the winches, the pumps, the steering gear, the engines and boilers, and all the thousand and one things that go into the ship, are standardized, and may be produced in large quantities at some point other than the yard of the builder. The standardization of the fittings of a vessel is more important to my mind than the standardization of the hull. The amount of money saved in the latter will be that required to build the templates, patterns, etc., amounting to not more than $12\frac{1}{2}$ to 15 per cent of the labor cost of the hull. We are told, too, that all the riveting will be done at the steel mills. It probably will not, and if 20 per cent of the riveting is done there, it will be more than I think, unless the railroads will carry pieces of steel as large as this auditorium.

Shipyards have naturally tried to standardize within their own practice the fittings that go on the various ships they build, and a great step is being made in that direction by one of the largest corporations in the country. The Bethlehem Company own so many shipyards that they are in a position to standardize as between their various yards, with the result that there will be considerable saving in cost and in time in the production of all the things that go into a ship.

But in building the standardized ship, or in building any other ship, the real problem is not the problem of equipment; it is not the problem of money even; it is not, except in part, the problem of location, but it is the problem of men. A very simple lesson in arithmetic will indicate that if 100,000 rivets are to be driven in one day, and any one gang of riveters will drive 300, then it will take so many men and boys and helpers

to get that drive. It is quite desirable to get back to our arithmetic again when we have built so many ambitious high hopes of what we expect to do. I can state for our company that the most fortunate thing we did when this war started was that we promised to deliver ships only in the quantity that we had been delivering before.

Saying that we are going to do a thing does not do it, and *hoping* that we are does not do it, and promising to the newspapers that we are going to build all these ships does not do it. As a matter of fact, enthusiasm and high hopes, unless counterbalanced by good judgment and experience, do more harm than good, because a good many people are lured into a sense of security that we are going to win against this submarine menace, when, as a matter of fact, there is nothing to justify any such conclusion. For instance, on the Delaware and on the Chesapeake, which we, on the Chesapeake, are pleased to consider the two largest shipbuilding communities in the United States, there are at present about 33,000 men employed in the shipyards. There could be employed to advantage in these same yards at this time a total of 48,000 men, and within the next six months, or the next nine months at the latest, these same yards, barring the fabricated shipyards, could employ to advantage a total of 60,000 men. So the problem becomes arithmetical again. There are 32,000 men working. To get the maximum production out of the shipyards already in existence, 60,000 men will be needed. Where are the 28,000 extra trained shipbuilders to come from? Add to these shipyards the fabricated shipyards, which on the Delaware will probably require 20,000 men, and in the vicinity of New York an extra 10,000, and we have in this immediate district need for approximately 60,000 new mechanics in the shipbuilding business.

According to Admiral Capps, there will be needed in the whole United States in shipbuilding within the next six months an additional 150,000 men. Now consider for a minute where these men must come from or how we are to get them. In the first place, most shipbuilding men or mechanics require both skill and experience. We can give them the experience fairly quickly, but we have not time to give them the skill. In other words, it is necessary that men be recruited from industries where they do work similar to the work of shipbuilding. I say other industries without specifying what particular industry. Of course, it would be natural to pick the non-essential industries, if there are any such. But I would say that they should be taken from *any* other industry if necessary, because our problem in the war becomes the most difficult when the question of transportation is considered.

We are operating or preparing to operate 3000 miles from our base, and that is the crux of the whole question. A reasonable solution has been proposed for every physical problem presented by this great war except the problem of oversea transportation. The problem of oversea transportation absolutely has to be met before we can get into the war effectively, and the problem of sea transportation is probably the most difficult of all problems we have to face. Therefore, the men should be furnished for the solution of this problem, no matter what industry they are taken out of. We are making a fine, large army; we are making all kinds of quartermaster supplies and guns, and other things, but none of them are of any use whatever unless carried to Europe. Our soldiers must be carried to Europe, and not only that, but the soldiers that are carried to Europe must be fed and must have ammunition. The excitement created by the war so far will be but a gentle zephyr compared to the excitement that would permeate the United States if, perchance, we should get a million men in France from the United States and they should go hungry. My own opinion as a plain American is that that is the largest problem that looms up in the future. It is a military problem of prime importance—the most important single problem that confronts us at the present time.

I have been quoted in an extract of this talk that I gave to the newspapers as favoring the conscription of laboring men. I do not say that I favor the conscription of laboring men, but I do say this—that sooner or later the United States will tell all men who are essential in any industry or any occupation in the prosecution of the war that *this* is their job, and they are to stay by it until the war is over. It is ridiculous that our men who are already in Europe and those who are going there now should suffer on account of some difficulties that arise between employers and employees in the great shipyards of this country. Not only should the man who pounds iron and drives rivets be told that he shall be kept on his job, but also every employee in the company, from the president down to the office boy, that he is to do the same thing, and is not to seek or obtain other employment, except for good reason given the Government authorities. It simply comes down to this: Whether we are playing a game of amusing ourselves, or whether we are in to win. If we are in the war to win, no one should be timid about telling the laboring man or the unions, or anybody representing them, just what part they have got to play along with the part that other people should also play. In fact, when the war started a few of us in conversation with the Secretary of the Navy told him that we thought the thing for him to do was to commandeer the shipyards, together with all their employees; to put us all on the Government payroll if he wanted to do so, and give us as many stripes on our uniform as he thought proper, and if we did not do as he thought the United States wanted us to do to court-martial us and send us down to Atlanta or some other convenient penitentiary. And I think something of that sort should be done. Any man who has charge of shipbuilding or engineering in any capacity who is not perfectly willing that that should be done both to himself personally, as well as to his men, has a very one-sided view of this war which needs to be corrected. Of course, it is held by the National Council of Defense and by a number of exalted bodies that the *status quo* as between employer and employee should remain the same during this war. Of course it should remain the same, and we all know that it is not remaining the same, and we all know that the labor leaders, as a rule, are unable to control the men.

There is a solution of this labor problem effected with the transport workers on the other side; Liverpool, for instance. A number of the soldiers were sent back to Liverpool and went to work. A few years ago in France a great threatened strike on the railroads was settled by making soldiers out of all the railroad employees. Our present stevedore troubles are in a fair way of being settled by giving the colored man a chance to be a stevedore instead of being a soldier in the trenches; and so far as I have been able to observe in our neighborhood, several thousand of them are glad to take advantage of this glorious opportunity, and are stevedoring for their country very quietly and very effectively. I do not see why of all the men who have been passed into the National Army that we should not have in so essential an industry as shipbuilding those of them who are mechanics on conditions set by the Government, and on pay to be approved by the Government, to work in these shipyards until the war is over, or until they should perchance prefer to go to the front instead of staying in the shipyards.

I understand that in Philadelphia it is very difficult to have

any of the shipyard employees excused from military service. Of course, they have their own rules to go by in Washington, and we must all abide by them, but it is rather unfortunate that they should be differently interpreted in different parts of the country, and it seems to me most unfortunate that the shipbuilders have been allowed to go to the front. The experience of England was that they had to take out of the trenches not only the shipyard workers but the ammunition workers, and send them back to the factories again. It is a pity that we could not profit by that, but I suppose we will after we have gone a little further into the war. That would be a solution that would help very much with this laboring-man difficulty.

Of course, the real trouble with the employers of labor is they are told that they must get together with the men and must have no trouble during this war: that they must keep the plant going. Every manager that I have talked with feels that it is incumbent on him as a good American to see that the wheels are kept going around and that these ships are produced, and I dare say that all the employers are perfectly willing that they should fight with their own laboring men, and fight to a finish if need be, except at this time. We all know what that means. The demand is largely in excess of the supply of men. The sympathy of the Government is with the men. At our Navy Yard, under the law, we pay the going rate in that vicinity, and arbitrarily fix the rate at a larger rate than the going rate in the vicinity which we have to meet. and we are told in case of difficulty we must keep going, so it is only a question that can be worked out by the Government's representatives and the shipyard employers together.

I would be perfectly willing to see all the shipbuilders go down to the Navy Department and Shipping Board and say, "We will agree with you on these conditions and stand by them, and will shut up our shop before we pay any more." Of course, it can be said that a man who works is entitled to any wage he can get. Perhaps he is, but he is not entitled to stop working now, and he is not entitled to say that any other man shall not serve an apprenticeship now. He is not entitled to say that a helper shall not do a mechanic's work if he can do it. How perfectly ridiculous when a million and a half of the best young men that we have in the whole United States are serving an apprenticeship in the war, leaving their homes and going out to learn the art of soldiering in a very short time, and quite as difficult work to learn as riveting. What a ridiculous thing to say at a time like this that a man cannot get a job unless he has served his time at the trade, and tie the hands of the United States in this great war, which it must win if you and I are going to keep on being proud of living in the United States.

I was shown today in the case of a number of workers that the money which they could earn in a day was limited by the organization to which they belonged, and that if they earned that much money at two or three o'clock in the afternoon they would work no more, notwithstanding the fact that the management wanted them to do it. When will people ever learn that production by the use of labor-saving machinery to get a large production per man is all that gives us more than we ever would have otherwise, or than we ever would have had before the days of large production? And yet they have limited production with the idea of giving more jobs to more men in time of war when we have not got enough men and have about three jobs for one man!

I will take just a little bit of your time in presenting what I might say is the worker's side of the story. I do not know the conditions in Philadelphia, but I imagine they are rather bad for laboring men. As an instance of what can happen, in Newport News, a town ordinarily of 30,000 people, we now have 55,000 people. The place is so full of people that no one can even go there to see the soldiers off. The condition of laboring men who are gradually coming in from the West to all the seaboard towns is a very difficult one, and a great deal of the basis of discontent is a lack of suitable housing conditions. That is ordinarily taken care of in the towns and cities by real-estate people and those who build for investment, but at the present time that method is wholly inadequate, and this question will have to be considered along with the same program as that for our Army which is being installed in cantonments all over the United States. Why? Because we cannot find vacant houses for 20,000, 30,000 or 40,000 men in any one place, and so quarters have to be provided the same as for the soldiers.

The Government is waking up to this situation in the case of some recent contracts let for destroyers. The Government itself will finance the building of barracks or temporary hotels for the men, so that several hundred can be housed at or near the shipyards where the work is to be done. For instance, in Philadelphia you have large fabricated plants to be built, and you have a number of large war industries settled here. In addition, Essington will need probably 20,000 men and the fabricated-ship yards probably 20,000 or 30,000 more. It becomes necessary even in this city, which is known all over the country as the best workmen's city in the United States, that the housing be looked into, and that large additional facilities be quickly provided. One of the biggest problems England had was the formation of new communities and the building of whole towns. In some cases they were almost ten miles square, and in them were provided not only ordinary houses and living accommodations, but public parks, playgrounds, theaters and everything needed in a modern town.

[Mr. Ferguson continued by referring to the need at this time for patriotic service to the country on the part of all alike, regardless of the group or individual. He could not imagine the United States letting stand in its way any band of men whatever when National honor and life depend on our winning this war, and we are sending our young men to France by thousands. The Government might exact any toll so long as all were treated alike and business was left with enough money to carry on its operations, pay a moderate return to the owner and be able to serve the Government in the best way.]

The Chamber of Commerce of the United States, representing many business men of the country, at its meeting at Atlantic City, gave voice to this sentiment: that if they treat us all alike they could not go too far in exacting the greatest toll from the business of the United States. We are willing to have the plants commandeered by the Government, under the terms of the United States and under conditions which they see fit to impose; but we insist that managers, foremen, superintendents and men shall all be treated alike.

With reference to the difficulty in securing priority in the delivery of material. I would say that we have received from the Navy Department and from the War Department and from the Shipping Board orders to proceed with the utmost vigor and despatch to do their work, each in the same tone of voice, each with equal authority, all vested in these various departments by Acts of Congress, so that actually what has happened is that the president of our company has had to settle the question of priority himself—an entirely improper function for him. The question of priority and preference is now the biggest industrial question there is, for

the very simple reason that the total production of the United States has been over-absorbed by these war activities.

With the prices settled, the only important thing is, who gets his first, who second and who third. The Government wants to get the material in such quantities as it can, but it is simply impossible to satisfy all these bureaus and departments. What is the answer? The answer that was found in Great Britain in the very first months of the war was to divorce the question of business, buying and price-fixing from the naval and military activities of the country. A munitions minister was appointed; just the kind that we need. The same chamber of commerce I was speaking of recommended that a board be appointed. I am a director in that chamber, but I think a minister should be appointed, because you want a *man* who will coördinate the interests of the country, and when blankets are necessary he will buy blankets for the United States, and not buy three blankets for the sailors and none for the soldiers.

The weakest point in the shipbuilding business is the forging situation, in my judgment. There are not enough forges in the United States to turn out all the forgings required for the shipbuilding. The great Bethlehem Company, Midvale, and the Allis-Chalmers are practically the only large ones we have, whereas Great Britain has twelve or fifteen very respectable forging concerns. It is absolutely necessary that some one determine whether this or that or the other kind of forgings shall be first; otherwise a lot of us are apt to end up with hulls but with no machinery to put in them. It seems to me that we all want to do the best we can, but we would very much appreciate it if we could go to Washington and say to some one that this is the most important, and that is the next, and that is the next. Instead of that, we appeal from one department to another, and the result is that we frequently end up with nothing.

I hope that the good people in Philadelphia will always maintain an open market for beginners in the shipbuilding industry, and when the Shipping Board works out its program of breaking in new men and bringing them in from the West, then every one in our business will do his best to give a helping hand. We invited the Board to bring its school to Newport News. I think they have been invited by one or two Delaware shipyards to establish a school for the instruction of teachers who would go back to their home yards to break in all of the new help. We have to break in large numbers of new men, and the most important question next to the housing question is the breaking in of these new men, and our foremen and superintendents must get used to the honor of subjecting themselves to the discomfort and inconvenience and annoyance of breaking in large numbers of perfectly green, raw country boys.

We all know that it is a joy to have a few good mechanics and give them a job and forget about it, but we have to get away from that and to teach new people, which may fortunately be done with ships of standard make and duplicate makes. The problem that the employment managers have at the present time is to get hold of the best material possible, house it as decently as we can, and teach it shipbuilding as quickly as possible. The problem almost dazes one to contemplate. It can only be solved by bringing in enormous quantities of new men, and which must be done without any hindrance. The leaders of the unions have stated that they would allow this to be done. We have to do it, and no matter what else happens we must insist upon the right to break in any number of new men in the business. The Shipping Board will back it up, and I am sure that sooner or later the Administration itself will insist upon that being done on such a comprehensive scale as to make it possible for the United States to carry out its great shipbuilding program, which *must* be carried out.

OUR INDUSTRIES AND THE WAR

A Timely Discussion Before the New York Section on the Open Question of the Adjustment of Our Industries for Effective War Work

FACED with the diametrically opposed conditions, on the one hand that several billions of dollars are being spent by the Government upon manufactured products for war purposes, inflating and seriously taxing one set of manufacturing resources and, on the other hand, rendering it necessary to limit production in other lines not directly essential to winning the war, and the disruption of those organizations, the industrial situation today calls for an adjustment which, if not approached from the standpoint of the welfare of the nation, is liable to produce, and has unfortunately already produced, disaster in some channels. The common ground for attack of the two-sided problem is, of course, unbounded patriotism and the desire to win the war as soon as possible, and it is to the credit of the manufacturers mostly concerned—the small manufacturers whose activities are at the present time apparently not available for mass production—that they have approached the problem on this ground, and many have made sacrifices worthy of the cause. At the same time, however, there is the other side—the protection of our industrial organization as a stabilizing element during the war and a subsequent economic necessity.

With the hope of developing some of the facts in the case as a means of bringing out some constructive suggestions to meet the problem, the New York Section of the Society organized and conducted an impartial meeting on the evening of February 21, to which a number of prominent manufacturers were invited to express their views. The following is a brief account of the protracted meeting, which culminated in a definite recommendation to the Council of the Society to take action in the form of appointing a committee to act as a clearing house to bring the requirements of the Government to the industries, so distributing work that the resources of the nation would be made completely available.

GEORGE K. PARSONS, in opening the meeting, said that it was to be regretted that the term "non-essential" had ever been applied to industry, since it was misleading. Essentiality is a relative term, and no industry exists which cannot contribute in some way to the demands of war. He cited a report from the London *Economist*, showing that while luxuries were now less in evidence in Britain, no British industries had been destroyed—they had merely been converted. He said that organized professional engineers could and must use their peculiar and particular abilities in publicly and privately helping industry to accommodate itself without upheaval to the problem of winning the war, and to help the

Government in such a way as to make the application of drastic measures unnecessary. The object of the meeting was therefore to see how engineers could promote the essentiality of the various industries.

Secretary Rice emphasized this object by stating that it was the duty of engineers to help solve the problems of the Government. It was especially their duty to discuss the subject of conversion of the industries, as it was impossible to carry out such conversion without an engineering analysis. He said that industrially the problem of the Government is to secure the necessary supplies for the conduct of the war. The second problem is to insure continuance of our industrial strength during and after the war. He described a plan of the Fuel Administration which, by applying fuel curtailment to certain industries, automatically provided restriction of non-war industries. This plan had already proven practicable, and industry had given its hearty support to it. The actual effect of the plan was to limit production of non-essentials.

President Main congratulated the Section for taking up its share of public work. He hoped that the meeting would result in some constructive suggestion which could be made to the owners of non-essential plants, who were looking to engineers for assistance in getting the Government to utilize their facilities for making, perhaps, small parts of munitions.

Frederic W. Keough, editor of *American Industries*, official organ of the National Association of Manufacturers, declared that it was impossible to prepare a detailed classification of essential and non-essential industries, as there was no such thing as a non-essential industry. Many products which seemed at first thought to be non-essential in wartime might be just the things to send abroad instead of gold in exchange for essential raw materials. He thought we all ought to be eager to promote war work, but in doing so there was no occasion to tear down our industrial structure which we would probably need very badly to meet foreign competition at the end of the war. Manufacturers generally were not only "doing their bit," but were doing their utmost of their own accord to convert their plants to war purposes and to supply men for war work. He urged that no drastic action be taken to curtail industry, but that the engineers tell the manufacturers how adjustments may be made with the least friction and waste so that all their resources may be applied to the common good.

Horace B. Cheney, of Cheney Bros., South Manchester, Conn., wrote that it might very well be that the industries most necessary now for military success would be of the very least value at the termination of the war, and when that time comes we must not find our industry in a position from which it will be unable to arise and quickly meet the ordinary business of life. He thought it was possible to make a rough estimate of what the Government needs for war purposes, such as ships, munitions, clothing, food, etc., and what the civil population needs, beginning with food, clothing and shelter, and what the country needs or may need directly after the war and thus arrive at an idea of the relative value of industries. The best way to find out how an industry can be of most use in the war is through the trade associations, which are already in many instances conducting distribution of raw materials as well as furnishing information regarding stocks and needs of industries.

Past-President Hollis said he had never been able to distinguish between the essential and the non-essential industries. He said that while a great many of the smaller industries had been willing to make sacrifices and to help in the war, it had never been made quite clear how they could help best. He thought it was for the engineer to instruct the manufacturers and the public in that particular so that no industry would be sacrificed unnecessarily. He thought that one essential industry which the Government had more or less lost sight of was the "college industry." Up to this time no way has been found by which our boys who are being trained to take their places in the industries can be left free to obtain their training without the feeling or imputation that they are slackers. He thought that our Society could help out in this situation by educating the people as to what is best for the future.

P. W. Henry, vice-president of the American International Corporation, evidenced the absolute necessity of curtailing the manufacture of certain products if the Government is to carry out its war program. The Government should work on the public and emphasize the need of its limiting its purchases to bare necessities in order that the Government may have at its command the men and material necessary to produce the articles it requires. To this patriotic appeal should be added a system of taxation so drastic as to compel every individual to curtail his expenditures for non-essentials. This would not mean the cessation of the manufacture of non-essentials, for these factories could still continue their business for export, which is necessary in order to stabilize exchange. There would be a slump, of course, but every manufacturer of this class must expect to have his plant put on part time sooner or later, and it behooves him to get in touch with the Government to find out for what articles needed in the war his plant is particularly adapted. He, knowing his business, should take the initiative in bringing the Government and himself together on a mutually satisfactory basis.

Wm. Hamlin Childs, president of The Barrett Company, declared that there is no such thing as a non-essential industry. The non-essentials will be taken care of by arrangement between the parties interested—in other words, they will take care of themselves. A good many plants will do different things from what they have done before, but they must be preserved to go back to their old conditions after the war is over. He did not believe there was a class of men whose spirit was more energetic for the public good than the manufacturers of this country, and they should offer, and continue to offer, their advice to the country until this question of the industries is settled right.

Frank Mossberg cited the case of industries which were willing to take on Government manufacture, but found it difficult to get the work. Many of the small manufacturers were not in the position to go to Washington to secure an order, and therefore, if the case of these could be brought to the attention of the Government, something might be accomplished.

He mentioned that in southern Massachusetts some 10,000 people were employed in the jewelry industry. He did not know what would become of these people if their factories were closed down. He thought that if, on the other hand, they were given other lines of work which would be of service to the Government they would work harder than before. That would surely be much better than stopping their work entirely.

C. R. McMillen, vice-president of the Union Bag & Paper Corp., suggested more earnest consideration of the need of industrial coöperation as the means to the economic betterment of business. He considered that all business may be divided into three classes—directly essential, indirectly essential and non-essential. All productive business is essential, and every idle dollar or person capable of productivity is a burden on the nation. Labor employed in semi-essential or purely non-essential business may be unfitted for the production of essentials, and if unemployed becomes a carrying charge, a cost, to the nation. It would be well for the Government to issue bulletins indicating kinds of experience or labor, materials, buildings, plants, machines, tools, etc., wanted, so that all resources may be utilized where and in what manner they are most needed.

J. R. Haas, secretary and treasurer of Loft, Inc., New York, entered an interesting argument for the classing of confectionery as an essential since it was a food. He said that in 1906, when the pure-food law was framed, candy was included in its operation, and that in the city of New York the Department of Health maintains a pure-food division which inspects candy factories, classing their product as food.

Erik V. Oberg made an able presentation of the manner in which the problem of the non-essential industries had been handled in England. In that country they have not forbidden any kind of business; on the contrary, all kinds of business have been encouraged to go on exactly as in peace time, provided they can do so without taking material necessary for war purposes. Such manufacturers cannot get iron and steel, nor practically any other metals, so that in the iron and steel industries very little is being done except war work.

Mr. Oberg also described how England had handled the labor problem under the War Munitions Act, not a paragraph of which but was not first agreed to by the Government officials, the manufacturers' associations and the labor officials in joint conference.

Ellis L. Howland, one of the editors of *The Journal of Commerce*, wrote that the answer to the question what are non-essential industries depended entirely on the viewpoint of the judge. No man who has worked hard to create a working entity which has served the public likes to be told it is non-essential. It is not in normal times, but when our national needs are distorted it may be truly dispensable as compared with the one thing needful. The decision must rest with one power, the Government, and with its superior opportunities for knowing all angles of the situation, hasty condemnation of its decrees is not to be encouraged. Once a decision is rendered, however, common sense ought to dictate that any upheaval of normal conditions should be made partial rather than total. With business men sharing in the responsibility of necessary adaptation, better results will be obtained than when inexperienced dictation prevails and practical opposition stands in the way.

He believed the best way to win the war was first to arouse and inspire the patriotism of the business man, coördinate him with the Government, get to a common understanding and above all a mutual respect and confidence, and then let the business man carve out his details as he will.

Sterling H. Bunnell said that it is impossible to win the war without hardship. It is not to avoid loss of profits by the manufacturer and his organization that any should protest against the limitation of the work of any plant or industry, but rather it is to avoid reducing the output of the United States. We need every ounce of effort of every citizen. The authorities should never stop a man's work in one line without putting him instantly into another job more necessary. This condition is an ideal impossible of full attainment, but its attainment is worthy of a strong and continued effort. Let us think of the situation as needing not the limitation of non-essential activities. In this way every plant and every organization available for any part of the essential work of the United States should be utilized, and then the few remaining non-essential industries could safely be left to take care of themselves.

D. D. Jackson, professor of chemical engineering, Columbia University, said he wished to correct the impression that the Government has forgotten the colleges, and has considered them non-essential. As a matter of fact the Government has asked the scientific schools to pick out one-third of their men and have them enlist and then return to the college to complete their scientific courses.

As an example of what might usually be considered a non-essential he mentioned photography. He said that under the auspices of the War Department a war school of photography had been established at Columbia, and was turning out a hundred men a month for foreign service. He thought there was no question but what every line of business could be modified so as to be applied directly or indirectly to war work.

At this point the chairman called for a brief, sharp discussion of what the engineer was going to do in this matter of the industries.

Spencer Miller, in responding to the request, said it seemed to him that so far the meeting had been somewhat one-sided. He vigorously assailed some certain things as non-essentials, and said that if we did not school our appetites and eliminate these we would lose the war and would deserve to!

He suggested a higher degree of specialization on behalf of our manufacturers. One manufacturer should not make more than one thing, and should let other manufacturers take the responsibility for making other things. If they would do that they would be efficient and could do essential things.

Finley R. Porter called attention to a situation which he thought ought to be looked into in connection with the matters under discussion. He said that at the outset of the war he tendered the Government the free use of his factory which is making automobiles, but while his offer was courteously acknowledged it had never been accepted. The Government apparently takes the attitude it wants work in large quantities. He knew of dozens—he might say hundreds—of factories that cannot possibly get work from the Government. Mr. Miller promised Mr. Porter that he would see he got some of it.

Charles W. Barnaby said his impression of the object of the meeting was that it was to arrive at the best means by which each individual manufacturer of non-essentials might switch over to essentials. He himself was connected with the mechanical side of the ship-equipment industry. They had plenty of work, and he imagined most of the shipbuilders had; and he thought that any manufacturers in the East who were prepared to make parts of engines and similar articles could get plenty of work from the shipyards if they only went after it or let the shipyards know where to go after them.

E. J. Hubaux, an American of Belgian birth, referred very feelingly to the manner in which the peoples of the stricken countries have had to revise their ideas of essentials and non-

essentials. He said that while it was quite true that certain things, like food and clothing, were essentials, they were so only when used sparingly—just enough, no more. He thought we should draw a lesson from Belgium, where if they have sufficient bread to eat so as to keep body and soul together, that is enough for them.

Our aim is to win the war quickly, and everyone must co-operate. If the jewelers cannot make jewelry they can make something else—time fuses for shrapnel or precision parts for torpedoes; those who are used to making pleasure automobiles can make motor trucks or aeroplane parts.

F. A. Clawson, formerly associated with the Imperial Munitions Board of Canada, thought the point of view taken by that board was worth bringing out, and that was that there was no manufacturer in Canada who was too small but what he could be made use of. In one instance the Canadian Pacific Railway Company was given a contract for manufacturing complete shells, and instead of doing all the work themselves they got other plants in the vicinity to do whatever they could to help out. One company they went to, the Northern Electric Co., of Montreal, had only five or six lathes! He urged the Society to bring this possibility to the attention of the Government.

He considered it of little use to argue whether there are non-essential industries—there are lots of them. The main point is to win the war. If the Germans win there will be neither essentials nor non-essentials!

Andrew M. Coyle thought that what we can do to bring our industries into better correlation than they are, with the least disadvantage to those that are non-essential and with the quickest results, is to get the small industries, like the automobile factory mentioned by Mr. Porter, into action and service by some system drawn up by a committee which this Society would recommend, and then bring the matter before the officers of the Government.

Selby Haar said that since this was a Local Section meeting, matters would be simplified if everyone who had something to suggest would write to the Secretary, who would see that the proper action was taken.

Secretary Rice said he wished, if possible, to convert the impulses of the meeting into action, and he suggested that each industry represented should form its war committee. They should then have a representative from this committee get in touch with either Mr. Waddill Catchings, representing the U. S. Chamber of Commerce in this work, or Mr. George N. Peek, representing the War Industries Board, and form a clearing house through these officials so that the non-essential industries should get a chance to manufacture the things the Government needs. He thought that by this means the end sought would be attained.

W. Herman Greul said that Mr. Rice had given the suggestion that should lead into definite action, and he therefore moved that the Council of the Society be recommended to appoint a committee to take definite action toward aiding in the solution of the problem of the readjustment of the industries, leaving it to the committee to determine how best to carry out its work, but following somewhat along the line suggested by the Secretary of creating a body to do something the Government, apparently, cannot do.

The motion was heartily seconded by Mr. Miller, who observed, however, that too much expectation should not be placed upon the ability of such a committee to make a very great impression at Washington, where the officials were already overburdened with thousands of suggestions. After a brief discussion, Mr. Greul's motion was carried unanimously.

FUEL CONSERVATION

With Special Reference to the Saving of Coal in Connecticut, as Outlined by Prof. L. P. Breckenridge, of Yale University, and O. P. Hood, of the U. S. Bureau of Mines

A CONSIDERATION of one of the country's vital war problems dominated the first meeting of the newly organized Connecticut Section, held under the auspices of the New Haven Branch on November 14 last. An account of the meeting appeared in the December 1917 issue of The Journal. There were two sessions, both devoted to the subject of fuel conservation. At the afternoon session Prof. L. P. Breckenridge, Mem.Am.Soc.M.E., delivered a paper on the Problem of Fuel Conservation, in which he presented some very interesting data on the production of coal throughout the world and also, in more detail, the production in the several states of this country. He illustrated his remarks by charts which he later exhibited at the Annual Meeting of the Society and which were published in the January issue of The Journal. The paper called forth discussion from Professors Seward, Perry and Barker, and Messrs. R. J. S. Pigott and A. J. German. Mr. T. W. Russell, fuel administrator for Connecticut, also participated. The following resolution was adopted:

Voted, That the Connecticut Section of The American Society of Mechanical Engineers instruct the chairmen of its several branches to name a committee on fuel saving for their respective localities.

At the evening session Mr. O. P. Hood, chief mechanical engineer of the U. S. Bureau of Mines, Washington, D. C., presented a paper entitled Fuel Conservation by the Bureau of Mines, followed by a number of slides of the new Bureau of Mines Building at Pittsburgh. His address was discussed by Prof. E. H. Lockwood, Mem.Am.Soc.M.E., Mr. C. H. Bromley, Mem.Am.Soc.M.E., Mr. F. O. Wells, Mem.Am.Soc.M.E., and Professor Breckenridge.

The meeting closed with an address by the then President of the Society, Dr. Ira N. Hollis, on the part the engineer is destined to play in the twentieth century in the service of mankind.

Extended abstracts of the papers and discussions follow.

THE PROBLEM OF COAL CONSERVATION

By L. P. Breckenridge, New Haven, Conn.

Member of the Society

(Abstract of paper)

THE importance of fuel conservation is evident to all. We in the Connecticut Section of The American Society of Mechanical Engineers, who represent the five largest and

most important cities of the state of Connecticut, might well spend some time reviewing some of the features of the problem to see if we cannot think of some plan by which we can save coal.

First, let us consider general methods. The continued improvements in boiler-plant equipment have meant a great deal in the economical use of coal, but when improvements in equipment can no longer be made, the employment of better methods of firing and operating must be considered. Better methods of operating mean economical use of steam, for a very large proportion of coal is used in the making of steam. Practically all railroad coal, all steamboat coal and all public-utilities coal makes steam.

The whole question of the economical use of steam has been before the mechanical engineer for forty years, and methods have constantly been devised whereby steam can be saved. But the manufacturers have not taken this question into sufficient consideration for the reason that coal has always been cheap and, in the operation of certain industries, has entered into the cost accounts in very small quantities. But at the present time, when the price of coal has gone up and the quality is so uncertain, and when equipment which was suitable for a fixed quality of coal must serve for a fluctuating quality, the economical use of steam will of necessity have to be given much more consideration.

The question of using power economically is a very complex one, in that it is so intimately connected with the question of heating, and thus it is very difficult to say just what should or should not be done. All the large public-utility concerns are today manufacturing power for much less than ten years ago. This they are able to do on account of the careful attention and study that has been given to the economical use of power. It is fair to say that power generated in the larger stations has usually been manufactured at a much less cost per unit of output than that generated in the smaller individual plants, especially at times when the question of heating the buildings is not of prime importance.

It has been suggested that one way of saving coal is by substituting another fuel. But the question is, What fuel? All the oil that we have is needed, and gas is scarce; wood is a luxury for it costs from $8 to $12 a cord, and there is little else left.

The matter of not allowing coal to be used for non-essential purposes has been suggested. But how can one list the purposes for which coal should not be used and for which it should be used? For example, the Government has stated that if lights in cities were dispensed with, 250,000 tons of coal would be saved for the entire United States. And yet there is no one city that uses over one per cent of its coal for illumination purposes. Such an action might have a psychological effect and, if so, much is gained. It is not so much a question of saving the coal because it costs but because we cannot get it. One-third of the tonnage carried on our railroads is coal. Forty-three per cent of the tonnage that comes into New England is coal. Thus we should first devise means of *getting* coal, and then later the question of using it for essential purposes can be taken up.

This brief consideration of the general methods of coal conservation will help us to devise a plan whereby coal can be saved in Connecticut. The five branches of the Connecticut Section of The American Society of Mechanical Engineers represent five very important industrial cities. As a possible suggestion the chairman of each of these branches could appoint a fuel-saving committee consisting of three members who are familiar with the situation in their respective localities. These committees should put themselves into such a position that they could help, if asked, and would coöperate with the Government committees working on the same problem. For example, the New Haven committee might be asked to make a census of the industries in New Haven in order to secure figures as to how much coal they are using and to ascertain if they care to have some one come to their plants to look over their problem.

Again, a publication of the requirements of the fuel problem might be undertaken. A vast store of valuable material has been compiled by the Bureau of Mines and is available on application.

DISCUSSION

H. L. Seward emphasized the importance of keeping records in order to save coal, especially in the smaller plants. The large plants keep good records, and are more careful about such things, but for the sake of the smaller plants such records should be installed. No record system will be of much use unless one knows just what things to record. Some simple form can be devised on which can be stated the amount of fuel and water used. The total amount of coal can easily be recorded by counting wheelbarrow loads. When the daily forms are studied, the amount of coal used, the ratio of water to coal for a particular plant, and the operating conditions, can be easily ascertained.

Any system of records is bound to increase the responsibility of the man operating the plant. If he signs a report as to the basis of operation and repairs made, he knows that just where the responsibility begins and where it ends can be easily checked.

Perry Barker believed that in connection with the conservation of fuel in factories equipped with steam boilers, the question of the fuel loss which occurs in the operation is a matter which should receive attention, and which will ultimately show what saving can be made.

In the distribution of heat in the operation of a steam boiler, first, a large percentage of heat comes off in gas and is absorbed by the boiler; second, there is a large loss of heat up the stack during combustion; third, there is the loss due to unburned gas; fourth, there is the loss of combustible material in ashes and the material removed from the grates, and lastly, there is the loss due to radiation from the boiler.

These losses can be divided into, first, necessary losses, and second, those which can be controlled. The gases have to leave the boiler at a temperature at least as high as that of the steam in the boiler. All heat above that temperature can be cut down. By a brief computation it can readily be seen that there is a great loss of energy in a boiler plant; only about fifty per cent of the heat in the fuel goes into the boiler, and fifty per cent is lost. Seventy-five per cent of that fifty per cent could be controlled. Simple methods either in changing the form of operation or changing the equipment have reduced it 10 to 50 per cent in certain cases.

The three principal controllable losses are loss of heat up the stack, the loss due to unburned gases, and loss in the ashpit.

In considering the stack loss and the unburned-gas loss, the process of combustion should be reviewed. Coal is thrown into the fire and products are distilled off and pass through the furnace. They are burned with the air that comes through the grate or over the fire, and should go out of the stack at the boiler temperature. However, if in their passage through the furnace they do not come into contact with sufficient air or are

improperly mixed, or have their temperature suddenly reduced, they leave in an unburned condition. This is an incomplete combustion, not that of mixing gases and air, but the incomplete combustion due to the gases passing up the fuel bed. This is the well-known water-gas reaction. The carbon dioxide formed in the fuel bed passes forward, is reduced to carbon monoxide, and that in turn passes through the furnace. This sounds somewhat foreign to boiler operation, but it is surprising to find that on careful analysis many cases which were believed to be due to insufficient air supply are due more directly to the process outlined above. By examining the composition of the average fuel gases, we see that there is a possible fuel loss of over 16 per cent. Figures on the analysis of gases through the furnace show the combustion loss to be six-tenths of one per cent.

What can be done to control the loss of heat in boiler operation? The three different elements concerned are: first, the type of fuel used; second, the firing efficiency, and third, the design and equipment. In these times we cannot complain about the kind of fuel. The fuel is very inferior, but it is all we can get. Some New England plants are adapting themselves to the use of the coal they now have to use, and it is a patriotic duty as well as a necessity.

As to firing efficiency and equipment, these are very poor times to go into the market for new boiler equipment. Boiler and heating changes which can be effected in any plant are purely a matter of expediency. In a plant where the boilers were run ordinarily with about 10 per cent carbon dioxide, there was a fuel loss of about 4 to 5 per cent. The boilers were raised about 2 ft. and some arches put in, and they have since maintained continuously 14 per cent carbon dioxide with no trace of unburned gas.

Another element which makes for poor boiler efficiency and which can be easily reduced is leaks and dirty water receptacles. Those are the places to look for trouble when the temperatures are high. The question of air leaks in the boiler setting is another item which of course has received the attention of all. As good an instrument as can be found in the small plant for testing this is a lighted candle passed over the outside of the boiler once a week.

In conclusion, coöperation between management, engineers and firemen is one essential feature in the conservation of fuel. There are hundreds of engineers who are ready and willing to report the conditions under which their fuel is used if they have the proper backing of the management and the available material by which they can interpret the results which they obtained.

R. J. S. Pigott said that the fuel situation had simmered down to a question of boiler operation and better methods of combustion. In this section of the country the best way to insure this is to use the underfeed-stoking method. During the last five or six years the use of this has grown with leaps and bounds, the reason being the much better method of combustion which is obtained. The old feeds on such coal as we now obtain would be even less satisfactory. As an instance of what the difference is, Mr. Pigott said he knew of a station that changed to underfeeds on some boilers and whose coal factor dropped 12 per cent as soon as the change was made. The station was one of the best-operated ones in the country, but it could not compete with the underfeed.

Two of the principal features of the system are that there is a proper mixture of air and a higher temperature during the period of combustion. The air is blown through the fire so it has a chance to mix with the gas on its way to the surface of the fire, and the lumps of coal act as a mixer. Then in its further passage it maintains a higher temperature while combustion is going on, and the use of equipment resolves itself into a matter of extensions, and the only way we can put in suitable equipment now is to put in extensions. We must turn to the underfeed stoker, and for industrials, at least, great consideration should be given to turbines and making use of low-pressure steam instead of high-pressure. There is no engineering excuse for the use of high-pressure steam in power plants such as we find all over the New England states. Most of our operations could be carried on with low-pressure plants as well as with high-pressure plants.

We find operation after operation run on high-pressure that can very well be put on low-pressure steam. We find dry kilns and other operations allowed to run over the Saturday and Sunday rest periods, thus wasting the steam. In one plant in Bridgeport the over-pressure load on Sunday is maintained and wasted. The use of steam in other connections can be made equally wasteful. The use of steam engines in shops should be discouraged; it is much better to develop all the power in a central station than to have the engines scattered all over the shop.

A. J. German believed that at very slight expense coal can be burned more economically in a furnace by sloping the brick wall of the furnace instead of having it straight. By having the wall straight it becomes very hot, and all the gases that are coming up, instead of having a free passage, strike the wall and ignite. The condition of the combustion can be improved very simply in this manner.

Another way of saving coal is to try to find the number of boilers that can most economically carry the various loads. Take a factory load that is fairly constant during the day and is less constant at night. There are a number of boilers in the factory, and the question is, How many are the most economical? That must be found out by testing the whole plant, and the best thing to do is to start with the full number of boilers and cut down one boiler, then run through the week and average the coal used. Then cut down another boiler, and so on, until the number you can run most economically to carry the varying load is found.

T. W. Russell, State Conservator of Coal for Connecticut, said that every communication from Washington on the general situation is to the effect that there will be enough coal to go around provided the maximum possible amount is mined, and then the largest possible efforts made in the way of economy and efficiency. Here at this end of the line there is nothing we can do to increase the production at the mines. The increase at the mines is rather sharply fixed by the physical limitation of the number of coal cars, and the underlying cause of possible fuel trouble in this country is the physical shortage of coal cars. Therefore it seems at this end of the line we must devote our efforts toward securing more equal distribution of coal, and that the greatest efforts and most fruitful efforts can be put in along the line of increasing the efficiency of every pound burned.

Mr. Russell agreed heartily with the suggestion made by Professor Breckenridge that committees be appointed from the Section to work toward the increasing of efficiency. The state administration office has given considerable time to this question. It has almost completed the appointments for the state committee on coal conservation under the chairmanship of Mr. Charles G. Bell.

The Connecticut Section can do much during the coming months. The poor coal dealers have been filling out blanks much more than they have been endorsing checks during the

past two months. The Federal Trade Commission has made a survey in order to get a number of facts from each of the coal dealers. But in our work there is, unfortunately, an absolute necessity for us to come back to these men for almost the same information they have already given to the Commission. This information is buried away in Washington so far as any immediate availability for us is concerned, and it is very much quicker to write to Mr. Pigott at Bridgeport than to write to the Federal Trade Commission for it. I hope it may be possible to unify matters so that there will be no duplication of work.

The coördination of work should be considered very seriously. There are a number of organizations that are interested and are working more or less independently, but we must not have too many committees and too many blanks to do good work. Instead of having a local committee of The American Society of Mechanical Engineers in New Haven and a local committee of the Chamber of Commerce, and possibly a few other local committees, it would be more logical and more efficient to have all the work coördinated.

FUEL CONSERVATION BY THE BUREAU OF MINES

By O. P. HOOD,[1] PITTSBURGH, PA.

Member of the Society

(Abstract of address)

I HAVE been asked to speak about the Bureau of Mines and what it is doing for the conservation of coal. The function of the Bureau is not always understood. We have certain limitations—as far as the fuel of the Bureau of Mines goes, we are limited to the fuels belonging to or for the use of the United States Government. Instead of being a research laboratory for the general public, we must perform that function indirectly. The work of the Bureau of Mines is primarily for Uncle Sam, himself a fuel user. As a user of something like eight million dollars' worth of coal a year in normal times, the Government has a somewhat varied fuel problem.

At the beginning of the war our director asked me what the Bureau could do to adapt itself to the particular situation. Was there a new gospel to be preached? Was there something new and startling that ought to be brought out? My reply was that it was the same old gospel that had to be preached, that it was only a question of different values and different emphasis, but that our problems were exactly the same problems that we had been working on for years.

The Bureau is taking the stand just at present, as every engineer would, that this is not the time to try new experiments, and to look for relief from some new invention, or from some new way of doing things, but we must draw on the well-known and well-tried methods. If each one of us operating a power plant or having anything to do with the fuel problem would do as well as we know how to do without any further instruction, without any more technical information, we could save about ten per cent of our fuel. Perhaps we cannot save that a year from now. People are getting busy; the higher price of coal has forced them to take this gospel more seriously than they have before, and so the problems of the Bureau of Mines are not so essentially different in these war times.

Formerly we were trying to make war on waste, trying to find out the fundamental principles involved in the use of coal and to get people to believe that what we found out was so. The emphasis, however, of the work has been greatly changed. The Bureau believes, or has believed, that educational methods were in the long run the sure methods. There is a growing sentiment which comes to the ears of the Bureau from a great many directions that under the present condition of things some power must be used. It is only a veiled reference to the "big stick." It seems manifestly unjust, if we are to be limited in fuel, that in the same industry two plants, one of which is using its coal inefficiently and the other efficiently, should be treated in exactly the same way and given the same amount of coal. It seems as though there should be some distinction. It would mean going into the plants and finding out the facts. We who have tried to find out facts about a very simple plant know what it costs, know what a tremendous job it is, and how poorly equipped most plants are to give out facts with regard to their coal consumption. The educational processes are of immediate value, at any rate, although they may not be the only means which may have to be applied. These processes must be speeded up; they must be carried on with a magnitude which we have never conceived of before.

General publicity and the creation of an atmosphere which will be favorable to fuel economy, rather than against it, will help in that it will apply to about 20 per cent of the coal mined, and about 20 per cent of the coal is domestic coal. We must influence about twenty million people in order to save a piece of that 20 per cent. Suppose that they could save 10 per cent of it, that means 10 per cent of 20 per cent, which is, roughly, 2 per cent of the whole. To interest that twenty million people means publicity, placards, advertising, and all of the methods the Food Administration employed, for example.

About 63 per cent of the coal mined is used for producing steam. It is used by probably a quarter of a million firemen, and if we could influence and train that quarter of a million men to do their best, we would be doing a valuable thing. In order to reach that quarter of a million firemen who have the coal on their shovels, educational methods on a large scale must be used again. Like all good teaching, this cannot be done by correspondence-school methods, and at long range. It cannot be done by talking about fuel economy as an art. It is a practice. You may read about the fundamental principles on which it is based, but ultimately you must be taught by the hand, and taught at the furnace in just the same way that blacksmithing is taught at the anvil.

The particular work of the Bureau perhaps can be divided into three main headings. There is the purely research work, the attempt to find out things which we did not know before. For that purpose laboratories have been provided. The work has been going on for a good many years, but it is not going on as vigorously today as we could wish. The Bureau is faced with exactly the same conditions that every employer of labor is facing. We are losing our men, we are breaking in new men, and we no sooner get them broken in than they leave us to go to somebody else, and the solution of our problem is thus interfered with. Above all, the Bureau is adapting itself to the new problems which are being presented to it because of the exigencies of the war. A new plant is just being completed in Pittsburgh, and it represents in round numbers about a million dollars. The plant is given up very largely to fuel work, and it is the exponent of the fuel end of the Bureau of Mines.

Another line of work in the Bureau is the purchasing of coal under contract. The Bureau is known to a great many through this activity more than any other, perhaps, in that

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the Bureau has stood for the purchase of coal on specifications drawn on the basis of B.t.u. It is almost needless to say that under the present conditions the contract has gone glimmering. We no longer think of B.t.u.—we have gracefully retired for the time being, but we will come back stronger than ever when this trouble is over. Fundamentally, the basis is right, but the country is faced with a situation which we have had only once before: namely, we have a sellers' market instead of a buyers' market, and it is only a buyers' market that can talk about B.t.u.

I looked at an analysis the day before yesterday of coal delivered to a Government building. It had 26 per cent ash and 23 per cent moisture. Of course, we realize that the pressure to increase the quantity of coal mined has been severe, and that in the speeding-up process anything black has been called coal. Coals which run around 8 per cent in ash in normal times are now running in the neighborhood of 12 to 15 per cent in ash, and if that extra 5, 6 or 7 per cent ash in the coal applies to all of the coal mined, it means that the apparent increased production in coal is not an increase in coal, but an increase in ash.

Professor Breckenridge's experiments at the St. Louis Exposition seemed to show that in the coals used out there, for every 1 per cent of ash increase in the coal the efficiency of the good coal was reduced about 1½ per cent. There is no absolute figure for that—it will vary anywhere up to 2 or 3 per cent. But suppose there is 7 per cent increase in ash and 10½ per cent decrease in efficiency due to the ash, it can easily be seen what that means to the coal problem.

It can be seen that when one of the great central-station managers made the statement that to produce the same effect his plant was compelled to burn something like 20 per cent more of the stuff they were delivering as coal than they used to burn, it is a serious thing.

Our mining people are beginning to realize this, and they are going to do better. The miner himself has not realized that he was tying up a good many coal cars to haul ash, and that many of his efforts were vain in giving us that stuff.

There is another phase of the Bureau's work. The fuel work of the Bureau was intended to apply to coals belonging to or for the use of the United States Government. We are well aware that if they have any gospel to preach we ought to practise it at home or in our own plants. In the Government plants in general there should be some reasonably high degree of efficiency. There are a number of Government organizations that are very efficient in their steam practice, among them the Navy and Treasury Departments. But there are some organizations of the Government that treat the coal problem just the same as they would the wrapping-paper problem. Coal was cheap, of course it had to be bought, and there was little or no strong organization at the head of the engineering side.

The Bureau of Mines acts as a consulting engineer to the other Government bureaus when they call on us for help in that way. That keeps a number of men busy. For example, over a year ago the Assistant Secretary of the Interior, who had the Bureau of Mines as part of his charge, came to the conclusion that it was not a wise and economical thing to send anthracite coal to Montana, Idaho, Colorado and New Mexico in order to heat the Indian schools; that most people who live out there had to burn local fuels, and he could not see why the Indian schools could not do the same thing. Blanket orders were issued that no anthracite coal was to go west of the Mississippi or north of Kansas. It was proved conclusively that they could not keep a fire over night unless they had anthracite coal. The Bureau had never thought before of trying to contradict this, but now we bought an ordinary hot-blast stove. We had small supplies of coal from all over the world there at the plant, and we proceeded to prove, to ourselves, at any rate, just what kind of a heat curve we could get if we would learn how to use that ordinary hot-blast stove, which we could recommend to an Indian school. I cannot reproduce the curve for you, but you will be interested to know that it is not so very much of a trick to learn how to use those western coals from North Dakota and Wyoming so they can keep a fire just as well as you can in an anthracite burner. Further than that, one can get a temperature curve from the heating surface of the stove that compares very well with anthracite burners. In other words, the Bureau knows that it is just a matter of knowing how.

The Bureau of Mines has to do with the conservation of its own fuel and its own plants for the Government service. Lately there has been a change in accent in the Bureau's work. It was perfectly evident that this was the psychological moment for the propagation of right doctrines; that this was the time when fuel problems must be discussed on a sound physical and economical basis. The air is full of fuel fallacies. As an illustration, I was in Tennessee about a month ago looking over a number of plants there, and I ran across a number of instances where they were following the fallacy that what you need is to get the fire up close to the boiler so it will absorb heat. What was the use of having the boiler way off from the flames? They wanted the flames to hug the boiler!

In all this work there is going to be a large amount of publicity on fuel matters which will help to eliminate the most glaring of the fuel fallacies and will educate the public in the proper facts of the matter.

Just what can the Bureau do in publicity work at this time? It is limited in its funds and it cannot send out literature broadcast. If one wants anything the Bureau has, one must write and ask for it, and can have just one copy. Now it is evident that we cannot carry on a great fuel propaganda under such circumstances.

A number of organizations in Washington believe it is their duty to feature fuel propaganda. It is perfectly natural, perhaps, to expect that the Fuel Administration should do that, and almost equally evident that the Bureau of Mines should do something of the sort. The Geological Survey has been doing something of the sort for years in its particular field, and so has the Chamber of Commerce. The Food Administration is in the fuel game for perfectly good reasons. The Department of Agriculture in its domestic-economy work, which applies directly to the farmer's wife, is considering the question.

In this time of stress the engineering societies ought to do something in this field. The members of these societies have the technical information to give that will set the thing going correctly. It is desirable that in some way the technical information given out shall be consistent. It is not desirable to have anything advocated in one way in one place and another way in some other place. The proper function of the Bureau of Mines at this time is to try to influence the sources of information to publish fuel propaganda; to act as consulting engineers to any of these organizations that we can induce to let us see their manuscripts.

It would be presumptuous for the Bureau of Mines and its limited staff of engineers to perform this function alone. We want the backing and we want to be able to reflect the knowledge and good judgment of the engineers of the country, and so there has been appointed by the Engineering Council

committee from the engineering societies to act as controlling engineers to the Bureau of Mines in helping to guide the technical information which is being disseminated.

DISCUSSION

E. H. Lockwood related some experiments he had made in his laboratory on keeping the doors of the boiler open and seeing what effect this had on the temperature of gases leaving the boiler.

In making some tests with a small boiler, he found that when he closed the grates in the door he got a certain temperature, and when he opened the grates 1/8 in. the thermometer went up 10 to 15 deg., which implied that air coming in the front door made a hotter fire. He opened the grates still wider, and the thermometer began to go down, and it was perfectly plain that in order to get a maximum temperature he had to move the grates in the door open a certain amount.

C. H. Bromley said that the engineers have been preaching and learning how to save coal for many years, and yet they know nothing about burning coal economically! The magnitude of the waste must be brought home now with sufficient force to make us do what we already know how to do. That is the chief problem, and is the reason for wide publicity that will move men to do what they know how to do.

Any man who knows steam-boiler work knows that 20 per cent of the coal burnt under them is wasted. That is a very conservative estimate; we could say more accurately that the avoidable loss in steam production is 35 per cent to 40 per cent. But to be conservative call it 20 per cent, and we have a loss of 45,000,000 tons avoidable waste per annum. Reducing the figure to \$5 a ton, we get an average figure of \$225,000,000 as the money loss per annum.

Another serious loss that occurs in boiler operation is due to the design of the stoker. The stoker has been brought to a very fine state of perfection, but unfortunately no stoker builder has incorporated in his particular stoker the two features necessary to make his machine perfect commercially. The losses due to the combustion in the ash are running now, in the average well-conducted plant, from 20 per cent to 50 per cent. Some stokers have air admission to the dump plate, many of them have not; some have clinker breakers at the clinker or dump grate to break up the clinkers with the air admitted in the fire bed of the stoker. What is wanted is a combination of air orifices or openings that will not clog up, and through which air will be admitted directly to the clinker as it is formed, so that we may burn the carbon up. It was estimated several years ago that Germany was losing approximately 4,000,000 tons of combustible a year due to losses in the ashpit. Our loss in that respect is running very close to 8,500,000 tons of combustible. These are staggering figures, such as we need to stimulate us to action. That 45,000,000 tons, which may be taken as fair waste, means not only money loss, but it means tying up approximately 900,000 fifty-ton cars, a very serious thing.

In the Rainey resolution introduced before Congress in May 1917, it was alleged that over 200,000,000 tons of coal a year are wasted in mining. The eight-hour day granted in May 1916 is responsible for that loss in production. It has amounted in five months in the anthracite industry to over two million tons of coal, and if you look for the anthracite mines on the coal map you can find them. The big problem seems to be at the present time to learn how to burn lower grades of fuel. That must be done through stokers or through better coal. We will have to be moved to action by startling figures so that we may do what we know how to do.

INDUSTRIAL PRODUCTION

A Few of the Elementary Principles of Increasing Production and Decreasing Cost in a Medium-Sized Manufacturing Plant, and at the Same Time Promoting the Welfare of the Employee

By William M. Dollar, Buffalo, N. Y.

Member of the Society

Any scheme of industrial production to be efficient must embody, among others, the following points:

1 The proper purchasing of the proper raw materials
2 The storing of this material so that it will be safe and accessible
3 The rapid and economical transfer of material from the stock room to the factory as needed
4 The progress of material from machine to machine and department to department with a minimum of handling and without congestion
5 The maintenance of a proper system of inspection of work in progress
6 Forms, transfer cards, etc., that require nothing in filling in but the ability to read and make legible figures
7 The handling of time cards first by a man familiar with shop details
8 Remuneration that will bring out the workman's best efforts in regard to quality and quantity of output.

Abstract of paper presented before the Engineering Society of Buffalo, October 31, 1917.

Purchase of Raw Materials

The proper purchasing of the proper raw materials is a commercial matter. It means buying the right quantity at the right time and at the right price, and is largely a matter of judgment which almost amounts to instinct in some men. Regarding quantity, the man who buys should be in close touch with both the sales and the production ends of the business. Buying a large supply of a certain raw material at a low price is of absolutely no advantage if the interest on the money required to make the purchase offsets the saving before the material is used up.

Proper raw materials should be specified by the production or engineering department; many a 2 per cent off has developed into 10 per cent *on* because the goods were not proper for the use to which they were to be put, and the purchasing

agent will usually benefit by taking the advice of the man in the shop, since three times out of four the latter will be right.

Storing Raw Materials

The arrangement of the raw-stock room must be such as to require a minimum of effort both in getting the goods in and passing them out as required. The specific arrangement and construction of the various bins and racks depend on the character and quantity of the goods, and these in turn on the requirements of the business. Only the most general rules can be laid down, as the details of each store room must be worked out to suit the particular case. Accessibility, visibility and cleanliness are important points to keep in mind, and no sacrifice of these should be permitted. A stock room is built but once, but is used every day for years, and the manufacturer can well afford to spend whatever may be necessary to get the best and most economical arrangement and construction.

Equally important is some method by which the stock man can tell at once the exact quantity of a given material on hand, and this, too, with the least labor, clerical or otherwise. One of the easiest ways to accomplish this is by means of a card index consisting of the standard 3-in. by 5-in. cards, with columns for "Date," "In," "Out" and "On Hand," respectively.

The Moving of Material

The rapid and economical transfer of material from the stock room to the factory as needed is emphatically a problem that must be worked out according to the conditions. How the material is handled, whether loose, in bundles, barrels, tote boxes or singly; and whether transported on barrows, trucks, motor trucks, hand trolleys, monorail or traveling crane, depends on the material and the character of the buildings. The less man power used, particularly under present conditions, the better.

The progress of the material from machine to machine and department to department must be effected with a minimum of handling and without congestion. All movements of material should be in one direction, and in as nearly straight lines as possible, from the raw-stock room to the assembling floor, the finished-store room, or the shipping department, whichever its ultimate destination may be. Means should be provided to trace the progress of all material through the factory so that just what progress is being made may be known and the responsibility fixed for any delay.

Inspection of Work in Progress

A proper system of inspection of work in progress must be maintained, as it insures against unnecessary labor on spoiled or defective parts, and also permits steps to be taken at once for the replacement of these parts and avoids delay in the final assembling.

It is not always, or even usually, necessary to maintain an inspection department for this work. Each operator can inspect the work done when the part comes to him, and if it is made to his interest to do so, and to his detriment not to do so, the inspection will be even better done than by the class of help found attached to many inspection departments.

In one instance that comes to mind, where the product was particularly well adapted to piece work, the management hesitated to install it on account of the cost of the inspection. A system of bonuses for the detection of errors and fines for failure to detect them was worked out, with the result that not only was the quantity of the output largely increased but also its quality, while the cost was very materially lowered—and this with all the inspection done by the regular machine hands and assemblers.

Simple Forms Desirable

Nothing beyond the ability to read and make legible figures should be required in filling out forms, transfer cards, etc. Shop men are not bookkeepers, and they usually resent all attempts to make them such. Where conditions are right, some form of time stamp can be used to record the beginning and ending of a given operation; if this method is not practical cards can be so designed that all the workmen has to do is to record the exact start and finish time.

Whatever form these records take they must be used as the foundation not only on which costs are built but also on which the payroll is made up. The workman is not interested in costs but he is vitally interested in the payroll, and if he is obliged to give correct data for compiling costs in order to insure the correct amount in his pay envelope, he will be very careful in filling out his time cards.

Time cards on reaching the office should go first to some one who is familiar with shop details. While the correct number of hours may appear on the card, the time may not be charged to the right job. The man who first handles these cards should be so familiar with the shop that he can not only judge whether the time has been charged to the proper order, but also whether the time so charged is reasonable for the work done. If he is in doubt the card or cards can be at once returned to the shop for correction while the matter is fresh in the minds of the foreman and the workman. This will avoid the recording of incorrect data. Millions have been spent in the shops of this country in the last twenty years by laboriously recording erroneous cost data, because the man who made the record did not know whether the data were correct or not.

While the recording of cost data is a clerical job and properly belongs to the accounting department, the collecting of cost data is an engineering job and must be done by men trained in the practical work of the shop; men who can tell at a glance whether the particular work specified was performed on a given piece, and whether the time alleged to have been so spent is reasonable for the work done.

Erroneous costs, like erroneous drawings, are worse than useless. Not only is the time spent in their preparation wasted, but they lead astray men who without them would usually come out all right by the exercise of their own common sense.

Remuneration Should be Measured by Output

The remuneration received by the workmen must be such as will bring out the best there is in him both as to quantity and quality of his output. I sometimes think that the whole scheme of remunerating human effort is wrong. We pay by the hour, the day, the week, and occasionally by the year. What we are attempting to get is the product. Why pay this man so much for a hour of his time when what you really want is inlet valves, or that man so much for a day of his time when what you want, and all you want from him, is camshafts?

While human nature is as it is, the paying of so much money for so much time will only result in an effort on the part of the employer to get as much as possible for as little money as

possible, and on the part of the employee to get as much money as he can for the smallest possible output. While the workman is taught that the wealth of the world is the result of his labor, he has not been taught that if he shirks his task he detracts just so much from that wealth and consequently from his share of it, so that in the end his shortcomings come back on himself.

What we all need to bring out the best there is in us, is incentive. Under the time-wage system there is no incentive for any man to do more than is sufficient to keep the boss off of his back and hold his job. To those who are troubled with this problem, and with the prevailing idea of making work for as many men as possible, a very potent remedy is an opportunity for the man to add a dollar or two to his weekly earnings in return for a little extra effort. Get away from the idea that there should be a limit to what a man may earn in a given trade. Let the workman understand that you require output. The more pieces he finishes, the lower your cost. If he doubles his output, as he can and will in many cases, your cost per piece is much less, as you have twice the output with practically the same overhead.

How to accomplish this is a matter each manager must settle for himself. There are innumerable schemes under all sorts of names. Whether you use straight piece work, differential piece work, the premium plan, a bonus system or what not, depends on your conditions. While there may be no best system, generally speaking, there is always a best system for each individual plant. There should be no antagonism between employer and employee, their interests should be identical—namely, to add the greatest possible amount to the wealth of the world in order that they may have the greatest possible comfort and enjoyment of it.

To get the best of competitors, make the pay and the working conditions in your plant better than those in any other plant in your line. Get the good men, give them a chance to earn all they can on some equitable plan, and they will do the rest. When you set a price for a piece of work, be sure that the price is just, and then stick to it no matter what the earnings may be. Much of our trouble, and much of the antagonism shown by labor organizations to all forms of piece-rate and profit-sharing payment for labor, is the direct result of improper rates, fixed through lack of knowledge of what can be done, and lack of moral courage on the part of the employer to stand the consequences of a situation brought about by his own ignorance or carelessness.

Planning, Routing, Etc.

So far we have been considering only what is applicable to the small and medium-sized shop, which, in the aggregate, covers a large percentage of the total production. The large shop is in a position to go very much farther along the lines of planning and routing than the small concern can.

There is one best way to do every job in a given shop. There is one best machine for the operation, one best sequence of operations, and one best tool and cutting speed and feed to use. If the material is purchased on rigid specifications, so that it comes uniform, it is perfectly practical to have a planning department which will give to the shop the sequence of operations, the machine to be used for each operation, the cutting tool to be used, and the speed and feed under which it shall be operated.

In the small shop, whether it operates its own foundry or buys its castings from a jobbing foundry, the castings do not usually come of such uniform texture as to make this planning practical. The most feasible plan in a shop of this size is to have the foreman do the routing, and put the entire sequence of operations, together with the character of the tools, speeds and feeds, in his charge. With a competent man having the necessary data in charge of the routing, and material of uniform texture, very satisfactory results can be obtained.

The machine shops of the country owe a deep debt of gratitude to the late Fred W. Taylor and his associates for their work along these lines. Mr. Taylor's paper before the A. S. M. E. on the Art of Cutting Metals is a fitting companion to his former paper on A Differential Piece Rate. The only trouble is that neither of them is applicable in its entirety to any shop, and their introduction into a given shop must be in the hands of men who will select only the part which is practical in that shop. While the modern tool room and the idea of having all tool grinding done in the tool room and not by the individual workmen is the proper thing in the larger shops, it is not practical in a large majority of the small and medium-sized institutions. The solution of the problem in the smaller shop is competent supervision.

It should be the principal duty of the department foreman to see that proper feeds and speeds and proper cutting tools are used on every job. In many shops the foreman is expected to do routine work himself. Any man who is competent to act as foreman, and has charge of more than five or six men, can be of more value to the firm if he spends his entire time in the direction of the others. He should have his finger on every man all the time, and do for his gang just what the planning and routing department would do. If he is the right man for the job he can do this better than any centralized department, because unexpected complications are bound to arise which a competent foreman can straighten out immediately.

Jigs and Fixtures

Just how far any shop can afford to go and how much money it can spend for jigs and fixtures depends on the class and character of its work. On standard manufacturing, proper jigs and fixtures will permit the work to be done with practically unskilled labor, and the modern tendency is to make machine hands and not machinists—the employer has probably gone entirely too far in this direction. With proper jigs and fixtures and a proper tool-room equipment, any man of ordinary intelligence can soon be taught to perform a certain operation or operations so that his output is all that could be accomplished by the most expert machinist. There has been altogether too much of a tendency to consider the operator as simply an attachment to the machine. The idea is that once a green man has been broken in to perform certain operations, he can earn a fair wage on these operations though he be almost worthless on any other job. This is a shortsighted policy and the machine shops today are suffering from it. The workman feels that he is simply a part of the machine. In order to earn a living wage he must stick to the little job which he has been taught to perform, and he resents the treatment. A dissatisfied employee is never profitable, and the sooner the employers wake up to this fact the better for all concerned.

While it is true that this is an age of specialists, is it not also true that before a man can be a specialist on one phase of a given occupation he must first have a good general knowledge of that occupation as a whole? Is it logical to expect to make a specialist on the cylinder-boring machine who has no knowledge of the rest of the machine trade? A man may be an expert in doing a certain thing so long as the conditions are

uniform, but the moment he is confronted with some unusual condition he must fall back on his general knowledge. In machine work, as in every other line, the larger a man's general knowledge of the business, the more expert he will become in some special branch.

The above is a brief statement of the principles upon which successful industrial production is based. Although most of them are self-evident, there is danger of losing sight of them in these days of abnormal conditions. To obviate this danger it might be well to append the following heresies:

a The shortening of the working day has been one of the most serious drawbacks in the effort toward increased production and lower cost. It has been detrimental alike to employer and employee.

b None of us can produce enough in eight hours to enable us to live as we want to live and enjoy the luxuries we have grown to consider necessities.

c American supremacy in manufacturing has come largely through ability to judge what was good enough for the job. Those who waste time and money trying to find whether a given job cost \$9.42 or \$9.47 fail to realize that all costs are only a more or less close approximation, and that the same job can never be duplicated at exactly the same cost.

d Our whole scheme of making machine hands is wrong, and unless we get busy and revive the almost extinct species called "general machinists" we are going to lose out in the race for mechanical supremacy.

e In spite of our boasted ingenuity, our present enemies had us beaten mechanically because they trained men for the job for which they were best fitted. Unless they are all killed off or we change our ways they will do it again. You cannot make a superintendent out of a man who has only the capacity of a gang boss.

f We must get away from the fads now in vogue, and must employ men to fit the job.

CORRESPONDENCE

Contributions to the Correspondence Departments of The Journal by members of The American Society of Mechanical Engineers are solicited by the Publication Committee. Contributions particularly welcomed are suggestions on Society Affairs, discussions of papers published in The Journal, or brief articles of current interest to mechanical engineers.

The Crippled Soldier

To the Editor:

"Though far apart, we're one at heart,
In the homelands of the free."

It is for the second reason that I wish I could have been present to listen to and discuss in person the interesting paper on the crippled soldier read by any old friend, Major Frank B. Gilbreth, E. R. C.

For the past 1000 days or more we in England have suffered in spirit with the maimed heroes back from the front, and have had daily ocular proof of the urgent necessity of supporting any movement to make them, where possible, healthy, happy and productive citizens again.

Much has been done, but plenty of scope still exists for the engineer, the scientist and others to exercise their talents in devising improved methods and channels to assist the ever-growing army of sufferers, whether victims of the war or of industry, and I hope that all classes of society in the allied countries will enter heart and soul into the campaign.

In Europe, where scientific management and motion study have not yet made the headway we could wish, its teachings being unknown to the majority, greater difficulty in establishing Major Gilbreth's recommendations will be encountered than in the U. S. A., for you have already introduced and are profiting by accurate measurement.

I feel sure, however, that when you have shown what can be done, we shall be glad to avail ourselves of your practical experience and achievements. To instance the prejudice and lack of imagination existing here, I quote from a reply written recently by a Government department whose attention had been drawn to some of Major Gilbreth's instruments of precision:

"Although these matters have obviously considerable interest in appropriate spheres, it is not thought that such apparatus as is described presents sufficient advantages and utility from the point of view of possible assistance to crippled soldiers as to justify any further action being taken in the matter."

The pity of it!

Nevertheless we must not be discouraged, but must keep on hammering away until the rust is dispersed and the true metal appears. We know it is there, and that sooner or later it must be reached, and, as a result, the lot of all cripples made more contented and easier.

James F. Butterworth.

London, England.

Cooling of Water

To the Editor:

The curves of cooling efficiency in the paper on The Cooling of Water for Power Plant Purposes, presented by Prof. C. C. Thomas at the Annual Meeting, are of great use in predetermining the size of pond for a given duty. It is questionable, however, if the expression connecting efficiency and temperatures: namely, $E = (T_1 - T_2)/(T_1 - T_w)$, is applicable outside of certain narrow limits of wet-bulb temperatures T_w. Some readings taken recently on a Thomas nozzle in cold weather were as follows:

Temperature of hot water, deg. fahr.	115	91
Temperature of cold water, deg. fahr	85	68
Temperature of air, deg. fahr.	31	26
Pressure at nozzle, inches of mercury.	8	10
Efficiency, per cent.	36	35
Character of spray	Fine	Fine

In calculating the efficiency the wet-bulb temperature was assumed equal to the dry-bulb. For the same conditions the chart of Fig. 9 indicates efficiencies from 55 to 65 per cent. In other words, if this chart were used to predict cooling for winter conditions, temperatures of sprayed water would be indicated much lower than those actually obtainable.

This phenomenon can be explained by the fact that cooling by evaporation goes on less readily in cold weather than in

warm. Thus, suppose the air rising through the spray is heated 25 deg. fahr. Then the volume of air required to take up 1 lb. of moisture or "absorb" about 1000 B.t.u. will be as follows:

Air required, cu. ft.	2500	1800	1300	1000	750	600	500
Wet-bulb temp., deg. fahr	30	40	50	60	70	80	90

In warm weather only one-third to one-fifth as much air is needed to take up the same heat.

This decrease in relative efficiency of cooling was noted some time ago in the analysis of cooling-tower performances. For this purpose a coefficient of heat dissipation was used, equal to the heat units per hour per degree difference of temperature between mean water temperature and wet-bulb temperature per square foot of air-flow area. For the two types of towers the following values were found:

Wet-bulb temperature, deg. fahr.	Coefficient of Heat Dissipation	
	for forced-draft towers	for natural- or chimney-draft towers
−10	500	
+30	700	
50	1000	...
60	1250	340
70	1500	...
80	1800	440

In applying empirical formulæ for spray cooling the influence of the season of the year should not be overlooked. The same caution applies when making acceptance tests of cooling ponds or towers.

PAUL A. BANCEL.

New York, N. Y.

Broader Fields of Usefulness for the A.S.M.E. Sections

TO THE EDITOR:

At this time, when the spirit of service is in the air, loyal Americans are looking for opportunities to make their experience and influence felt. It, therefore, seems to come with special fitness that the sectional activities of the A.S.M.E. are being stimulated and encouraged by the adoption of new By-Laws providing for a more comprehensive and progressive plan for the future.

This has been well pointed out by Louis C. Marburg in his address at the last annual meeting in New York, which was published in the March number of THE JOURNAL.

The opportunity afforded by the revised By-Laws for each section to suit its activities to the local needs gives freedom of action which can be of great value in arranging the best program for each locality.

Coöperation between local engineering interests can also be cultivated to advantage through the Sections, and in such matters as standardization, which in most cases affect more than one line of engineering, greater uniformity of action and results more far-reaching in their scope can be attained.

Such coöperation also is of special value in taking up community matters of an engineering character, which, as Mr. Marburg says, should be more and more a feature of the work of engineering organizations, in order that they may hold the place which is due them on account of the importance of their work.

All these reasons, which apply strongly in times of peace, are much accentuated now that we are in the midst of the critical situations arising from the Great War.

LUTHER D. BURLINGAME.

Providence, R. I.

HOW TO JOIN THE ARMY ENGINEERS

During the past three years the best engineering skill of France and Great Britain has been matched against that of the Central Powers, and the same skill is urgently required in the United States Army. Enlistments of experienced technical men in our army, however, are below requirements. While this deficiency is undoubtedly due in part to the high salaries which American firms are paying their employees, it probably is also due to the lack of proper information concerning the engineering branch of the service. Few civilians know that it is possible for them to perform in the Engineering Corps almost exactly the same kind of work in which they are at present engaged.

It is more important to have the right man in the right place in our army, where lives of men are at stake than it is in any business enterprise. The First Replacement Regiment of Engineers was organized at Washington Barracks, D. C., on December 14, 1917, with the express idea of accomplishing this end. This regiment has not only the responsibility of finding men to fill up depleted ranks but it must also fit the men thus obtained to step into the work of trained, efficient and disciplined soldiers.

The preliminary work of the recruit is first a thorough training in military drill, for the engineer soldier must be prepared to lay down his shovel and take up his rifle at any time. Infantry drills gradually give way to engineer work and more specific technical training. The engineer soldiers must know how to tie all the important kinds of knots and lashings, to build spar and truss bridges, to construct revetments, dig trenches, place wire entanglements, construct machine-gun emplacements, build pontoon bridges and to construct roads. They must also know the methods of demolition, sapping and mining. Specialized training in lithography, zincography, surveying, mapping, photography, carpentry, blacksmithing, electricity and machinery will also be given to all of those who are qualified for further training in any of these branches.

The Replacement Regiment will be called upon to furnish men for the following regiments, battalions or companies: Camouflage; Crane Operating and Maintenance; Depot Service; Electrical and Mechanical; Forestry (Saw Mill); Forestry (Auxiliary Road, Camp and Bridge); Gas and Flame Service; General Construction; Mining; Quarrying, Sapper; Searchlight; Supply and Shop; Surveying, Ranging and Map Reproduction; Water Supply.

Every male citizen in the United States who is physically fit, and between the ages of 18 and 21, and 31 and 40, is eligible to join the regiment by voluntary enlistment.

To be assured of assignment, the applicant for enlistment, should write for an application blank to the Commanding Officer, 1st Replacement Regiment Engineers, Room 107, Headquarters Building, Post of Washington Barracks, D. C. If the blank shows the man to be eligible, an enlistment card is filled out and sent to the Recruiting Officer nearest to the applicant's place of residence, with instructions to enlist the man for service in this Regiment. Transportation and meals will be furnished by the Recruiting Officer and the man will be instructed to report at the Post for duty.

WORK OF THE BOILER CODE COMMITTEE

The Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York City.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval, after which it is issued to the inquirer and simultaneously published in THE JOURNAL, in order that any one interested may readily secure the latest information concerning the interpretation.

Below are given the interpretations of the Committee in Cases Nos. 175, 185 and 186, as formulated at the meeting of February 20, and approved by the Council on March 15, 1918. In this report, as previously, the names of inquirers have been omitted.

CASE NO. 175

Inquiry: How is the maximum allowable working pressure to be calculated for the radial section of the outside fire-box plate of locomotive boilers where stayed to the firebox sheet?

Reply: There appears to be no rule in the Boiler Code that makes allowance for the supporting power of such curved stayed surfaces. It has been proposed to revise Par. 212 of the Code to read as follows:

212*a* The maximum allowable working pressure for any curved stayed surface subject to internal pressure shall be obtained by the two following methods, and the minimum value obtained shall be used:

First, the maximum allowable working pressure shall be computed without allowing for the holding power of the stays, due allowance being made for the weakening effect of the holes for the stays. To this pressure there shall be added the pressure secured by the formula for braced and stayed surfaces given in Par. 199 using 70 for the value of C.

Second, the maximum allowable working pressure shall be computed without allowing for the holding power of the stays, due allowance being made for the weakening effect of the holes for the stays. To this pressure there shall be added the pressure corresponding to the strength of the stays for the stresses given in Table 4, each stay being assumed to resist the steam pressure acting on the full area of the external surface supported by the stay.

b The maximum allowable working pressure for a stayed wrapper sheet of a locomotive type boiler shall be determined by the two methods given above and by the method which follows and the minimum value obtained shall be used:

$$P = \frac{11{,}000t \times E}{R - s\Sigma \sin \alpha}$$

in which

α = Angle any crown stay makes with vertical axis of boiler

$\Sigma \sin \alpha$ = Summated value of sin α for all crown stays considered in one transverse plane and on one side of vertical axis of boiler

s = Transverse spacing (in.) of crown stays in crown sheet

E = Minimum efficiency of wrapper sheet through joints or stay holes

t = Thickness of wrapper sheet (in.)

R = Radius of wrapper sheet (in.)

P = Working pressure of boiler, lb. per sq. in.

11,000 = Allowable stress, lb. per sq. in.

c An internal cylindrical furnace which requires staying shall be stayed as a flat surface as indicated in Table 3, except that the pitch may be increased to p_1 as provided in the following formula:

$$p_1 = p\sqrt{\frac{PR}{PR - 250t}}$$

in which p, P, R, and t are the same as in Par. 199.

CASE NO. 185

Inquiry: Where horizontal fire-tube boilers are so set that the lower part of the shell is not exposed to the fire or products of combustion, is it allowable to dispense with through braces as required by Par. 218 of the Boiler Code, and employ tubes at the sides of the manhole in place of such braces?

Reply: In horizontal fire-tube boilers which are set so that the fire or products of combustion do not come in contact with the lower part of the shell, tubes may be used instead of braces at the sides of the manhole as outlined.

CASE NO. 186

Inquiry: What should be the radius of the fillets formed by the flanging of the sheets of domes to drum connections for riveting to the shells of boilers? There does not seem to be any rule in the Boiler Code covering this detail of construction.

Reply: It is the opinion of the Boiler Code Committee that the flanges should be formed with a corner radius, measured on the inside, of at least twice the thickness of the plate for plates 1 in. thick or less, and at least three times the thickness of the plate for plates over 1 in. in thickness.

REVISION OF BOILER CODE

THE Council of the Society directed that a hearing be conducted in accordance with the recommendation in the Boiler Code that a meeting at which all interested parties may be heard be held at least once in two years to make such revisions as may be found desirable in the Code and to modify the Code as the state of the art advances. The first of these meetings was held at the Society's headquarters in New York, December 8 and 9, 1916.

The Council also directed that the proposed revisions in the Boiler Code be published in THE JOURNAL with the request that they be fully and freely discussed, so as to make it possible for any one to suggest changes before the Rules are brought to the final form and presented to the Council for approval. This has been done, and the revisions were presented in the March issue of THE JOURNAL, pp. 234-247, in the form finally proposed for submission to the Council, except as they may be modified by editing without change of sense. Discussions should be mailed to Mr. C. W. Obert, Secretary of the Boiler Code Committee, 29 West 39th Street, New York, N. Y., and they will be presented and acted on by the Boiler Code Committee.

Since the publication of the March issue of THE JOURNAL, however, certain typographical errors have been discovered in the revisions there presented, and corrections of these are published below, together with the modification of Par. 21, which it was stated in the March issue was in the hands of a special Sub-Committee of the Boiler Code Committee on Tube Sizes. The Sub-Committee has now completed its research and investigation, and its recommendation that Par. 21 be replaced by a table of maximum allowable working pressures

for different diameters and gages of tubes has been approved by the Boiler Code Committee.

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PAR. 21. CHANGE PAR. 21 TO READ AS FOLLOWS:

21 *Tubes for Water-Tube Boilers.* The maximum allowable working pressures for tubes used in water tube boilers shall be for the various diameters and gages measured by Birmingham wire gage, as given in Table 2.

TABLE 2 MAXIMUM ALLOWABLE WORKING PRESSURES FOR TUBES FOR WATER-TUBE BOILERS

FOR DIFFERENT DIAMETERS AND GAGES OF TUBES

Outside diam. of tube in inches, D	Gage, B. W. G.												
	17	16	15	14	13	12	11	10	9	8	7	6	5
	t=.058	t=.065	t=.072	t=.083	t=.095	t=.109	t=.120	t=.134	t=.148	t=.165	t=.180	t=.203	t=.220
$\frac{1}{2}$	434	686	938	1334									...
$\frac{3}{4}$	206	374	542	806	1094	.							
1		218	344	542	758	1010	...	.					
$1\frac{1}{8}$		166	278	454	646	870	1046	...			.		
$1\frac{1}{4}$		124	225	383	557	758	916	1118	.		..		
$1\frac{1}{2}$			146	278	422	590	722	890	1058	...		..	
$1\frac{3}{4}$				203	326	470	583	727	871	1046	...		
2				146	254	380	479	605	731	884	1019	...	
$2\frac{1}{4}$					198	310	398	510	622	758	878	1062	...
$2\frac{1}{2}$					153	254	333	434	535	657	765	931	1053
$2\frac{3}{4}$					117	208	280	372	464	575	673	824	935
3						170	236	320	404	506	596	734	836
$3\frac{1}{4}$							199	276	354	448	531	658	752
$3\frac{1}{2}$							167	238	310	398	475	594	681
$3\frac{3}{4}$							139	206	273	355	427	537	619
4								178	240	317	385	488	565
$4\frac{1}{2}$									186	254	314	406	474
5									142	204	258	340	402

$$P = \left(\frac{t-0.039}{D}\right)18000 - 250$$

Where P = Maximum allowable working pressure, lb. per sq. in.
t = Thickness of tube wall, in.
D = Outside diameter of tube, in.

[1] Maximum allowable working pressures for superheater tubes shall be the same as for boiler tubes.

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PAR. 28. CHANGE THE LIMITS OF TENSILE STRENGTH FOR THE FIREBOX GRADE OF STEEL TO READ AS FOLLOWS:

55,000-65,000

MARCH JOURNAL, P. 237

UNDER PAR. 212a CORRECT SIXTH LINE FROM BOTTOM OF PAGE TO READ AS FOLLOWS:

the weakening effect of the holes for the stays. To

MARCH JOURNAL, P. 238

UNDER PAR. 212b CORRECT THIRD LINE TO READ AS FOLLOWS:

determined by the two methods given above and by the

CORRECT THE FOURTH LINE UNDER THE FORMULA TO READ AS FOLLOWS:

$\Sigma \sin \alpha$ = Summated value of $\sin \alpha$ for all crown stays considered

CORRECT ELEVENTH LINE UNDER FORMULA TO READ AS FOLLOWS:

t = Thickness of wrapper sheet (in.)

MARCH JOURNAL, P. 238

IN TABLE 4 INSERT IN FIRST COLUMN OPPOSITE b, THE FOLLOWING:

8,000

MARCH JOURNAL, P. 241

CORRECT PAR. 286 BY INSERTION OF OMITTED FIRST SENTENCE OF PAR. 286 IN ORIGINAL EDITION OF THE CODE, AS FOLLOWS:

286 A safety valve over 3-in. size, used for pressures greater than 15 lb. per sq. in. gage, shall have a flanged inlet connection.

A number of fundamental laws governing the properties of wood, such as those covering the relations between strength and specific gravity, and between strength and moisture content, are laid down in Bulletin No. 556 just issued by the Department of Agriculture, entitled Mechanical Properties of Woods Grown in the United States, by J. A. Newlin and Thomas R. C. Wilson. In this publication are presented the results of about 130,000 strength tests, probably the largest single series ever run on one material, made by the Forest Products Laboratory of the Forest Service on 126 species of American woods. The laws derived from the tests cover the general relations existing between mechanical and physical properties of each species, and also the general relations existing between these properties irrespective of species.

SOCIETY AFFAIRS

A Record of the Current Activities of the Society, Its Members, Council, Committees, Sections and Student Branches; and an Account of Professional Affairs of Interest to the Membership

IT will hearten the membership, I know, to learn more in detail of the extraordinary service being rendered by this Society through its Engineering Resources Committee.

A classification sheet was sent out to every member of the Society and nearly every member has responded. Based on the replies, the following are the statistics secured:

Common-school education	8600
High-school education	8280
Graduate mechanical engineers	5550
Graduate electrical engineers	575
Graduate civil engineers	140
Graduate mining engineers	21
Other degrees	920
Speak and read French	2510
" " " German	2290
" " " Spanish	600
" " " Russian	64
" " " Italian	70
" " " Japanese	31
" " " other languages	490
Traveled extensively in Europe	1360
" " " South America	225
" " " Central America	145
" " " Japan	178
" " " China	102
" " " Korea	21
" " " Canada	640
" " " British Isles	462
" " " other countries	970
Have had military training	3050
" " naval training	230
Now in the service	910
Can devote full time to the service of the United States	4100
Can accept service involving travel	5020
Can report in one week or less	1970
Specialist in the Branch of:	
Aeronautics	310
Automotive engineering	950
Architecture	475
Ballistics	94
Chemical engineering	490
Civil engineering	1260
Electrical engineering	1910
Fire engineering	390
Heating and ventilating	1720
Hydraulic engineering	1200
Management	2850
Marine engineering	610
Mathematics	1080
Mechanical engineering	6540
Metallurgy	430
Metallography	144
Machine-shop practice	3190
Mill engineering	1720
Military engineering	176
Mining engineering	242
Municipal engineering	216
Naval architecture	220
Navigation	138
Patent law	320
Power engineering	1800
Public-utility service	555
Physics	660
Railroad engineering	1190
Safety engineering	735
Welfare work	420
Positions members have held:	
Appraiser	323
Consulting engineer	2440
Construction engineer	2300
Contractor	660
Designer	4050
Draftsman	3820
Editor	225
Erecting engineer	2200
Estimator	1780
Foreman	1420
Industrial engineer	1060
Inspector	1450
Laboratory assistant	515
Manufacturer	1460
Master mechanic	1230
Office executive	2180
Operating engineer	1780
Organizing engineer	960
Production engineer	1290
Publicity engineer	283
Purchasing agent	1050
Rate setter	320
Research engineer	1030
Sales engineer	1610
Sales manager	840
Specification engineer	840
Superintendent	2020
Teacher	1210
Testing engineer	1740
Works manager	1185

To date nearly 3000 names have been furnished to the several Bureaus of the Government and to the industries generally since the beginning of the war. Notwithstanding that this is obviously a "win the war" activity, our lists are invaluable for the industries whether or not those industries may be engaged in war activities. We probably have the most complete list in existence of specialists, together with their attainments, experience, etc.

Any member not having filled out the classification sheet should immediately write and ask that such a sheet be furnished him, as it is of the highest importance that every man should make his services available to his country. Even if one is not free to give all of his time, if he can give a portion of his time or can make special investigation in his own establishment, all of such services can be made available.

The members of the Committee, George J. Foran, Chair-

man, Fred H. Colvin, Henry C. Meyer, Jr., W. Herman Greul, and formerly J. H. Barr and A. D. Blake, until they were transferred to Washington and absorbed in the service of the United States, give personal attention to requests. The Secretary and his staff supplement the work of the Committee, so that the Government and the industries generally get not only the benefit of a list of specialists, but the assistance of the Committee and the staff of the Society in an attempt to select the men best fitted for the particular work. An excess of the number required is always recommended, so that the Government has the opportunity to make a selection from among those given.

Please help by making sure that your name is on this roll, and still further by suggesting the names of any men especially competent in any realm of engineering who are not now members and whose availability for service should be recorded, and we shall be pleased to send them classification blanks, to be filed separately.

CALVIN W. RICE,
Secretary.

COUNCIL NOTES[1]

A MEETING of the Council was held on Friday, February 15, 1918, in the rooms of the Society. The following members were present: Charles T. Main, *President;* R. M. Dixon, *Chairman Finance Committee;* R. H. Fernald, George J. Foran, representing the *Publication Committee;* F. A. Geier, W. F. M. Goss, Ira N. Hollis, John Hunter, F. R. Hutton, D. S. Jacobus, H. de B. Parsons, Charles T. Plunkett, D. Robert Yarnall, Wm. H. Wiley, *Treasurer;* Henry Hess, *Chairman Standardization Committee,* and Calvin W. Rice, *Secretary.*

Nominating Committee. The President announced that the Sections had selected the following names, and that he had had great pleasure in making them his appointments for the Nominating Committee for officers for 1918: L. P. Breckenridge, William P. Caine, Thomas E. Durban, C. F. Hirshfeld and George R. Wadleigh. A full announcement regarding these appointments was published in the March issue of THE JOURNAL.

Power Test Code. In accordance with the vote at the last Council meeting, the President presented a set of rules for the guidance of the Power Test Code Committee and its sub-committees and advisory board, prepared in collaboration with George H. Barrus, Chairman of the Committee.

Engineering Council. It was voted to approve the appointment by the President of Charles Whiting Baker, George J. Foran and D. S. Jacobus to represent this Society on a special Conference Committee of the Engineering Council to consider and report back to the Engineering Council rules for the admission of associate societies.

Society for the Promotion of Industrial Education. In response to the invitation from the Society for the Promotion of Industrial Education, John W. Lieb and R. H. Fernald were appointed honorary vice-presidents to represent the Society at its Philadelphia meeting, February 21 to 23.

National Security League. A. D. Bailey, William B. Jackson and Arthur L. Rice were appointed honorary vice-presidents to represent the Society in response to the invitation of the National Security League at their meeting in Chicago, February 21 to 23.

War Activities. It was voted that all committees of the Society having to do with war activities be requested to report each month to the Council.

Library Committee. The Council approved in principle recommendations of the Library Committee that the title of the Library of the Society be transferred to the United Engineering Society. The matter was referred back to the Library Committee to obtain advice of counsel.

Sections Committee. D. Robert Yarnall, Chairman of the Committee on Local Sections, presented a report of recommended procedure for the election of a Nominating Committee, and it was voted to transmit copies of the report to the Committee on Constitution and By-Laws and to every member of the Council for consideration, and report at the next meeting.

Meetings Committee. This committee reported that in consultation with the Worcester Local Committee, the date for the 1918 Spring Meeting of the Society at Worcester, Mass., had been set for June 4 to 7.

War Department, Ordnance. The Secretary reported the receipt of a letter of thanks from the Chief of Ordnance for the coöperation of the Society in securing ordnance officers.

Screw Thread Tolerances. Acting upon a communication of January 23 from the various tap manufacturers, requesting permission to scrutinize that part of the report of the Committee on Tolerances in Screw Thread Fits relating to taps, the report was referred back to the Committee to carry out this request and, should the manufacturers ask for any revision, to give their request due consideration and again submit the report, revised, if necessary, to the Council.

Machine-Shop Practice Committee. The Secretary reported that another way in which the Society was helping in war activities was through the Sub-Committee on Machine Shop Practice, and that in response to a request from the Director of Division Trade Tests, Committee on Classification of Personnel of the Provost Marshal, our committee had met and was assisting the Provost Marshal in the preparation of statements of the requisites in the various machine trades.

Sub-Committee on Protection of Industrial Workers. The following reports from this committee were received and ordered printed in TRANSACTIONS as part of the proceedings of the year 1917:

1 Code of Safety Standards for Elevators
2 Code of Safety Standards for Woodworking Machinery
3 Code of Safety Standards for Industrial Ladders
4 Code of Safety Standards for Power-Transmission Machinery.

Nos. 1 and 2 were presented at the Spring Meeting, 1917, and Nos. 3 and 4 at the Annual Meeting, 1917.

Coöperation and Organization. On account of the assignment to war work of the members of the Committee on Coöperation and Organization, it was voted that this committee be discharged with thanks and the work be referred to the Sub-Committee on Machine Shop Practice.

Electric Welding Society. A request of the Electric Welding Society asking affiliation with this Society was referred to the Boiler Code Committee with instructions to appoint a subcommittee on Electric Welding of the Boiler Code Committee.

Boiler Code Committee. It was voted that the present Committee on Boiler Code be reappointed as the Committee for 1918.

Adjournment was taken to reconvene on March 15, 1918.

CALVIN W. RICE,
Secretary.

[1] The March JOURNAL went to press before the February Meeting.

United Engineering Society

Extracts from President's Annual Report

FOR the year 1917 the noteworthy occurrences are the creation of the Engineering Council, the completion of the addition to the Engineering Societies Building and the occupation by the American Society of Civil Engineers of the space thus provided for it, the addition of 67,000 volumes from the Civil Engineers' Library to the Engineering Societies Library, the election as Director of the Library of Harrison W. Craver, formerly of the Carnegie Library of Pittsburgh, and the election of Alfred Douglas Flinn to serve the United Engineering Society, the Engineering Foundation and Engineering Council jointly as their secretary, with offices in the Engineering Societies Building.

The Engineering Council held its first meeting on June 27, elected Ira N. Hollis chairman and Calvert Townley secretary, and during the year appointed the following committees: Executive, Rules, Finance, Public Affairs, American Engineering Service, and War Committee of Technical Societies. Good work has been done, but the Council has not perfected its organization, and it was not until the close of the year that a definite financial arrangement was made; an appropriation of $16,000 was requested and granted for the term ending October 31, 1918, to be assessed equally upon the four Founder Societies.

In October, the three new stories of the Engineering Societies Building were so far completed that the American Society of Civil Engineers could move into its new quarters, and were wholly completed before the end of the year. The total cost was $302,027.01, the increase over the estimate being caused by the War. The American Society of Civil Engineers held its annual meetings in the building in January, 1917, and its first regular semi-monthly meeting on November 21, since which latter date all the meetings of this society have been held in the new quarters.

On December 7, at a meeting in the Auditorium, the three original Founder Societies and United Engineering Society tendered a welcome to the American Society of Civil Engineers. [An account of this meeting has already b en published in The Journal.]

In February, 67,000 books and pamphlets from the Civil Engineers' Library, which were not duplicates of books and pamphlets previously in the Engineering Societies Library, were removed from the 57th Street house of the Civil Engineers to the Engineering Societies Building and placed upon stacks in the same arrangement as in the old building. Ownership of this collection of books has been offered by the American Society of Civil Engineers to the United Engineering Society. Similar action has been taken by the American Institute of Mining Engineers and is expected to be taken by the other Founder Societies. Mr Craver began his duties as Director of the Library on April 2.

September 20, 1917, terminated the year for which the Engineering Foundation had appropriated its income and devoted the services of its secretary, Dr. Cary T. Hutchinson, to the establishing of the National Research Council. The Council was organized on September 19, 1916, and during the year accomplished much useful scientific work in coöperation with the Government. Among these achievements may be mentioned advance in the art of submarine detection, location of aircraft by sound, telephoning between airplanes, protection of balloons from ignition by static charges, progress in gas-warfare problems, and the production of optical glass. The National Research Council now acts as the Department of Science and Research of the Council of National Defense. Further interesting details of the work of establishing the National Research Council are contained in a report dated September 20, 1917, which was published in the Proceedings of the Founder Societies. The National Research Council is now wholly supported by the Government and has offices in Washington.

Completion of the first and major portion of the Catskill Mountain water-supply system for New York City was celebrated by the United Engineering Society and the four Founder Societies by a special meeting held in the Auditorium, November 14, attended by about 1100 persons. [An account has already been published in The Journal.]

During the year the by-laws of United Engineering Society were amended to create the office of Director of the Library and to provide for the creation of the Engineering Council, the former amendment being made in February and the latter in June.

During the summer, the Tax Department of the City of New York placed the Engineering Societies Building on the list of taxable property and referred the claim of United Engineering Society for exemption to the Corporation Counsel. Later it was decided that six of the associate societies in the building did not satisfy the exemption requirements found in Subdivision 7 of Section 4 of the Tax Law, and that consequently the portions of the building occupied by them would be subject to taxation.

At this date the membership of the four Founder Societies is 33,100 and of the associated societies 25,154, so that a total of 58,254 engineers now have headquarters in the Engineering Societies Building.

The real estate now owned by United Engineering Society is valued at $1,947,171.16.

The income of the Society during 1917 was	$55,854.72	
Expenditures totaled	53,791.87	
Gain for the year	2,062.85	
Surplus at the close of 1916	6,053.25	
Total		$8,116.10

Funds for the benefit of the Engineering Societies Library were obtained during 1917 from the following sources:

American Society of Civil Engineers	$4,000.00
American Institute of Mining Engineers	4,000.00
American Society of Mechanical Engineers	4,000.00
American Institute of Electrical Engineers	4,000.00
United Engineering Society	262.35
Income from endowment fund	5,760.42
Gross income from searches	6,556.19
Sales and income	29.40
Total income	$28,605.36

Library expenses were as follows:

Salaries	$16,961.16
Books purchased	1,614.47
Binding	1,393.35
Supplies	1,299.89
Moving Civil Engineers' Library	381.50
Searches, salaries, and miscellaneous	6,759.54
Total	$28,605.36

Funds held by the United Engineering Society were of the following amounts at the end of the fiscal year 1917:

Library endowment fund	$102,559.70
Engineering Foundation fund	203,374.80
General reserve fund	10,000.00
Depreciation and renewal fund	75,037.41
Surplus	8,116.10
Total	$399,088.01

In the report of the Treasurer are many interesting details about the Society's finances, and in the report of the Library Board a full statement of its activities, showing the importance of the work being done.

Mr. Calvin W. Rice resigned as Secretary of the United Engineering Society to take effect at the end of December, and the Society is indebted to him for a year of gratuitous service.

To Mr. Joseph Struthers who has been Treasurer for nine years, and to the members of the Building Committee, especially its Chairman, H. H. Barnes, Jr., the Trustees would express hearty thanks for valuable services.

CHARLES F. RAND,
President, United Engineering Society.

New Officers of Engineering Council

At the first annual meeting of the Engineering Council, on February 21, J. Parke Channing was elected chairman; Harold W. Buck, first vice-chairman; George F. Swain, second vice-chairman; and Alfred D. Flinn, secretary. The following committees were appointed:

Executive Committee: The chairman, the two vice-chairmen, and David S. Jacobus, Calvert Townley, George J. Foran.

Finance Committee: E. Wilbur Rice, Jr., chairman; Charles F. Loweth, Sydney J. Jennings, David S. Jacobus.

Rules Committee: J. Parke Channing, chairman; Clemens Herschel, Nathaniel A. Carle, Irving E. Moultrop.

Public Affairs Committee: Charles Whiting Baker, chairman; George F. Swain, Benjamin B. Thayer, E. W. Rice, Jr., Charles E. Skinner.

American Engineering Service: George J. Foran, chairman; George C. Stone, Alfred D. Flinn, Dr. Addams S. McAllister, Edward B. Sturgis, secretary.

War Committee of Technical Societies: D. W. Brunton, chairman; Arthur H. Storrs, secretary; James M. Boyle, Nelson P. Lewis (American Society of Civil Engineers), Edmund B. Kirby (American Institute of Mining Engineers), A. A. Greene, Jr., R. N. Inglis (American Society of Mechanical Engineers), Harold W. Buck, Dr. Addams S. McAllister (American Institute of Electrical Engineers), Dana D. Barnum, E. C. Uhlig (American Gas Institute), Joseph Bijur, Dr. Chas. A. Doremus (American Electrochemical Society), Louis B. Marks, Preston S. Millar (Illuminating Engineering Society), Christopher R. Corning, George C. Stone (Mining and Metallurgical Society of America), Henry Torrance, F. E. Matthews, (American Society of Refrigerating Engineers).

Fuel Conservation Committee: L. P. Breckenridge, chairman; Ozni P. Hood, secretary; Robert H. Fernald, Charles R. Richards, Charles L. Edgar, Carl Scholz, David Moffat Myers, Edwin Ludlow, Harold W. Buck.

J. PARKE CHANNING

J. Parke Channing, the newly elected chairman, was born in New York City and was graduated from Columbia University with the degrees of Engineer of Mines and Master of Science. After graduation he was first engaged in mining in the Lake Superior iron and copper region, and later in Montana, Utah and Tennessee. In 1900 he developed and equipped the Tennessee Copper Company, and a few years later built one of the largest sulphuric-acid plants in the world to utilize the waste gases from its copper furnaces. In 1907 he discovered and developed the Miami copper mine in Arizona, now producing copper at the rate of 60,000,000 lb. per year.

For three years Mr. Channing was president of the Mining and Metallurgical Society of America, and is now its vice-president. He was one of the founders of the Lake Superior Mining Institute and is one of its past-presidents. He was directly responsible for the founding of the Michigan College of Mines. He is a member of the American Institute of Mining Engineers and one of its former vice-presidents. He is also a member of the Institute of Mining and Metallurgy, England. He is vice-president of the Miami Copper Company and of the General Development Company.

Dr. Ira N. Hollis, the retiring chairman of the Engineering Council, has given untiring effort to the first year of the Council's existence, with its many problems of organization and the great number and variety of suggestions for usefulness to the Government in connection with the war. In spite of his residence in Worcester, Mass., and his many duties there, he attended all Council meetings and meetings of the executive committee in New York, and made frequent trips to Washington. His enthusiastic devotion to the Engineering Council during the year that he was also President of The American Society of Mechanical Engineers made large demands upon time already heavily mortgaged by his duties as president of the Worcester Polytechnic Institute and by related activities.

SPRING MEETING

WORCESTER, MASS., JUNE 4-7

THE program for the Spring Meeting, an outline of which appears on this page, provides a much-needed opportunity for the engineers of the country to get away from their strenuous war duties, take counsel with each other, and obtain a broader vision of the great undertakings for which they are now responsible. America must supply home demands during the war, without sacrificing the war demands, with firms of other countries; but under the stress of the present moment it is necessary to pool our knowledge and to coördinate our work, a result which can be best attained by getting together for an interchange of ideas. It is this function which it is expected that the Spring Meeting will fulfill, and to this end the Committee on Meetings has arranged for a discussion of topics of great industrial importance.

TENTATIVE PROGRAM

TUESDAY, JUNE 4

Afternoon: (Hotel Bancroft)

Registering of Members and Guests at Society Headquarters

Meeting of Research Committee and Flow Meters Sub-Committee

Evening: (Hotel Bancroft)

Addresses of Welcome by Mayor Pehr G. Holmes, Past-President Ira N. Hollis, and R. Sanford Riley, President Worcester Chamber of Commerce

Reception and Dance following the addresses

WEDNESDAY, JUNE 5

NEW ENGLAND DAY

Morning: (Worcester Polytechnic Institute)

Business Meeting

First New England Session:

Papers and addresses contributed by the New England Sections of the A. S. M. E. and the Providence Engineering Society. The topics listed below will be begun at this session and continued in the afternoon

The Growth of an Industrial City, Hon. Charles G. Washburn

The Small Industry and Democracy, Dr. George H. Haynes

The Textile Industry in Relation to the War, J. E. Rousmaniere

Other subjects to be presented are: Changing a Non-essential Industry to Munition Manufacturing; Organizing a Compact Community for the Manufacture of War Material; Fire Protection for Industrial Plants; The Boston Plan for Vocational Training of Enlisted Men; Aeroplane Manufacture; Constructional and Manufacturing Problems in Building Destroyers

Sections Luncheon and Conference

Afternoon: (Hotel Bancroft)

Second New England Session:

General Session with technical papers

Industrial Safety and Workmen's Compensation Session

Tea at Tatnuck Country Club

Evening: (Hotel Bancroft)

General War Session. The general theme of this evening session will be: How the Engineering Societies Can Assist in the Procurement Program of the Government. Some major topics to be discussed are: Ordnance and Ships for the Navy Department; Munitions for the Army; Aircraft Material; Merchant Ships

THURSDAY, JUNE 6

Morning: (Worcester Polytechnic Institute)

General Session with technical papers

Fuel Session (a list of topics follows the program)

Public Relations Session

Afternoon: (Norton Company's Plant)

Luncheon

Paper on Housing Problems

Inspection of the Norton Company's community housing and garden projects

Evening: (Worcester Country Club)

Dinner

Illustrated Lecture: Harvard's Contribution to Astronomy, Dr. S. I. Bailey, of Harvard Observatory

FRIDAY, JUNE 7

Morning:

Automobile Trip to Camp Devens, via Clinton Dam

Lunch at Camp Devens

Afternoon:

Auto Trip to Concord, Lexington and return via the Wayside Inn

and she must do this with a gradually diminishing supply of labor. Mass production is required on an enormous scale and machine production must be carried into fields where hand work has formerly prevailed. There must be greater efficiency and economy, greater foresight, more extended research and more careful planning.

In normal times Americans have generally accomplished their results individually in competition with one another and

New England is probably the largest center of munitions production in the country. Accordingly, a New England Day has been arranged, when the engineers connected with the manufacturing plants of that section engaged upon war work, are asked to present their problems for discussion and to contribute any data which will be of value to others. On the evening of the same day, representatives of several of the governmental departments engaged in the procurement of supplies

for the Army and Navy will give addresses. Another session will be for the discussion of questions incident to Fuel Economy, as outlined in the article which follows, when all who have had to give serious consideration to improved methods for fuel burning during the past winter are asked to contribute the results of their experience for the benefit of the Fuel Administration.

Vocational training for enlisted men, and housing problems incident to war conditions are to be discussed and one session will be devoted to municipal problems of the engineer in war times. There will also be a careful selection of miscellaneous technical papers, so that there may be put on record in the Society Transactions the results of engineering research, in accordance with the usual custom of the Society in conducting its publications.

The Local Sections of New England and the Providence Engineering Society are actively coöperating with the Committee on Meetings in the preparations for the convention. During the first three days simultaneous sessions will be held in order to complete the professional business by Thursday night. This will leave Friday free for a trip by automobile to the cantonment at Camp Devens, Mass., and for a visit to the historic places of Concord and Lexington. Probably most of those who will be present fully appreciate that this part of New England is one of the most beautiful sections of the country for outdoor life, and this trip on Friday, as well as the other social features, has been arranged with a view to the enjoyment of outdoor pleasures to the fullest extent.

FUEL SESSION

SPRING MEETING, WORCESTER, MASS., JUNE 6

On Thursday morning, June 6, there will be a session of the Spring Meeting at the Worcester Polytechnic Institute for five-minute presentations of data relating to fuel economy. This session has been planned by the Fuel Conservation Committee of the Engineering Council to assist the United States Fuel Administrator in his nation-wide campaign for fuel economy. The topics upon which discussion is solicited are listed below and all members of the Society, or others, who have studied the problems incident to the adverse fuel conditions of the past winter are invited to give the results of their experience in the form of brief written communications of from 100 to 1000 words each. In so far as possible, these will be presented at the time of the meeting and later collated for publication and for transmission to Dr. Garfield's department at Washington. Contributions to this session should be mailed to the Secretary of the Society, 29 West 39th Street, New York, not later than May 1.

1 WHAT ARE THE ECONOMIC EFFECTS OF IMPURITIES IN COAL?
Incombustible in fuel has a detrimental effect upon furnace operation out of all proportion to the percentage of refuse contained. It has been claimed that when coal contains 40 per cent of refuse it becomes valueless as fuel. Recent conditions have afforded opportunities for interesting observations in this connection. What has been your experience?

2 TO WHAT EXTENT IS FUEL OIL LIKELY TO BE USED AS A SUBSTITUTE FOR COAL?
Information is desired as to present use, advantage found, probable available supply, etc.

3 HOW CAN SOFT COAL BE BURNED WITHOUT SMOKE IN MARINE BOILERS?
The avoidance of smoke would decrease the radius of visibility of our ocean carriers by many miles and greatly reduce their liability to attack by submarines. If efficiency is improved incidentally it means much more than the mere coal saving.

4 WHAT ARE THE POSSIBILITIES IN THE DIRECTION OF THE UTILIZATION OF ANTHRACITE WASTES?
What success have you had in burning anthracite slack or culm? Do you mix it with soft coal, and in what proportions? What sort of grate do you use and what is your practice with regard to thickness of fire, draft, rate of combustion? Can the mixture be burned in a stoker?

5 WHAT INSTRUMENTS ARE USEFUL AND DESIRABLE IN THE BOILER ROOM AS AIDS IN SAVING COAL?
What class of equipment has been of the most value to you and how?

6 WHAT IS ESSENTIAL TO THE ECONOMICAL OPERATION OF HAND-FIRED BOILER FURNACES WHEN USING SOFT COAL?
Helpful hints as to firing methods, front or side; frequency of firing; management of dampers; cleaning; etc.

7 TO WHAT KINDS OF PLANTS AND COALS ARE THE DIFFERENT TYPES OF MECHANICAL STOKERS RESPECTIVELY ADAPTED, AND WHAT IS THE LIMITING FACTOR TO THEIR USE IN THE SMALL PLANT?
Can we agree upon the type of fuel to the combustion of which each type of stoker is best adapted? How large must a plant be to warrant the use of a mechanical stoker?

8 WHAT EXPERIENCE HAVE YOU HAD IN THE USE OF WOOD AS FUEL? TO WHAT EXTENT IS WOOD AVAILABLE AS A FUEL?
The coal shortage has occasioned the use of wood fuel in many unwonted places. Accounts of experience that will be helpful are solicited.

9 WHAT COAL ECONOMIES CAN BE EFFECTED IN RESIDENCE HEATING?
He who could make one ton of coal do the work of two during the past winter, not only conserved the coal for his neighbor and saved his own money but was comfortable when he might have otherwise been cold. How can it be done?

10 WHAT COAL ECONOMIES CAN BE EFFECTED IN THE SMALL STEAM PLANTS?
Plants which are not sufficiently important departments of their industries to warrant expert supervision and are too small to support real engineers waste a lot of coal and steam in the aggregate. What are the principal sources and methods of waste and how can they be avoided and corrected?

11 WHAT EXPERIENCES HAVE YOU HAD WITH THE STORAGE OF COAL?

12 While the above topics are all that can be suggested for discussion, additional short papers on any fuel topic are desired for publication. Items of interest on fuel performance should be sent to the Secretary. A few additional topics are suggested:
a To what extent and where will the gas producer be used to produce economies?
b To what extent is natural gas being used as a fuel for power purposes?
c What is the relative economy of the locomotive of 1900 and today?
d What proportion of the coke is made in by-product ovens?
e What are new and important developments in methods of burning coal?
f What economies have resulted from recent practice in making brick settings leakless?
g To what extent is coke being used for residence heating?
h Is automatic air supply correctly proportioned to coal supply possible?

John Fritz Medal

On Wednesday, April 17, at 8.30 p. m., there will be held in the auditorium of the Engineering Societies Building, New York, a meeting at which the John Fritz Medal will be publicly presented to J. Waldo Smith, Mem.Am.Soc.M.E., for "Achievements as Engineer in Providing the City of New York with a Supply of Water." Col. John J. Carty, Past-President, American Institute of Electrical Engineers, will preside. The medal will be presented by Ambrose Swasey, Past-President Am.Soc.M.E., and addresses will be given by other speakers.

AMONG THE LOCAL SECTIONS

THE Spring Meeting at Worcester will afford an opportunity for representatives of the Sections to hold a conference. They will meet at luncheon with the Council on Wednesday, June 5, at which time addresses will be made by President Charles T. Main and Dr. Ira N. Hollis. The sessions of the Spring Meeting will be devoted to a large extent to developing ways and means by which the Society can speed up and increase the service which is being patriotically rendered the Government. This Sections Conference will therefore assume proportions almost international in importance, because it is largely through the medium of the Sections that the Society can achieve undertakings of this nature. Several of the Sections have already held meetings which promise to prove of enormous assistance in winning the war. In fact, the dominant note in Sections activities is that nothing is now worth while which does not contribute to this end.

The meeting of the New York Section on non-essential industries, an extended account of which is given in this issue of THE JOURNAL, has aroused more general interest than any meeting held by that Section in years. The press gave considerable space to a report of the meeting, the New York *Evening Post* devoting practically two columns to it. Representatives of a large variety of trades and industries were present and the journals specially devoted to their interests contain full accounts of the discussion. A resolution was passed at the meeting to the effect that the Society organize to develop the use of any of the available equipment and working forces of plants engaged in the manufacture of anything not directly necessary to winning the war. In this way the disturbance to the industries will be minimized, and their plants kept working to capacity.

The Committee on Sections has distributed to the chairman and secretary of each Local Section a record book. This is arranged in loose-leaf style and contains forms for the reporting of meetings, concise statements relative to the By-Laws governing Sections activities, the requirements for membership, and the privileges thereof, and a description of the publications and of the library. There are forms for recording details about the various committees of each Section, a history of the Section, the development of special mailing and telephone lists, a diary for notable events during the year, the development of papers for meetings, a balance sheet, and corrected lists of the personnel of the Council and Sections Committees with their addresses. These record books should help the Sections officers in the organization of their work, and thereby give them more time for the important work of preparing for meetings.

Section Meetings

ATLANTA

February 12. At the invitation of Mr. Robert Gregg the members of the Section participated in a dinner at the Druid Hills Golf Club.

Chairman Elsas gave a report of the conference of Sections delegates at the Annual Meeting. The discussion which followed developed a general feeling that the affiliated technical societies should receive more active support by the local sections of the national engineering societies.

CECIL P. POOLE,
Section Secretary.

BALTIMORE

March 12. At the fourth regular meeting the attendance was the largest on record, and great interest was shown in the discussions presented on canning of foods, as this is one of Maryland's most important industries.

The first paper of the evening, presented by J. H. Shrader, Assistant Physiologist, U. S. Department of Agriculture, outlined the general process of canning, referring particularly to tomatoes, which are the staple product of Maryland. Each process used was described and illustrated, its faults and inefficiencies from a food-utilization viewpoint pointed out, and it was shown that fully 45 per cent of the food value of the tomato as delivered at the plant is wasted in the process. This waste occurs in storage during excessive supply, in poor sorting, in wasteful peeling and in can filling.

The question of the manufacture of "tomato paste" was considered, and as the waste, labor charge and loss in this process is very small, it offers wonderful opportunities for the efficient operation of canning plants. The food value of the product is as high as that of the regular canned goods, while the bulk is tremendously reduced, thus reducing space and freight and providing a cheaper product than the ordinary canned tomato.

Prof. Julian C. Smallwood, Mem.Am.Soc.M.E., who has conducted extensive researches in the use of steam in the canning industry, and is an authority on this subject, presented the second paper, on Economy in the Use of Steam, by means of diagrams. The wastes covering washers, scalders, kettles, exhausters and process kettles, together with radiation were traced in the various steps of the process and the ways and means of elimination were discussed. A plant where losses of this kind were reduced to a minimum was described and it was shown that the boiler hp. necessary could be reduced from 265 to 140, with a corresponding saving of fuel. Experiments showed the ordinary exhauster process is most ineffective in securing the result desired. Great opportunities for economy in the process kettles and the advantage of using low-pressure steam are offered.

The last paper was delivered by J. C. Taliaferro, plant manager, Continental Can Co., on The Filling and Closing of the Modern Can. The problem for engineers is to design a filling machine that will put the required amount, without waste, into each can. The Government requires a certain standard of filling the cans, and canners usually overfill their cans thus making it impossible to exhaust properly and thereby spoiling the contents. When cans are overfilled some liquid must be spilled before exhausting, and this is wasted. Until our engineers can design such equipment we must continue to thus needlessly waste a large proportion of our food products in the process of canning.

A. G. CHRISTIE,
Section Secretary.

BIRMINGHAM

At the February meeting held jointly with the Alabama Technical Association, C. B. Davis, Mem.Am.Soc.M.E., delivered a paper on Fuel Conservation.

March 21. Mr. J. A. Sirnit, of the Alabama Power Co., gave a talk on Water and Fuel Equipment Warrior River Reserve Station. A more detailed account of the meeting will appear in a later issue.

W. LEE ROUECHE,
Section Secretary.

BOSTON

March 16. A subject of the greatest importance and most serious to the American nation at the present time was the address on Man Power delivered by J. Parke Channing. A more detailed account of the meeting will be published in a later issue of THE JOURNAL.

W. G. STARKWEATHER,
Section Secretary.

BUFFALO

February 20. After a trip through the Buffalo High School, Chairman F. E. Cardullo gave a talk on Manual Training, emphasizing its general educational value to the student.

March [illegible]. Under the auspices of the American Chemical Society Section an illustrated lecture on Some Phases of Glass Making was delivered by Dr. E. C. Sullivan, Chief Chemist of the Corning Glass Works. The lecture was extremely interesting as the speaker has done much toward meeting the glass situation in this country since the exports of Germany have been cut off.

March 13. The Hydroelectric Power Problem and the general considerations involved in the exploitation and design of hydroelectric plants formed the subject of an address by J. A. Johnson. The economic question of the relation between the location of available power and the location of industries was discussed and the speaker traced the advantages and disadvantages in the generation and transmission of power over short and long distances; the value of the steam plant and the economic relations between the two.

March 20. Under the auspices of the S.A.E. Section a paper on Worm Gear Bronze was delivered by W. M. Corse.

March 27. A night of "Mystery" held under the auspices of the A.S.M.E. Section. Details of the meeting not being available at this time, will be published in a later issue.

E. B. NEIL,
Section Secretary.

CHICAGO

March 1. The subject of the meeting was the Coal Situation and was discussed by Joseph Harrington, Mem.Am.Soc.M.E., and Prof. H. H. Stock, head of the Mining Department, University of Illinois, and also chairman of the Conservation Committee of the Fuel Administration for Illinois. Mr. Harington dealt with one phase of the subject, plant control, and showed how the efficient equipment of a plant and the keen observation on the part of the employees will increase the efficiency of the plant. He emphasized the fact that employers very often fail to grasp the point that while conscientious, intelligent operatives often overcome certain losses by inefficient machinery, it is essential to have the newer type of machinery installed in order to work efficiently. The question of improving plant operation by education or by autocratic overseeing by the Government was also discussed. Mr. Harrington claimed in addition to having educated engineers as operatives it is also necessary to have compulsory measures through Government committees in order to have any practical effect on the consumption of coal of the country.

Prof. Stock in discussing the coal situation showed the lack of fuel to meet the present demands and advocated restrictions in unnecesary demands.

A. L. RICE,
Section Secretary.

INDIANAPOLIS

January 25. At a joint meeting of the Indiana Engineering Society with the A.S.M.E. and A.I.E.E. Sections which lasted throughout the entire day, the following papers were presented at the morning session: Concrete Roads versus Other Types of Construction, by W. E. Graves, Assistant City Engineer, South Bend, Ind.; Discussion on Roads and Recent Development in Brick Paving, by E. B. Smith, Laporte, Ind.; Indiana Market Highways in War Time, by W. S. Moore, Chairman State Highway Commission; History of an Old Bridge, by J. S. Spiker, Vincennes, Ind.; and Water Bound Gravel Roads, by Karl L. Hanson, Connersville, Ind. Motion pictures showing the construction of buildings and roads at the cantonment at Camp Dodge, Iowa, were presented by C. D. Franks, of the Portland Cement Association.

At the afternoon session Colonel Slaughter, U. S. A., presented a paper on Recent Development in Signaling at the Front, in which he described the use of carrier pigeons, message bearers, sound signaling and radio communication.

Mr. J. F. Gilchrist, Vice-President of the Commonwealth Edison Company of Chicago, delivered a paper on Financial Problems of the Utility in War Times, pointing out that as utility companies generally have an investment of from five to six times their annual gross receipts, whereas in many other lines of business the annual gross receipts and investments are about the same, public utility corporations require large amounts of capital for their operation. This capital has been raised in the past principally by the sale of bonds and preferred stock, for which there is little sale at this time. An estimated sum of $100,000,000 will have to be raised in the year 1918 to take care of the necessary expansion of the public utilities. In past years, a number of plants, especially in Pittsburgh and the Atlantic Coast districts, have had so many demands for power to take care of war needs that they have found it necessary to ask the Priority Committee at Washington to designate which plants should be given preference. Some industries were given current for five days of the week instead of six, or for eighteen hours instead of twenty-four. As expenses, especially local, are costing the utilities more than in the past, it is apparent that if a number of the utilities are to remain solvent, rates must be raised by the Commission.

Considerable discussion followed, led by H. O. Garmon, Chief Engineer of the Indiana Public Service Commission, and George Hubley, Manager of the Merchants' Heat & Light Co. of Indianapolis.

An illustrated lecture on Concrete Ships and Barges was given by J. E. Freeman, of the Portland Cement Association, Chicago, Ill., pointing out the great possibilities of concrete, and of how stability is maintained in ships and barges.

A paper entitled Vocational and Industrial Education was given by A. S. Hurrell, Assistant Superintendent of Vocational and Industrial Education of the Indianapolis Public Schools.

At the evening session Mr. Will H. Hays, Chairman of the State Council of Defense of Indiana, delivered an address on the subject of The Engineer and the State Council of Defense, in which he brought out that every citizen has a patriotic duty to perform, but upon the engineer particularly the burden rests. The Indianapolis Engineers' Club was praised most warmly for the active influence and help extended to the state in the organization of the Battalion of Engineers of Indiana.

The concluding number on the program was an illustrated lecture by W. S. Culver, District Engineer of the General Electric Company, Cincinnati, Ohio, on The King of the Rail.

W. A. HANLEY,
Section Secretary.

NEW ORLEANS

March 11. At a meeting of the Louisiana Engineering Society, to which the members of the A.S.M.E. Section were invited, A. M. Lockett, Mem.Am.Soc.M.E., delivered a lecture on The New Orleans Industrial Canal. Further details regarding the meeting will be published in a later issue of THE JOURNAL.

H. L. HUTSON,
Section Secretary.

NEW YORK

February 21. How non-essential work might be turned into aid toward winning the war, was a subject which brought forth much discussion at the meeting. Ten or twelve speakers representing as many industries discused the subject, each setting forth his reason for considering the industry he represented, an essential one. Among the speakers were the following: Calvin W. Rice, Secretary, A.S.M.E.; Frederick W. Keough, Editor of *American Industries*, published by the National Association of Manufacturers; William Hamlin Childs, President of the Barrett Company; Sterling H. Bunnell, of R. Martens & Company; Horace B. Cheney, Jr., Vice-President of Cheney Brothers; Charles T. Main, President, A.S.M.E.; J. H. Haas, of the Loft Candy Company; Erik Oberg, Editor of *Machinery;* C. R. McMillen, of the Union Paper Bag Corp.; Frank Mossberg, of Attleboro, Mass.; P. W. Henry, of the American International Corporation, and Prof. D. D. Jackson, of Columbia University.

A detailed report of the meeting will be found in the Technical Section of this issue.

March 19. Terminal Facilities of New York was the subject of the meeting and was discussed by the following speakers, each covering a special phase of the subject: A. B. Pough presented the first topic, on Demands, including Pre-War, War, After-War and Future Demands. B. F. Cresson, Jr., discussed Land Facilities to meet the demands, such as railroads, marginal railroads, trucking and warehouses. W. J. Barney spoke on the Water Facilities to meet the demands, such as harbor, rivers, canals, docks, lighterage and mechanical. Deficiencies and Their Correction were discussed by George H. Pride. Agencies in Development, such as private capital, city, state, and national Government, were covered by Ira Place, and Charles Whiting Baker gave a résumé of the entire subject, offering a great many practical suggestions.

W. HERMAN GREUL,
Section Secretary.

PHILADELPHIA

March 26. Dr. S. W. Stratton of the United States Bureau of Standards delivered a talk on Recent Developments in Methods of Measurement. Further details will be published in a later Journal.

John P. Mudd,
Section Secretary.

PROVIDENCE

March 4. At the first Annual Smoker and General Meeting of the Providence Engineering Society, Gov. R. Livingston Beekman gave an interesting acount of his experiences at the battlefront.

March 12. Under the auspices of the Machine-Shop Section, Henry K. Spencer, of the Blanchard Machine Company, read a paper on The Production of Flat Surfaces by Modern Surface Grinding Machines.

March 13. At the Power-Section Meeting Mr. Warren F. Hodges presented a paper on Motor Troubles, and a second paper on the subject of Automobile Starters was given by Alfred Maille.

March 22. Mr. G. Douglas Wardrop, Editor of the *Aerial Age*, gave an interesting lecture on War in the Air. Mr. Calvin W. Rice, Secretary of the A.S.M.E., delivered a short address on Methods of Coöperation in Meeting Present Emergencies.

James A. Hall,
Correspondent.

Student Branch Meetings

The Metropolitan Student Branches of the Society located at Columbia University, New York University, Polytechnic Institute of Brooklyn and Stevens Institute of Technology, will hold the usual spring meeting at the Engineering Societies Building on Tuesday, April 9. There will be an afternoon and an evening session, with a buffet supper between the sessions.

The committee in charge of the arrangements is composed of two representatives of each of the Student Branches, with Herbert Lowenstein as chairman and Lincoln V. Aquadro as secretary. The committee has been exceedingly fortunate in getting the acceptances of the following speakers: F. R. Hutton, Richard B. Sheridan, Ira N. Hollis, G. D. Wardrop, M. H. Avram and Jack Armour. Other prominent engineers have been invited with a view to having a number of short interesting talks in preference to a few lengthy ones. The subjects to be touched upon include aviation, marine engineering, the need for technical training, especially in war times, the engineering requirements of our allies, the railroad engineer, and the young engineer in the army and navy.

The New York Section of the Society has decided to coöperate with the students by joining with them in this meeting and making it the April meeting of the Section.

The lecture by Mr. Wardrop on War in the Clouds is illustrated by motion pictures and lantern slides, and brings this phase of the situation up to the minute.

Members of the Society are especially urged to attend this meeting, not only to give these embryo engineers an opportunity to meet some of those established in the profession, but also because of the opportunity afforded for meeting prospective assistants to take positions upon graduation or temporarily during the vacation period. It is hoped that a number of members will make a point of being present to give encouragement to these young engineers in making a success of the meeting. All technical students, whether student members or not, are likewise urged to attend. Those desiring to participate in the supper should notify the secretary's office not later than noon, April 9.

UNIVERSITY OF CINCINNATI

February 21. A paper on the Construction of Concrete Ships and Barges was presented by J. E. Freeman.

March 21. A paper on Shop Kinks was presented by Henry Ritter, Mem.Am.Soc.M.E.

Professor John T. Faig, Mem.Am.Soc.M.E., delivered a paper on The Economic Use of Coal by Communities. In view of the increasing need of conservation at this time, a method of using coal by which all of the by-products are saved was fully discussed.

Mr. C. W. Carpenter, Mem.Am.Soc.M.E., who has had considerable experience in training thousands of women for war industry, delivered an interesting lecture on The Training of Women for Industry.

J. T. Faig,
Section Secretary.

CARNEGIE INSTITUTE OF TECHNOLOGY

February 13. An illustrated talk was given by W. C. Wright on Modern Foundry Methods and Equipment, which showed present foundry practice and the various devices for increasing the output and decreasing the number of skilled molders necessary. The subject of the woman worker was presented, and the matter of making her surroundings more pleasant and sanitary and the need for safety devices in the line of work in which she is employed were discussed.

H. D. Krummel,
Branch Secretary.

UNIVERSITY OF COLORADO

March 7. Professor Black delivered an illustrated lecture on Properties of Commercial Steam Pipe Coverings. The lecture covered experiments performed at the University of Wisconsin. The different methods of measuring heat dissipation through pipe coverings, and the means of measuring temperatures, giving preference to the copper-constantan thermocouple, were discussed. Various curves were shown indicating the comparative insulating properties of different coverings and also the saving possible through efficient covering.

H. O. Croft,
Branch Secretary.

POLYTECHNIC INSTITUTE OF BROOKLYN

March 8. Benjamin Offen was elected treasurer, to succeed Joseph L. Kopf.

Mr. Arthur Seubert, in his talk on Engineering Education, pointed out that by affiliating with engineering or college societies the student's powers of leadership, tact and resourcefulness are developed.

A special war-time course in radio engineering, covering theory, code and laboratory work, is being given at the Institute and is open to seniors in mechanical engineering.

Nathan N. Wolpert,
Branch Secretary.

UNIVERSITY OF WASHINGTON

An inspection trip was made to the Ford assembling station and to the sub-stations of the Seattle Light & Power Company. Forty members and guests of the university participated.

The university is coöperating with the Government by having a Reserve Officers Training Corps in which underclassmen receive eight hours of training a week with upperclassmen as officers and members of the faculty as instructors, the latter being in the R.O.T.C. An A.U.S. Naval Training Station is located on the Campus with an enrollment of about a thousand and a course for marine operating engineers under the direction of the U. S. Shipping Board is given by the mechanical engineering faculty to men from all over the West and Southwest. Over a thousand men from the University of Washington are now in the service, and a good share from the engineering school are now in various branches of the Engineering Corps and other branches of service.

Fairman B. Lee,
Branch Secretary.

TENTH ROLL OF HONOR

***ONE HUNDRED AND SIXTY-EIGHT** additional names of members of The American Society of Mechanical Engineers are added to our ever-lengthening Roll of Honor, and the stars on the service flag now number over 900.*

Abercrombie, James H., Captain, British Army.
Abernethy, W. K., Aviation Corps, U. S. Army.
Alden, J. L., Second Lieutenant, Ordnance Department, N. A.
Allen, Henry A., Colonel, Commanding 108th Engineers, 33rd Division, Camp Logan, Houston, Texas.
Antonsanti, Louis, 2nd Officers' Training Camp, San Juan, Porto Rico.
Arkell, William C., First Lieutenant, Ordnance Officers' Reserve Corps.
Ashley, Edward E., Jr., First Lieutenant, Engineering Section, Signal Corps, U. S. Army.
Badowski, Alfred, Captain, Ordnance Department, U. S. Army.
Baird, James T., Jr., Captain, Ordnance Officers' Reserve Corps.
Baker, Philip C., Lieutenant, 79th Aero Squad, American Expeditionary Forces, France.
Banquet, Camille, Jr., Second Lieutenant, 1st Company, Coast Artillery Corps, Fort Mott, New Jersey.
Barry, Thomas J., Company A, 37th Engineers, Fort Meyer, Va.
Beard, Theodore H., Lieutenant, Sandy Hook Proving Ground, Fort Hancock, New Jersey.
Behr, F. J., Major, Coast Artillery Corps, U. S. Army.
Bensel, John A., Major, Engineer Officers' Reserve Corps, U. S. Army.
Bolles, Frank G., Major, Ordnance Department, U. S. Army.
Bond, William L., First Lieutenant, Ordnance Officers' Reserve Corps, Frankford Arsenal, Pa.
Bowles, Hardy, Captain, 23rd Engineers, American Expeditionary Forces, France.
Bres, Edward W., Lieutenant, 312th Engineers, Camp Pike, Arkansas.
Brooks, J. Ansel, Captain, Aviation Section, Signal Reserve Corps.
Brown, Clinton, First Lieutenant, Carriage Section, Production Division, Ordnance Officers' Reserve Corps.
Brown, Eugene L., Jr., First Lieutenant, Engineer Officers' Reserve Corps.
Buckley, Captain, Ordnance Officers' Reserve Corps, Frankford Arsenal, Philadelphia.
Buyers, A. S., Captain, Coast Artillery Corps, U. S. Army.
Campbell, Jeremiah, Major, Engineer Officers' Reserve Corps, American Expeditionary Forces, France.
Carothers, Charles G., Captain, Company 1, Engineer Officers' Reserve Corps.
Carter, William D., Captain, Ordnance Officers' Reserve Corps.
Case, Milo M., Major, Inspection Department, Ordnance Officers' Reserve Corps.
Chapman, Edmund E., Captain, Ordnance Officers' Reserve Corps.
Clarkson, Robert C., Jr., Mechanical Engineer, Signal Corps, U. S. Army.
Coburn, Frederic G., Naval Constructor, U. S. Navy.
Cole, C. L., Captain, Ordnance Officers' Reserve Corps.
Conant, William S., Major, Ordnance Officers' Reserve Corps.
Cone, Hutchinson J., Commander, U. S. Navy, Navy Department, Washington, D. C.
Converse, Bernard T., Major, Ordnance Officers' Reserve Corps, Watervliet Arsenal, Watervliet, New York.
Cordes, Paul H., First Lieutenant, Company C, 30th Engineers, Gas and Flame Regiment, Fort Myers, Va.
Cutler, James B., Lieutenant, U. S. Reserve, Battery E, 319th Field Artillery, Camp Gordon, Georgia.
Davies, Clarence E., First Lieutenant, Ordnance Officers' Reserve Corps, Frankford Arsenal, Pa.
Davies, T. R., First Lieutenant, Ordnance Officers' Reserve Corps.
Dexter, Harris E., Lieutenant, 30th Engineers, American Expeditionary Forces.
Doll, William E., Lieutenant, 35th Engineers, U. S. R., Camp Grant, Rockford, Ill.
Eddison, Barton, Lieutenant, Junior Grade, U. S. Naval Reserve Force.
Eddy, Benjamin S., First Lieutenant, Engineer Officers' Reserve Corps.
Eisenhart, H. W., Captain, Production Division, Carriage Section, Ordnance Officers' Reserve Corps, U. S. A.
Engesser, B. M., Aviation Section, Signal Corps, Army School of Military Aeronautics, M. I. T.
Evans, B. R., Machinist's Mate, 2nd Class, United States Navy, U. S. S. B 1 Submarine.
Farrington, Thomas H., Captain, Engineer Officers' Reserve Corps, Fort Leavenworth, Kansas.
Ferguson, W. Craig, First Lieutenant, Ordnance Officers' Reserve Corps.
Flagg, Paul M., Private, Company F, 304th Engineers, National Army, Camp Meade, Maryland.
Foord, James L., Lieutenant-Commander, N. N. V., U. S. Navy, U. S. Training Station, Great Lakes, Ill.
Ford, John D., Rear Admiral, U. S. Navy.
Forsyth, James M., Candidate Second Officers' Training Camp, Fort Sheridan, Ill.
Fraser, D. Ross, First Lieutenant, Engineer Officers' Reserve Corps.
Fravens, Frank H., Company A, 42nd Engineers, Camp American University, Washington, D. C.
Fulweiler, John E., Ensign, U. S. Naval Reserve Corps, U. S. S. *James*.
Gallaher, Charles W., First Lieutenant, Iowa Engineers, Brownsville, Texas.
Gibbs, Charles W., Machinist's Mate, Second Class, U. S. Naval Reserve Force.
Gibson, Julian B., Second Lieutenant, Quartermaster's Corps, National Army, Camp Meade, Maryland.
Gilbert, Huntley H., Captain, Ordnance Officers' Reserve Corps, Rock Island Arsenal, Ill.
Goodier, Homer W., First Class Private, Aviation Section, Signal Enlisted Reserve Corps.
Haasis, P. W., Aviation Section, Signal Officers' Reserve Corps.
Hawes, Alex. G., Captain, Ordnance Officers' Reserve Corps.
Hayes, William Parsons, Lieutenant, Fleet Naval Reserve, U. S. S. *Niagara*.
Heidelburg, Fred M., First Lieutenant, Inspection Division, Ordnance Department, U. S. A.
Henry, Alexander S., Jr., Aviation Corps, No. 104th Aero Squadron, U. S. Army.
Hicks, Rufus W., Jr., First Lieutenant, Ordnance Officers' Reserve Corps.
Horner, Benjamin B., Second Lieutenant, Engineer Officers' Reserve Corps, 311th Engineers, Camp Grant, Ill.
Hulburt, Wynne D., Second Lieutenant, 71st Regiment Engineers (Railway), American Expeditionary Forces, France.
Husted, Clifford M., Captain, Engineers, U. S. Army.
Hutchinson, H. H., Captain, Ordnance Officers' Reserve Corps.
Iddles, Alfred, First Lieutenant, Engineering Bureau, Ordnance Officers' Reserve Corps.
Ireland, Mark L., Major, Quartermasters' Corps, Fort Sam Houston, Texas.
James, Richard M., Private, Ordnance Training School, Pittsburgh, Pa.
Jamieson, Charles C., Colonel, Ordnance Department, N. A.
Jenks, Glen F., Lieutenant-Colonel Ordnance Department, American Expeditionary Forces, France.
Junkersfeld, Peter, Lieutenant-Colonel, Quartermaster Corps, N. A.
Keenan, Walter M., First Lieutenant, Aviation Section, Signal Officers' Reserve Corps.
Keet, Clarence T., Company A, 304th Engineers, Camp Meade, Maryland.
Kennedy, Grafton S., Lieutenant, Coast Artillery Corps, U. S. Army, Fort Morgan, Ala.
Kent, Robert W., First Lieutenant, Ordnance Officers' Reserve Corps.
Kessler, Herbert, First Lieutenant, Ordnance Officers' Reserve Corps.
King, William R., Major, Ordnance Officers' Reserve Corps.
Kingsbury, Chester L., Lieutenant, Ordnance Officers' Reserve Corps.
Knight, William, First Lieutenant, Aviation Section, Signal Officers' Reserve Corps.
Koch, Charles, Ordnance Draftsman, Philadelphia Navy Yard.
Lane, Abbot A., First Lieutenant, Signal Officers' Reserve Corps.
Lewis, J. Clifford, Construction Department, Signal Corps, U. S. Army.
Lipsner, Benjamin B., Captain, Signal Corps, U. S. Army.
Logan, Orwell, National Army, Camp Upton, Yaphank, Long Island.
Lonn, Julius M., First Lieutenant, Ordnance Department, Frankford Arsenal, Philadelphia, Pennsylvania.
Lowman, Roy L., Lieutenant, United States Naval Reserve Force.
MacDonald, Howard D., First Lieutenant, 131st U. S. Infantry, Camp Logan, Texas.
McCune, Joseph C., First Lieutenant, Engineer Officers' Reserve Corps.
McKinney, William P., U. S. Navy, Naval Aviation Corps.
McMurray, J. H., Captain, Ordnance Department, N. A.
Magee, Christopher, Company M, 332d Infantry, Camp Sherman, Ohio.
Martin, Edward, U. S. Navy, Naval Aviation Corps.
Massey, George B., Lieutenant, Junior Grade, Fleet Reserve.
Maxfield, Howard H., Colonel, 19th Regiment Engineers (Railway), American Expeditionary Forces, France.

Maxwell, George L., Company A, 29th Engineers, American Expeditionary Forces.
Meigs, Robert R., First Lieutenant, 19th Regular, Engineers (Railway), American Expeditionary Forces, France.
Merrill, Albert S., First Lieutenant, Inspection Division, Ordnance Officers' Reserve Corps.
Messner, Manfred, Private, Company K, 312th Infantry, Camp Dix, N. J.
Meyler, Robert G., First Lieutenant, Ordnance Officers' Reserve Corps, Rock Island Arsenal, Rock Island, Ill.
Miller, Clarence A., National Army.
Moody, Frederick H., Major, 116th Battalion, Canadian Infantry, France.
Moyer, Will D., Captain, Coast Artillery, Officers' Reserve Corps, Fort McKinley, Portland, Maine.
Nesbit, Joseph, N. G., Ordnance Division, Sandy Hook Proving Ground, Fort Hancock, New Jersey.
Norris, John B., Jr., First Lieutenant, Engineer Officers' Reserve Corps.
Osgood, W. H., Lieutenant, United States Navy.
Overmire, Wilfred J., Private, Company C, 334th Infantry, Camp Zachary Taylor, Kentucky.
Packard, H. N., Lieutenant, Junior Grade, Naval Reserve Force.
Palmer, Brian C., Science and Research Division, Signal Corps, U. S. Army.
Parkhurst, Harleigh, Major, Field Artillery, U. S. Reserve, 14th Field Artillery, Fort Sill, Oklahoma.
Pemberton, C., Lieutenant, Ordnance Department, Camp Jackson, South Carolina.
Pohle, Richard F., First Lieutenant, Inspection Department, Ordnance Officers' Reserve Corps.
Powell, Paul R., First Lieutenant, Engineer Officers' Reserve Corps, U. S. Army.
Ray, Martin H., Captain, Aviation Section, Signal Corps, U. S. A.
Reilly, Charles J., Company C, 21st Engineers, Camp Grant, Rockford, Ill.
Rider, David S., Private, Company E., Private, 10th Engineers (Forestry), American Expeditionary Force, France.
Riley, Joseph C., Major, Air Service, Signal Corps, American Expeditionary Forces, France.
Roberts, Richard F., Equipment Division, Signal Corps, U. S. A.
Rosenfield, Harold, Aviation Section, Signal Officers' Reserve Corps.
Ross, Sir Charles H. A. F. L., Lieutenant, Ordnance Officers' Reserve Corps, Fort Hancock, Sandy Hook, New Jersey.
Russ, John B., First Lieutenant, Engineer Officers' Reserve Corps.
Ryder, Frederick W., 1st Battery, Reserve Officers' Training Camp, Fort Niagara, New York.
Sauers, John A., First Lieutenant, Ordnance Officers' Reserve Corps, Frankford Arsenal, Bridesburg, Pennsylvania.
Schaum, Otto W., Aeronautical Mechanical Engineer, Signal Corps, U. S. Army.
Schmidt, John D., Ensign, U. S. Naval Reserve Force.
Schupp, Arthur A., Second Lieutenant, Signal Corps, U. S. Army.
Scott, Rossiter S., Captain, Engineers, U. S. Reserve, 8th Company, Camp Lee, Va.
Sharkey, W. E., Lieutenant, Ordnance Officers' Reserve Corps.
Sharp, Ralph E., Camp Meade, Maryland.
Slade, Henry L., Jr., First Lieutenant, Ordnance Officers' Reserve Corps.
Spaulding, Hollon C., Captain, Quartermaster Reserve Corps, Army Transport Service.
Streeter, Robert L., Major, Ordnance Department, National Army.
Stults, William R., Private, National Army, 18th Company, 5th Training Brigade, Depot Brigade, Camp Devens, Ayer, Mass.
Stureman, Robert V., Quartermaster Corps, Camp Logan, Houston, Texas.
Swift, Harley L., First Lieutenant, 16th Regiment Engineers (Railway), American Expeditionary Forces, France.
Swinton, David R., First Lieutenant, National Army.
Thompson, John T., Colonel, United States Army.
Tower, Glenn L., Lieutenant, Ordnance Department, National Army.
Trowbridge, Amasa, Major, Ordnance Officers' Reserve Corps, Watervliet Arsenal, Watervliet, New York.
Tuttle, George W., Aviation Section, Signal Reserve Corps.
Van Keuren, E. B., Captain, Ordnance Officers' Reserve Corps.
Vauclain, A. C., Major, Ordnance Officers' Reserve Corps.
Vehslage, H. E., First Lieutenant, Purchase Section, Gun Division, Ordnance Officers' Reserve Corps.
Vogt, Clarence W., Captain, Ordnance Department, N. A.
Voorhees, John R., Lieutenant, Ordnance Department, U. S. Army, Sandy Hook Proving Ground, Fort Hancock, N. J.
Waddell, Robert, Lieutenant, Royal Flying Corps, British Army.
Warren, William H., Corporal, Headquarters Company, 340th Field Artillery, National Army, Camp Funston, Kansas.
Webster, Lawrence B., Captain, Ordnance Officers' Reserve Corps.
Weeks, Paul, Captain, Motor Equipment Section, Ordnance Officers' Reserve Corps.
Wegnerer, Francis A., Naval Reserve Flying Corps.
Weinberg, George S., Major, 30th Engineers, American Expeditionary Forces, France.
Welford, P. G., Gunner, Canadian Field Artillery.
Wells, G. A., Captain, Carriage Division, Motor Equipment Section, Ordnance Officers' Reserve Corps.
Westervelt, W. I., Colonel, Field Artillery, N. A., American Expeditionary Forces, France.
Wheeler, F. B., Gas Defense Service, American Expeditionary Forces, France.
Whitlock, Elliott H., Lieutenant-Colonel, 24th Engineers, N. A., American Expeditionary Forces, France.
Wieland, C. F., Captain, Ordnance Officers' Reserve Corps, Manila Ordnance Depot, Manila, P. I.
Wightman, George A., Sergeant, Ambulance Company, Training Camp Zachary Taylor, Louisville, Kentucky.
Wilbur, R. L., First Lieutenant, Ordnance Officers' Reserve Corps, U. S. Army.
Williams, Harold E., Captain, Field Artillery, Officers' Reserve Corps.
Williams, R. G., Captain, Ordnance Officers' Reserve Corps.
Woodcock, William E., Second Lieutenant, Engineer Officers' Reserve Corps.
Ycasiano, F. R., Captain, Radio Company, Field Battalion, Signal Corps, National Guard, Philippine Islands.
Zeiger, Kenneth G., Student Officers' Training Camp, 2nd Coast Artillery Corps, Fort Winfield Scott, California.
Zink, Robert E., Captain, Ordnance Officers' Reserve Corps.

PERSONALS

In these columns are inserted items concerning members of the Society and their professional activities. Members are always interested in the doings of their fellow-members, and the Society welcomes notes from members and concerning members for insertion in this section. All communications of personal notes should be addressed to the Secretary, and items should be received by April 16 in order to appear in the May issue.

CHANGES OF POSITION

Henry A. Stringfellow has left the employ of the Epping-Carpenter Pump Company, Pittsburgh, Pa., to assume the position of first assistant engineer with R. Winthrop Pratt, consulting engineer, on the design of the new filtration plant for the City of Detroit, Mich.

John H. Wilhelm, formerly superintendent of the Gage Department of Frankford Arsenal, Frankford, Pa., has become affiliated with the Blair Tool and Machine Works, Inc., New York, in the capacity of chief engineer.

B. F. Safberg has left the employ of the Babcock and Wilcox Company and has become identified with the production department of the Emergency Fleet Corporation, Washington, D. C., in charge of boiler production.

John W. Mershon has resigned his position as mechanical engineer of Remington Arms, Bridgeport, Conn., to take a position as plant engineer at Bayles Shipyard, Port Jefferson, N. Y.

George M. Keenan, test engineer of the Union Electric Company, St. Louis, Mo., has assumed the duties of chief engineer of the Little Rock Railway and Electric Company, Little Rock, Ark.

Leo Loeb has severed his connection with the Coal Companies with which he has been associated within the past four years, and has joined the organization of Day and Zimmermann, Inc., of Philadelphia, Pa.

E. H. NILSON has resigned as chief engineer of the Blake-Knowles Plant of the Worthington Pump and Machine Corporation, and has accepted the position of general works manager with the Griscom-Russell Company, of New York, with headquarters at Massillon, Ohio.

ROBERT H. SCHAFER has resigned as mechanical superintendent of the Bridgeport Brass Company, to accept a position as mechanical engineer of design and equipment of the Brown's Copper and Brass Rolling Mills Company, Ltd., Toronto, Ont., Canada.

DANIEL M. SACHS, until recently vice-president and general manager of the Northern Pipe Line Company, Oil City, Pa., has accepted the position of general manager of the New York Transit Company, Binghamton, N. Y.

A. H. LANE has severed his connection with the Eastern Machinery Company, New Haven, Conn., with which firm he held the position of engineer for the past three years, and has taken a position with the Grant Hammond Manufacturing Corporation, of New York, as special machine designer.

Z. E. SARGISSON has resigned his position as chief designing engineer of the Illinois Traction System, Peoria, Ill., to accept the position of assistant works engineer of the Pan Motor Company, of St. Cloud, Minn.

O. D. A. PEASE, formerly assistant foreman of the test department of the Pennsylvania Railroad at Altoona, Pa., has accepted an appointment with the Bureau of Explosives, as inspector, with headquarters in New York.

EARL E. ADAMS, lately sales manager of the powdered coal department of the Bonnot Company, Canton, Ohio, and for some years in charge of gas producer work for the Power and Mining Machinery Company, has accepted a position as sales engineer for the Smith Gas Engineering Company, and will shortly be located at Dayton, Ohio, where the new plant of the Smith Gas Engineering Company is nearing completion.

WILLIAM T. PRICE has recently resigned as manager and chief engineer of the De La Vergne Machine Company, oil engine department, to become president of the P-R Engine Company of New York, and second vice-president of The Rathbun-Jones Engineering Company of Toledo, Ohio, which will undertake the sale and manufacture respectively of Price-Rathbun stationary and marine oil engines built in accordance with a new principle of fuel injection developed by Mr. Price during the past several years.

ANNOUNCEMENTS

The following appointments have been announced by the Worthington Pump and Machinery Corporation: JAMES E. SAGUE, consulting engineer, has been appointed vice-president in charge of engineering and manufacture; WILLIAM GOODMAN, manager of the Laidlaw Plant, appointed assistant to vice-president; WILLIAM SCHWANHAUSSER has been reappointed chief engineer; CHARLES E. WILSON, appointed assistant general sales manager.

ULDRIC THOMPSON, JR., formerly chief engineer of the International Steel and Ordnance Corporation, and who has until recently been serving in an advisory capacity in equipping the new artillery ammunition plant at Rock Island Arsenal, has opened an office at 120 Broadway, New York, under the firm name of Uldric Thompson, Inc., consulting and industrial engineers.

J. C. BERTSCH has resigned his position as refrigerating engineer with The Westinghouse Electric and Manufacturing Company machine works, to engage as consulting engineer in the design of thermo-compressors for air, steam and ammonia, and apparatus for rubber mill, gasoline extraction and marine refrigeration, with office in Pittsburgh, Pa.

RICHARD F. ROBERTS has been given an indefinite leave of absence from the Chile Exploration Company, to enter the equipment division of the U. S. A. Signal Corps, Washington, D. C.

CHARLES W. GIBBS has been enrolled in the U. S. Naval Reserve Forces as Machinist's Mate, 2nd Class, and will be detailed for duty at the Fuel Oil Testing Plant, Philadelphia Navy Yard.

HENRY E. LONGWELL announces his resignation as vice-president and general manager of The Westinghouse Air Spring Company, New Haven, Conn.

JAMES A. SHEPARD, vice-president and chief engineer of the Shepard Electric Crane and Hoist Company, Montour Falls, N. Y., gave an interesting talk on Designing at the February 22d meeting of the Shepard Progress Club.

HAROLD I. MARKEY has left the engineering department of the Firestone Tire and Rubber Company, Akron, Ohio, to take the position of assistant chief engineer of the Diamond Chain and Manufacturing Company, Indianapolis, Ind.

A. C. VOORHEES has resigned his position as chief submarine draftsman for the California Shipbuilding Company, to accept the position of assistant to the general superintendent with the Schaw-Batcher Company Pipe Works of San Francisco, which has contracts for 18 freighters for the Emergency Fleet Corporation.

FORREST H. BLANDING, formerly identified with the McEwen Manufacturing Company, Tulsa, Okla., as superintendent, has accepted a similar position with the ordnance works of the Otis Elevator Company, Chicago, Ill.

CHARLES A. MALONEY, efficiency engineer with the United Gas Improvement Company, Philadelphia, Pa., has become affiliated with the Merchant Shipbuilding Corporation, Bristol, Pa., in the capacity of mechanical engineer.

FRANCIS A. WEGENER is no longer connected with the Welsbach Company, Gloucester, N. J., having enlisted in the U. S. Naval Reserve Flying Corps. He is at present under instruction at Columbia University, New York.

FRANK O. WELLS, president of the Greenfield Tap and Die Corporation, is one of the directors of the Lincoln Twist Drill Company, of Taunton, Mass.

ROBERT P. LAY, assistant engineer of the experimental motor division of the Curtiss Aeroplane and Motor Corporation, Buffalo, N. Y., has been transferred to the Garden City, L. I., N. Y., plant of The Curtiss Engineering Corporation.

JOHN YOUNGER of the Pierce-Arrow Motor Truck Company, Buffalo, N. Y., is serving in the engineering division of the motor transport section of the Quartermasters Corps.

ROBERT T. KENT has become associated with Meyer, Morrison and Company, consulting engineers, of New York.

NECROLOGY

JOHN PORTERFIELD SPARROW

John Porterfield Sparrow, for many years a member of the Society, died at his home in Flatbush, Brooklyn, on March 18, 1918. He was born in Portland, Maine, on March 17, 1860.

Mr. Sparrow was an engineer by inheritance and education, his father, John Sparrow, being well known in the engineering field. His early education was obtained in the public schools of Portland, but this was largely supplemented by his father's teachings in physics, chemistry and engineering.

In 1879, being interested in sugar manufacture, Mr. Sparrow was taken to Europe by his father to study the industry, and while there visited all of the larger engineering works. In 1880 he entered the Portland Company's locomotive and marine-engine works as an apprentice. He served his apprenticeship and became a toolmaker and erector for that company, leaving them in 1888 to work for the Sprague Electric Company. During the next two years he acted as superintendent for the Sprague Electric Company, in charge of construction of electric railways in the various parts of the country. In 1890 he went to New Orleans for the New Orleans Electric Company on construction work. In 1892 he joined the construction staff of the Edison General Electric Company and was

employed in building lighting and power plants for them and the Canadian General Electric Company until 1895. In 1895 he joined the staff of the construction department of the Edison Electric Illuminating Company of New York, and in 1898 became superintendent of construction, having charge of all of the construction, which included the new Waterside Station, at that time the largest and most important construction of its kind which had been attempted. In 1906 he became chief engineer of The New York Edison Company in charge of construction and operation, the position he held at the time of his death.

Mr. Sparrow became a member of the Society in 1898 and was an active member, serving on various committees. At the time of his death he was Chairman of the Committee on Standardization of Flanges and Pipe Fittings, and had just finished the completed report on that subject. On February 1, 1918, he was appointed Chairman of the Advisory Board of the Power Test Committee. His work along these lines has been particularly valuable, as his long experience, trained judgment and personal influence insured the reconcilation of conflicting interests.

John Porterfield Sparrow

In the Association of Edison Illuminating Companies he was a member of the Committee on Steam Plants from 1906 up to the present time, and was chairman in 1910, 1912 and 1913. In this work his most valuable contributions were those in connection with coal testing and burning. Before the Edison Association he presented a number of papers on boiler-plant problems.

In the National Electric Light Association he was a member of the Committee on Prime Movers for a number of years, and was a frequent contributor to the Question Box.

Shortly after the United States entered the war he made a number of tests for the Naval Consulting Board in connection with smoke abatement on ships as a protection against submarines.

Mr. Sparrow's hobbies were largely of an engineering character. In photography his work as an amateur rivaled many professionals, and he was one of the first to take up color photography. Microscopy, as a result of his early training, was always one of his chief aids and his work on the photomicrography of lamp filaments is well known. In later years he turned to metallography in connection with the ever-present subject of the corrosion of condenser tubes, and assisted in the settling of important questions of heat treatment in the manufacture of this material. His knowledge of physical science was fundamental and he was an adept in the mechanical handling and manipulation which is a necessity in research work of this kind.

Mr. Sparrow had a charming personality and his optimistic temperament, uniform courtesy and entire absence of contentiousness endeared him to a host of friends. He was held in affectionate regard by the officials of The New York Edison Company, to whom his passing away comes as a personal loss.

FRANCIS E. GALLOUPE

Francis E. Galloupe was born in Lynn, Mass., on October 3, 1855. He attended the high school in Lynn and later the Massachusetts Institute of Technology at Boston, where he took the course in mechanical engineering and received his degree in 1876.

Upon graduation he was connected with the Rhode Island Locomotive Works for about two years and spent approximately the same time with the Baldwin Locomotive Works and with the Brooks Locomotive Works. The next two or three years he devoted to the design of rolling stock for the proposed Meigs Railroad. Following this period, he was engaged in the real-estate business. He was interested in developing and redeveloping properties and handled some very important transactions along this line. He possessed an unusually complete system of recording engineering information.

Mr. Galloupe was a charter member of the Society. He died in Boston, January 5, 1918.

JOSEPH FREDERIC KLEIN

Joseph Frederic Klein was born in Paris, France, on October 10, 1849. His parents were Huguenots and came to America when he was two and a half years old. They first settled in Bridgeport, Conn., where he attended the public schools, and moved to New Haven in 1858, where he attended the Eaton Grammar School. After finishing his common-school education he was employed as a machinist in the New Haven shops. Later, in 1866, he attended the famous military school of Gen. William H. Russell, which was also a college preparatory school. He was employed by Sargent & Co. and the W. & E. T. Fitch Co. as salesman and shipping clerk, always studying during his spare moments, as he was determined to get a college education.

His studious disposition won him many friends, among whom was the distinguished Prof. Willard J. Gibbs, of Yale University, who took a personal interest in him and through whose influence he decided to enter Sheffield Scientific School of Yale University. This he did in 1868, taking the course in mechanical engineering, then called dynamic engineering, and being graduated with the degree of Ph.B. in 1871. One of his classmates was Mansfield Merriman, afterward his associate at Lehigh University as professor of civil engineering. He was appointed the first instructor of the first evening school started in New Haven in 1868.

From 1871 to 1873 he did experimental work for Prof. W. P. Trowbridge of Yale and others. He also took a graduate course in mechanical engineering, receiving the degree of D. E. (Dynamic Engineer) at Sheffield in 1873. He entered the employ of Colt's Armory, Hartford, Conn., in 1873, first as draftsman and finally as assistant to the chief engineer, Mr. Charles B. Richards, that company being engaged at the time on the work connected with the heating and ventilating system of the (then) new State Capitol at Hartford. Mr. Richards, the inventor of the Richards steam-engine indicator, later became chief engineer of the Southwark Foundry and Machine Co., of Philadelphia, and subsequently professor of mechanical engineering at Yale University. Professor Klein was in the employ of Colt's from 1873 to 1877.

In 1877 Professor Klein returned to Sheffield Scientific School as instructor in mechanical engineering, being the assistant in this department of the late Prof. A. Jay DuBois. In the fall of 1881 he was called to Lehigh University to establish and develop a course in mechanical engineering, and was connected with that institution up to the time of his death. In 1887 to 1888 he was secretary of the faculty. In addition to his duties as head of the mechanical-engineering department he was appointed dean of the faculty in 1907, which additional work he has performed with distinction. From February to April, 1910, he was acting president of the University.

Professor Klein's published books are: Mechanical Technology of Machine Construction, 1884; Elements of Machine Design, 1889; Table of Coördinates for Laying Out Accurate Profiles of Gear Teeth, 1889; The Design of a High-Speed Steam Engine, 1892; and The Physical Significance of Entropy or of the Second Law, 1910. Also the following translations from the German:

Weisbach-Hertmann's Mechanics of Machinery of Transmission, 1883; Zeuner's Treatise on Valve Gears, 1884; and Zeuner's Technical Thermodynamics, 1907. He spent a number of years in researches on Dynamics of the Shaft Governor, intending to issue a work on Flywheels and Governors; this was never completed, although a part of the results of his investigations are in use in the mechanical-engineering course in Lehigh. He also made extensive researches in Kinematics of Machinery. His magazine articles are: Absolute Zero of Temperature, *Van Nostrand's Engineering Magazine*, April, 1880, Vol. xxxii; Concerning $(T_1—T_0)/T_1$ or the Limit of Efficiency of Heat Engines, *Journal of The Franklin*

JOSEPH FREDERIC KLEIN

Institute, March-April, 1879; Table and Diagram for Determining the Diameter of Speed Cones when Connected by an Open Belt of Constant Length, *Journal of The Franklin Institute*, May, 1880; Cone Pulley Diameters, No. 2, *American Machinist*, October 22, 1881; The Law of Proportional Resistance, *Journal of Engineering Society of Lehigh University*, November, 1889; and New Construction of the Force of Inertia of Connecting Rods and Couplers, and Construction of the Pressures on Their Pins, *Journal of The Franklin Institute*, September-October, 1891.

With Mr. L. P. Breckenridge, then his assistant at Lehigh University, now professor of mechanical engineering at Sheffield Scientific School of Yale University, he conducted a series of tests for the Lehigh Valley Road during the summer of (probably) 1888. Among other purposes, the tests were to determine the relative performance value of three different types of locomotive valves, the plain slide valve, the Allen-Richardson balance valve and the piston valve. Incidentally measurements were made of the exact length of the road, and they showed the official record to be a half mile in error.

Professor Klein was elected to membership in the Society in 1881, one year after its organization, and in 1907, on the occasion of the celebration of his twenty-fifth anniversary at Lehigh, he was presented by the alumni of his department of the University with a life membership in the Society. He was an honorary member of Tau Beta Pi. He died on February 11, 1918.

WILLIAM BURNHAM

William Burnham was born in Philadelphia on March 20, 1846. He was educated in private schools in Philadelphia and Allentown, Pa., and at the Lawrence Scientific School, Cambridge, Mass. After spending some years in the employ of the Baldwin Locomotive Works, in 1871 he became assignee for William Butcher, who first manufactured steel locomotive tires in the United States. When this business was reorganized as the Standard Steel Works, he was made secretary and treasurer, subsequently becoming chairman of the board. He was also a director of the Baldwin Locomotive Works.

Mr. Burnham was a member of a number of clubs. He was president of the Pennsylvania Working Home for Blind Men. He became an associate of the Society in 1888. He died on February 25, 1918.

GEORGE SUNTER POWER

George S. Power was born on May 17, 1870, in Brantford, Ont. He was graduated from the high school in Gaylord, Mich., and later took a five years' course at Cooper Union, New York, three of which were devoted to science and two to architecture.

Upon the completion of his high-school course he acted as principal for three years of a school in Duncan City, Mich. His next position was with the First National Bank of Duluth, Minn., as bookkeeper. About 1893 he left for New York City, where he became superintendent of the J. & J. Morrison Co., plasterers. In 1896 he became connected with the Witherspoon Plaster Mill, where his work consisted in the designing and building of labor-saving devices. In the following years he was associated with the Jackson Architectural Iron Works in designing and drafting; the Manhattan Concrete Co. in figuring and estimating; V. Dorne Sons, New York, as superintendent and estimator, and with the Rock Plaster Co., New York and Hoboken, as superintendent. In 1903 he was employed by the Robins Conveyor Belt Co. to design conveyor machinery; he also supervised the erection of a new plant for the company at Passaic, N. J. In 1903 he became identified with the U. S. Gypsum Co., Chicago, Ill., where his work consisted of designing and building new and remodeling old

GEORGE SUNTER POWER

gypsum mills. From 1905 to 1916 Mr. Power was associated with the firm of Wickes Brothers, Saginaw, Mich., where he held successively the positions of draftsman, designer of new machines, superintendent, and general manager of the rock-drill department. For the past fourteen months, up to the time of his death, he was with the Bayonne Steel Casting Co., Bayonne, N. J., as construction engineer and purchasing agent.

Mr. Power became a member of the Society in 1916. He died on January 14, 1918.

THOMAS FAWCUS

Thomas Fawcus was born in April, 1866, in Bedlington, England. He was graduated from the College of Science and Art, Newcastle-on-Tyne, England. He served his apprenticeship with

Black, Hawthorne & Co., Gateshead, England, locomotive, marine and stationary-engine builders.

He came to this country in 1888, locating in Birmingham, Ala., and was associated with various manufacturing firms in the southern states until 1893. At that time he became assistant to the superintendent of the Westinghouse Electric and Manufacturing Co., Pittsburgh, Pa. About two years later he accepted the position of assistant superintendent of the steel plant of the Anderson-Dupuy Co., resigning in 1897 to become superintendent of the R. D. Nuttall Co., Pittsburgh, Pa.

Wishing to control his own business he organized and established in 1900 the Fawcus Machine Co. at Pittsburgh, manufacturing gears and special machinery and particularly herringbone-gear drives.

Mr. Fawcus was responsible for many inventions, the most notable of which are the machines for cutting herringbone gears, which he started to design and develop in 1912. These machines were patented in the United States and foreign countries.

Mr. Fawcus took an active interest in civic affairs and was a member of the Chamber of Commerce and of the Manufacturers' Association of Pittsburgh. He was also a member of the Engineers' Society of Western Pennsylvania. He became a member of our Society in 1913. He died on January 22, 1918.

ARTHUR IRVING JACOBS

Arthur I. Jacobs was born in Hebron, Conn., in 1858. His educational advantages were meager during his boyhood and after his ninth year his schooling was limited to a short period in the winter. He worked with his father in mechanical lines until he attained his majority, when he secured employment in the Knowles Loom Works, Worcester, Mass. His mechanical bent

Thomas Fawcus

soon displayed itself and in a short time he made great improvements in the manufacturing methods of making harness chains for looms. He remained with this firm until 1887, during which period he invented and built a book-sewing machine of which several were purchased by Boston bookbinders. The Smyth Manufacturing Co., Hartford, Conn., which also manufactured such machines, became interested in his inventions, purchased his patents and engaged him to go to Hartford and he remained with them until 1901. During this period he invented and developed several machines for bookbinding; among these were two machines for making book covers which marked a great advance over methods which had been employed.

In 1902 he invented an improved drill chuck which he patented in the fall of that year. The following year the Jacobs Manufacturing Company was incorporated and has expanded from a small business to a large and active concern, of which he was president at the time of his death.

Mr. Jacobs became a member of the Society in 1913. He died on February 16, 1918.

LUIS G. MARQUINA

Luis G. Marquina was born in 1871 in Lima, Peru. He was educated in the Colegio de Guadalupe, Lima, and received his engineering degree in 1893 from the Escuela de Ingenieros, Lima.

His practical experience in general engineering was gained in

Arthur Irving Jacobs

the Casapalca and Rayo Smelting Works and with the firm of Backus & Johnston. From 1893 to 1897 he was in the drafting room of the Peruvian Corporation, Ltd., at Lobos Island. From 1897 to 1902 he was with the same company as superintendent and engineer of the Pascamayo Railroad. For the next four years he was general superintendent and engineer of the Eten Railroad. About 1907 he returned to the Peruvian Corporation and at the time of his death was general superintendent and engineer of that company.

Mr. Marquina became a member of the Society in 1906. He died on June 18, 1917.

FREDERICK W. SNYDER

Frederick W. Snyder was born on June 18, 1884, in Philadelphia, Pa. He was educated in the public schools and later attended the Williamson Free School of Mechanical Trades, from which he was graduated in 1904.

Upon his graduation he was employed as machinist in the Frankford Arsenal, Philadelphia, where he remained for over a year and a half. His next position was with the Buckhorn Portland Cement Co. as draftsman, but after a brief period in this capacity he was appointed assistant mechanical engineer of the plant. In 1908 he became associated with the Baldwin Locomotive Works, Philadelphia, Pa. His work there was in the drafting room and consisted of detailing and designing electric mine locomotives. After a year and a half he resigned to take a position with the Miller Lock Co., Frankford, Philadelphia, Pa., where he designed tool-room jigs and fixtures, blanking and bending dies, etc. In April, 1910, he became an instructor in the Williamson Free School of Mechanical Trades, Delaware County, Pa. At the time of his death he had charge of the classes in strength of materials and in machine-shop practice.

Mr. Snyder became an associate-member of the Society in 1916. He died on January 29, 1918.

CANDIDATES FOR MEMBERSHIP

TO BE VOTED ON AFTER MAY 10

Below is the list of candidates who have filed applications since the date of the last issue of The Journal. These are classified according to the grades for which their ages qualify them, and not with regard to professional qualifications, i.e., the ages of those under the first heading place them under either Member, Associate or Associate-Member, those in the next class under Associate or Associate-Member, those in the third class under Associate-Member or Junior, and those in the fourth under Junior grade only. Applications for change of grading are also posted. Total number of new applications, 256.

The Membership Committee, and in turn the Council, urge the members to scrutinize this list with care and advise the Secretary promptly of any objections to the candidates posted. All correspondence in this regard is strictly confidential. Unless objection is made to any of the candidates by May 10, and providing satisfactory replies have been received from the required number of references, they will be balloted upon by the Council. Those elected will be notified about June 15.

NOTE. The Council desires to impress upon applicants for membership that under the present national conditions the procedure of election of members may be slower than under normal conditions.

NEW APPLICATIONS

FOR CONSIDERATION AS MEMBER, ASSOCIATE OR ASSOCIATE-MEMBER

Arizona

RORK, Charles E., Chief Draftsman, Phelps Dodge Corporation, Douglas

California

CARSE, Herbert E., Lieutenant, U. S. Naval Reserve Training Camp, San Pedro

STROMGREN, Charles D., Superintendent, Y. M. C. A. Automobile and Mechanical School, Los Angeles

WHITE, Ernest M., Consulting Mechanical Engineer, Los Angeles

Colorado

NEILL, William A., Chief Mechanical Engineer, The Dorr Co., Denver

Connecticut

BLAKESLEE, Howard R., Asst. Master Mechanic, The American Brass Co., Waterbury

BRAWN, Elwin D., Designer, Bilton Machine Tool Co., Bridgeport

CUMMINS, Norman W., Chief Engineer and Director, The Bassick Co., Bridgeport

HANSON, Henry, Superintendent of Machine Dept., Wilcox, Crittenden & Co., Inc., Middletown

LINABURY, John E., Chief Engineer, Bristol Brass Co., Bristol

MASON PARRY, Edmund J., Directing Inspector, Hartford Steam Boiler Insp. & Ins. Co., Hartford

MOORE, Frederick T., Assistant Works Manager, Colt's Patent Fire Arms Mfg. Co., Hartford

Delaware

SHAFFER, Charles A., Engineer, Du Pont Nitrate Company, Wilmington

District of Columbia

GOODWIN, Percy F., Captain, Engineers, U. S. R. General Engineer Depot, U. S. Army, Washington

PORTER, Minott E., Principal Examiner, Steam Engines and Boilers, U. S. Patent Office, Washington

STEINMETZ, Charles M., Engineer, Washington

Georgia

HARRISON, Nathaniel C., General Superintendent, Atlantic Steel Co., Atlanta

Idaho

COATES, Arthur B., Assistant in Mechanical Engineering, University of Idaho, Moscow

ORR, Burton S., Associate Professor of Mechanical Engineering, University of Idaho, Moscow

Illinois

CORMACK, George, Master Mechanic, Appleton Mfg. Co., Batavia

FREDE, Charles F., Manager of Engineering, Commonwealth Steel Co., Granite City

KIMBALL, Raymond W., Boiler Room Engineer, Commonwealth Edison Co., Chicago

MOREY, William E., Mechanical Engineer, Rodger Ballast Car Co., Chicago

RAUNICK, Ernest J. M., Master Mechanic, By-Products Coke Corp., Chicago

STARKEY, D. W., Chief Draftsman, Griffin Wheel Co., Chicago

STOLL, Clarence G., Technical Superintendent, Western Electric Co., Chicago

WOODFIELD, George E., Sr., Superintendent, Flottorp Mfg. Co., Chicago

Indiana

BROSSMANN, Charles, Consulting Engineer, Indianapoils

MARSH, Harry B., President and Manager, Marsh Mfg. Co., Vincennes

MULLINS, Thomas C., General Manager, Sunlight Coal Co. & Ohio Valley Coal Co., Boonville

OTT, Albert J., President, Ott Grinder Co., Indianapolis

ROBBINS, Elmer J., Layout work, Engineering Dept., Dodge Mfg. Co., Mishawaka

Maine

CASWELL, Wilfred H., Master Mechanic, Sandy River & Rangeley Lakes Railroad, Phillips

DELANY, Edwin H., Naval Inspector of Machinery, Bath Iron Works, Bath

HANSON, Albert J., Principal Assistant Engineer, The Moulton Engineering Corp., Portland

Maryland

HUBER, Charles J., Mechanical Engineer, The Flynn & Emrich Co., Baltimore

Massachusetts

ACHILLE, Charles E., Branch Manager and Sales Engineer, Mathews Gravity Carrier Co. of Ellwood City, Pa., Boston

BARTLETT, Henry B., Chief Engineer, B. F. Perkins & Son, Inc., Holyoke

BARTON, George S., President and Treasurer, Rice, Barton & Fales M. & I. Co., Worcester

BEACH, Charles L., Manager, The Hoffecker Co., Boston

BENNETT, John C., Works Manager, Hampden Corundum Wheel Co., Springfield

BROADHURST, Frank S., Treasurer, Starkweather & Broadhurst, Inc., Boston

BURBANK, Albion P. W., Sales Engineer, B. F. Sturtevant Co., Boston

COLBY, Llewellyn A., Inspector, General Electric Co., Pittsfield

EBELHARE, William H., Industrial Engineering, Robert T. Pollock Co., Boston

GALUSHA, Albert L., In charge of Gas Producer Dept., Nelson Blowers & Furnace Co., Boston

GOULD, Henry G., Comptroller and Director, The Graton & Knight Mfg. Co., Worcester

KNOLLMEYER, Louis F., Chief Inspector, General Electric Co., Pittsfield

LEWTHWAITE, Alfred L., Mechanical Engineer, General Electric Co., Pittsfield

MEEK, Alden R., Sales Engineer, Westinghouse Elec. & Mfg. Co., Boston

SCANLON, Edward J., Chief Inspector, Boston Inspection Division, Maryland Casualty Co. of Baltimore, Md., Boston

SCHAUFUS, Hugh Albert, Production Manager, Metz Company, Waltham

SEWELL, Henry R., Manager Power Apparatus Dept., B. F. Sturtevant Co., Boston

TAYLOR, Clarence G., Draftsman in Engineering Dept. of U. S. Armory, Springfield

Michigan

BOSTAPH, Harvey P., Chief Engineer, Bostaph Engineering Co., Detroit

HOLDRIDGE, Clarence A., Factory Manager, Metalwood Mfg. Co., Detroit

KILPATRICK, William J., Factory Manager of Burroughs Adding Machine Co., Detroit

THOMAS, George J., Chief Engineer and Superintendent, Duplex Truck Co., Lansing

Missouri

QUINN, Everett J., Inspector Electrical and Mechanical Engineering, Kansas City

ROBINSON, Arthur D., Engineer, Monsanto Chemical Works, St. Louis

SCOTT, Lewis L., Chief Engineer, Scott Drill Company, St. Louis

Nebraska

RASMUSEN, Jesse E., Associate Professor, University of Nebraska, Lincoln

New Jersey

ENKE, George P., Insurance Engineer, James E. Garabrant & Co., Newark

GARSON, Thorvald N., Superintendent of Construction, The Singer Manufacturing Co., Elizabethport

RUSS, Charles W., Manager, Armstrong Cork Co., Camden Plant, Camden

WICKHAM, JAMES S., General Foreman, Crucible Steel Co. of America, Ordnance Dept., Harrison

New York

BARNUM, E. S., Editorial Work, G. M. Basford Company, New York
BENDURE, JAMES A., Sales Engineer, American District Steam Co., N. Tonawanda
COOK, SAMUEL, Air Brake Foreman, Van Nest Elec. Shops, N. Y., N. H. & H. R. R. Co., Van Nest, New York
DENISON, GRISWOLD, Engineer, Moses, Pope & Trainer, Inc., New York
DORNIN, ALEXANDER L., Engineer, Theo. E. Ferris, New York
EBY, EARL E., Asst. Manager, Industrial Bearings Div., Hyatt Roller Bearing Co., New York
ELLIOT, JAMES A., Assistant Engineer, Mathieson Alkali Works, Inc., Niagara Falls
FLECKENSTEIN, ALFRED C., Office Manager and Cost Accountant, Richmond Radiator Co., New York
FLEISHER, WALTER L., President, W. L. Fleisher & Co., Inc., New York
GRONBECH, CHRISTIAN E. A., Superintendent & Assistant Factory Manager, C. J. Tagliabue Mfg. Co., Brooklyn
HARD, MALCOLM, Mechanical Engineer, Nathan Manufacturing Co., Flushing, New York
HARRISON, GEORGE C., Industrial Engineer and Chartered Accountant, New York
HAVENS, WILLIAM W., Assistant Engineer, Liquid Air Division, Engineering Dept., Air Nitrates Corporation, New York
HELMER, NICHOLAS A., Consulting Engineer, Miranda Sugar Co., New York
HOOVER, A. PEARSON, Consulting Engineer, Goodrich, Hoover & Bennett, New York
HOPKINS, WILLIAM P., With C. E. Knoeppel & Co., New York
JENSEN, ARTHUR R., Instructor of Physics and Applied Electricity, Hebrew Technical Inst., New York
KIRSCH, GEORGE H., Member Committee of Examiners, Naval Consulting Board, New York
LATTING, JOHN W., Farming, Werah Farms, Inc., Locust Valley
MORROW, ALEXANDER P., President and Manager, Willys-Morrow Co., Elmira
NORDFORS, CONRAD, Contracting Engineer, Wood Newspaper Machinery Corp., New York
OLSON, HAROLD M., Mechanical Engineer, The Permutit Co., New York
O'ROURKE, GEORGE A., Chief Engineer, State Industrial Commission, Bureau of Boilers & Explosives, Albany
PAGE JULIAN D., Chief Draftsman, Perin & Marshall, New York
RANK, HOMER L., Asst. Manager, New York Office, Mead-Morrison Mfg. Co. of Boston, New York
ROTHWELL, COURTENAY R., President, Plant Engineering and Equipment Co., New York
RYTHER, GEORGE D., President, Ryther & Pringle Company, Carthage
SCHUYLER, LESLIE J., Production Manager, Porter-Cable Machine Co., Syracuse
SHOREY, JOHN A., Engineer Specialist, General Electric Co., New York
UEHLING, F. F., Combustion Engineer, also General Manager Uehling Instrument Co., New York
UPDIKE, DAVID M., Assistant Superintendent, Department of Buildings and Grounds, Columbia University, New York

Ohio

JOHANNESMEYER, CHARLES G., Chief Mechanical Engineer, The Liberty Machine Tool Co., Hamilton
KAARBO, AGNAR, Mechanical Engineer, Hydraulic Pressed Steel Co., Cleveland
KAHN, BERTRAND B., Works Engineer, The Estate Stove Co., Hamilton
PEARSON, MORRIS A., Chief Engineer, Turner Vaughn & Taylor Co., Cuyahoga Falls
SPARKS, A. F., General Manager and Chief Engineer, The James Leffel & Co., Springfield
TOWNSEND, THEODORE A., Chief Draftsman, McGraw Fire & Rubber Co., East Palestine
WITKER, CHARLES J., Mechanical Engineer, Baker Brothers, Toledo

Oklahoma

DRYDEN, RAYMOND P., Draftsman, Gosden & Co., West Tulsa

Pennsylvania

CAMPBELL, JAMES R., Mechanical Engineer, Baldwin Locomotive Works, Philadelphia
FOLTZ, THOMAS F., Mechanical Engineer, Pennsylvania Dept. of Labor & Industry, Harrisburg
GEE, NORMAN E., Assistant Foreman, Pennsylvania Railroad, M. E. Office, Altoona
GROAT, BENJAMIN F., Consulting Engineer, Pittsburgh
GROW, JOSEPH A., Mechanical Engineer, Blaisdell Machinery Co., Bradford
HARRIS, EDSON S., President, Philadelphia Steel Products Co., Philadelphia
HOOD, MARVIN C., Manager Employment Department, Chester Shipbuilding Co., Chester
JOHNSON, JOHN B., Superintendent of Power and Machinery Erection, Wm. Gordon Corp., Bristol
LARKIN, WILLIAM H., JR., Assistant Manager and Treasurer, Larkin & Co., Butler
MIKAELSON, ERIL W., Chief Engineer, Treadwell Engineering Co., Easton
RUSH, LEO E., Planning and Production Engineer, Bethlehem Steel Co., Bethlehem
SCHMID, WERNER E., Mechanical Engineer, Dravo-Doyle Co., Pittsburgh
SKINKLE, WILLIAM B., Assistant Chief Mechanical Engineer, Homestead Steel Works of Carnegie Steel Co., McKees Rocks
STAMETS, WILLIAM K., Machine Tool Dealer, Pittsburgh
STEVENSON, ARTHUR J., Watch Engineer, Westinghouse Electric & Mfg. Co., East Pittsburgh
STUDLEY, GIDEON, JR., Engineer, Condenser Dept., Westinghouse Elec. & Mfg. Co., Machine Works, East Pittsburgh
THOMPSON, JOHN L., Chief Engineer, The Koppers Co., Pittsburgh

Rhode Island

FLICK, LORENZ, Experimental Engineer at Sayles Finishing Plants, Saylesville
HIRD, GEORGE W., Foreman, Tool Department, Woonsocket Machine & Press Co., Woonsocket
TILLINGHAST, WALLACE E., Managing Owner of the Mass. Steam Specialty Co., Auburn

Tennessee

MURRIAN, WILLIAM S., Superintendent of Motive Power, Southern Ry., Knoxville

Texas

GLASGOW, JOHN B., Assistant Construction Engineer, Gulf Refining Co., Port Arthur

Utah

SECKELS, LOUIS J., Engineering Salesman, F. C. Richmond Machinery Co., Salt Lake City

Virginia

HAMMERSTROM, WILLIAM G., General Superintendent, Lynchburg Foundry Co., Lynchburg

Vermont

PAINE, WALTER H., Master Mechanic, Boutwell, Milne & Varnum Co., Graniteville

Wisconsin

BAIR, EDWARD H., Consulting and Sales Engineer, Fairbanks-Morse Co., Milwaukee

Canada

CANTELL, MARK T., Consulting Engineer, Winnipeg
NORRIS, EDWIN R., Master Mechanic, Algoma Steel Corporation, Sault Ste. Marie
WHITE, ALBERT F., General Superintendent, Marsh & Henthorn, Belleville, Ontario

Canal Zone

AUTEN, WILLIAM J., Mechanical Engineer, Mechanical Div. P.C., Balboa

Cuba

SNODGRASS, WILLIAM, Engineer, Honolulu Iron Works Co., Havana
WATERMAN, HENRY J., Chief Engineer, Central Stewart, Cuba Cane Sugar Corp., Stewart, Camaguey

Hawaii

McKAY, WILLIAM, Marine Superintendent, Inter Island Steam Navigation Co., Ltd., Honolulu
SIMPSON, ALFRED M., Superintendent, Honolulu Iron Works Co., Honolulu

Japan

HIRANO, T., Adviser of Kobe Steel Works, Kobe

Scotland

GIBSON, ARNOLD H., University Professor of Engineering, University of St. Andrews, Dundee

FOR CONSIDERATION AS ASSOCIATE OR ASSOCIATE MEMBER

Alabama

FEAR, FRANK G., Draftsman, Tennessee Coal Iron & R. R. Co., Ensley

Arizona

DUNNING, CHARLES H., Manager, Big Pine Consolidated Mining Co., Prescott

California

BLANCHARD, WALTER J., Assistant Chief Engineer, California & Hawaiian Sugar Refining Co., Crockett

Connecticut

BUCHANAN, WILLIAM C., Superintendent, Steel Works, Rolling Mills, American Tube & Stamping Co., Bridgeport
HONIG, FRANK, Designer of Special Machinery, The Bristol Brass Co., Bristol
MADDISON, WALTER F., Instructor, State Trade Education Shop, Bridgeport

District of Columbia

KARTSHER, HARRY S., Gage Designer, Engineering Bureau, U. S. Ordnance Dept.,

Massachusetts

KING, VERNON C., Chief Draftsman, Spencer Wire Co., Worcester
POLLEY, ALVIN H., Chief Draftsman, Brown Engine & Machine Co., Fitchburg

Minnesota

THAYER, PAUL W., Mechanical Engineer, Williams Bros. Boiler & Mfg. Co., Minneapolis

Missouri

GEORGE, Ralph D., Assistant Engineer, E. M. Stevens & Co., Consulting Engineers, Kansas City

New Jersey

FRAMBACH, Frederick S., Sales Engineer, Hyatt Roller Bearing Co., Newark

SLEEPER, William A., Assistant to President, Brighton Mills, Passaic

New York

BENSAMON, Edmond, Manager Refining Plant, American Chicle Co., Long Island City

MIANO, Nicholas J., Mechanical Engineer, Universal Fixture Corp., New York

POSTNIKOFF, Alexander A., Chief Inspector Russian Mission of Ways of Communication, New York

WALTERS, V. Edgar, Night Superintendent Savage Arms Corp., Utica

Ohio

McGILL, Minto, Draftsman, The Alliance Machine Co., Alliance

Rhode Island

FOLEY, Patrick H., Foreman, C. B. Cottrell & Sons Co., Westerly

Canada

BARRETT, Karl E., Superintendent and Chief Engineer, E. & T. Fairbanks, Ltd., Sherbrooke

FOZARD, Leonard G., Master Mechanic, The Marconi Wireless Telegraph Co., Montreal

JOYCE, Walter E., Engineer of Design, Mount Royal Tunnel & Terminal Co., Ltd., Montreal

MURPHY, Peter, Chief Draftsman, Marconi Wireless Telegraph Co., Montreal

FOR CONSIDERATION AS ASSOCIATE MEMBER OR JUNIOR

California

DOYLE, Frederick F., Engineer, Midway Gas Co., Taft

Colorado

MILLER, Albert F., Designing Engineer, Peters Machinery Co., Denver

Connecticut

BUCHANAN, David D., Night Superintendent, American Tube & Stamping Co., Bridgeport

COFFIN, Grange S., Mechanical Engineer, Remington Arms U. M. C. Co., Bridgeport

WEIDER, Arthur A., Installation, Industrial Engineering Staff, Winchester Repeating Arms Co., New Haven

Delaware

SCHNEIDER, Franz K., Assistant Chief Engineer, The Krebs Pigment & Chemical Co., Newport

District of Colombia

CHAPIN, William C., Assistant Inspector Weights and Measures, Bureau of Standards

HEDSTROM, Ernest R., Lieutenant, Engineering Bureau, U. S. Ordnance Dept.

WEISS, Erwin A., Ordnance Sergeant, Engineering Bureau, Motor Section.

Indiana

HUFF, Aaron B., Special Apprentice, Pennsylvania R. R. Co., Fort Wayne

Maryland

RYLANDER, Paul N., Aeroplane Inspector, U. S. Navy, Baltimore

Massachusetts

CARTER, Irving E., Machinist Mate 2nd Class, U. S. Naval Reserve, District No. 1, Boston

FOISY, George A., Designing Engineer, U. S. Cartridge Co., Lowell

PAINCHAUD, Phillip A., Inspector of Ordnance, U. S. Army, C. H. Cowdrey Machine Works, Fitchburg

PRATT, Winthrop S., Manufacturing Manager, Heald Machine Co., Greendale

SMITH, Raymond E., Assistant Engineer and Draftsman, Springfield Armory, Springfield

SPARROW, Stanwood W., Mechanical Engineer, Robert T. Pollock Co., Boston

Michigan

HOLMBERG, Abner W., Instructor Foundry Practice, Ironwood High School, Ironwood

Missouri

JOHNSEN, Peder, Mechanical Engineer, Missouri Cobalt Co., Fredericktown

New Jersey

ACKERMANN, William H., Mechanical and Production Engineer, Bayonne Bolt & Nut Co., Bayonne

KOHLBUSCH, Arthur H., Assistant Superintendent Construction, Public Service Electric Co., Newark

New York

CASE, Lynn B., Chief Engineer, Standard Wall Paper Co., Hudson Falls

LEWIS, William J., Jr., Assistant Manager Engineering Department, Shipley Construction & Supply Co., Brooklyn

McINTYRE, James J., Publicity Engineer, Machinery, New York

NEEL, Robert W., Chief Engineer, Erie Pump & Engine Works, Medina

OSMENA, Mariano, Draftsman, Combustion Engineering Corp., New York

PULSCHEN, Henry G., Draftsman, J. G. White Engineering Corp., New York

RABBE, Hellik, Draftsman, Kerr Turbine Co., Wellsville

RIDDLE, George G., Engineering Department, Ingersoll Rand Co., Painted Post

SYSKA, Adolph G., Assistant Engineer, New York Central R. R., New York

SWAIN, Wilbur A., Salesman, Jenkins Bros., New York

Pennsylvania

DOWNS, Leslie B., Assistant Chief Engineer, Epping-Carpenter Pump Co., Pittsburgh

FISHER, Herman A., Assistant to Plant Engineer, Chester Shipbuilding Co., Chester

GUTEKUNST, Leonard, Mechanical Engineer, De Long Hook & Eye Co., Philadelphia

KEENAN, William J., Draftsman, American International Shipbuilding Corp., Philadelphia

KIRKPATRICK, W. Alton, C. H. Wheeler Mfg. Co., Philadelphia

KOHN, Louis, Mechanical Engineer, Dravo Contracting Co., Pittsburgh

MORGAN, David W. R., Engineer, Condenser Department, Westinghouse Elec. & Mfg. Co., E. Pittsburgh

PRINGLE, Harry C., Master Mechanic, Franklin Works, Cambria Steel Co., Johnstown

SENIOR, John H., Sales Engineer, Smith & Furbush Machine Co., Philadelphia

Rhode Island

SHERWIN, LeRoy M., Mechanical Engineer, Brown & Sharpe Mfg. Co., Providence

Virginia

HORNE, Caleb L., Boiler Engineer, E. I. du Pont de Nemours & Co., City Point

Washington

TRACK, Frank A., Naval Architect & Marine Engineer, Sanderson & Porter, Shipyard, Raymond

FOR CONSIDERATION AS JUNIOR

Connecticut

BUTLER, Frank T., with 19th Engineers, U. S. Army, formerly with The Bristol Co., Waterbury

HORGAN, Daniel F., Naval Sub-Inspector of Ordnance, Office of Naval Inspector of Ordnance, Bridgeport

McCARTY, Robert P., Tool Designer, Colt's Patent Fire Arms Mfg. Co., Hartford

Delaware

BENST, Cecil J., Engineering Draftsman, E. I. du Pont de Nemours & Co., Wilmington

DOAR, E. Marion, Jr., Draftsman, Engineering Department, E. I. du Pont de Nemours & Co., Wilmington

Illinois

DUNDAS, William A., Field Engineer, Sherwin, Williams Co., Chicago

VAN DEVENTER, Frank M., Assistant Operating Engineer, Illinois Traction System, Peoria

Louisiana

MITCHELL, Grover L., Instructor, Louisiana Industrial Institute, Ruston

Maryland

STIERHOFF, George C., Engine Designer and Power Engineer, Riter-Conley Mfg. Co., Fairfield

Massachusetts

BEATTIE, Challen M., Mechanical Draftsman, Bethlehem Shipbuilding Corp., Ltd., Fore River Plant, Quincy

MENDELSOHN, Louis E., Engineer, Western Electric Co., Inc., Boston

Michigan

CAMERON, Hugh M., Chief Engine Draftsman, Saginaw Shipbuilding Co., Saginaw

Minnesota

ABERNETHY, Alfred A., Designer, Minneapolis Steel & Machinery Co., Minneapolis

Missouri

ANGEVINE, Leland C., Superintendent Hydroelectric Plant, Burns & McDonnell, Kansas City

ROYSE, Iram O., Instructor in Machine Drafting, David Ranken, Jr., School of Mechanical Trades, St. Louis

New Hampshire

CHICK, George E., Partner, John F. Chick & Son, Lumber Manufacturers, Silver Lake

GRAY, Frank A., Purchasing Agent, The Lebanon Machine Co., Lebanon

New Jersey

KING, Warren G., with Aeromarine Plane & Motor Co., Keyport

OBERLE, John H., Checker and Contract Analyzer, Babcock & Wilcox Co., Bayonne

ROTHOWITZ, Harry S., Production Engineer, Babcock & Wilcox Co., Bayonne

RUSCH, Olaf, Designer, Babcock & Wilcox Co., Bayonne.

New York

BOIES, Harry B., Inspector of Airplanes and Airplane Engines, Signal Service at Large, Buffalo

BROOKS, Frederick A., Airplane Designer, Curtiss Aeroplane & Motor Corp., Buffalo
CONWAY, John J., Testing Engineer, Alberger Pump & Condenser Co., Newburgh
DANKS, Roy L., Time Study Engineer, Winchester Repeating Arms Co., New York
DUNN, William K., Long Lines Engineering Dept., American Telephone & Telegraph Co., New York
GOSSELIN, Edward N., Industrial Engineer, Miller, Franklin, Basset & Co., New York
HAUSER, George H., Jr., Junior Engineer, The Arnold Co., Brooklyn
HILL, Herbert M., Manager, United States Machine Mfg. Co., New York
MORGAN, Albert H., Engineering Assistant, Western Union Telegraph Co., New York
NAUMANN, Carl, Factory Representative, Hannifin Mfg. Co., Syracuse
PERKINS, Donald L., Leading Man, Federal Shipbuilding Co., New York
RUNYON, Howard J., Jr., Sales Engineer, United Filters Corp., Brooklyn
SCHLEIFER, Arthur, Assistant Engineer, Interborough Rapid Transit Co., New York
STAMER, Frank R., Senior Student Mechanical Engineering, Brooklyn Polytechnic Institute, and Assistant to Dr. A. A. Adler, Consulting Engineer, Brooklyn
TUOMEY, Thomas D., Secretary and Manager, Sanitary Mechanical Specialty Co., New York

Ohio

ALLISON, John R., 2nd Lieutenant, Engineer Reserve Corps, U. S. Army, Cleveland
CHASE, Vernon B., Sales Engineer, The Acklin Stamping Co., Toledo
PHILPOT, Norbourn E., Testing Engineer, The Youngstown Sheet & Tube Co., Youngstown
ROGERS, J. Frank, Engineer in Charge Gas Producer & Furnace Dept., The Wellman-Seaver-Morgan Co., Cleveland
SPRONG, Edward A., Jr., Head of Production Department, Niles Tool Works, Hamilton

Pennsylvania

FLYNN, James A., Production Engineer, Blaw-Knox Co., Pittsburgh
HARTSIG, Emory R., Assistant to Resident Engineer, U. S. Shipping Board, Hog Island, Philadelphia
HENDEE, Robert W., Engineer, Midvale Steel & Ordnance Co., Nicetown, Philadelphia

Vermont

JOHNSON, Joseph B., Chief Engineer, Bryant Chucking Grinder Co., Springfield

Virginia

SMITH, Lewis M., Radio Draftsman, U. S. Navy Yard, Norfolk

Wisconsin

SEUTTER, Louis, Assistant Engineer in Forest Products, U. S. Dept. of Agri., Forest Service, Forest Products Laboratory, Madison

Canada

HIGGINSON, Richard H., Superintendent, Monarch Brass Mfg. Co., Ltd., Toronto
LEWIS, Donald, Chief Draftsman, Nova Scotia Steel & Coal Co., Ltd., New Glasgow, N. S.

APPLICATIONS FOR CHANGE OF GRADING

PROMOTION FROM ASSOCIATE

Massachusetts

CHAPMAN, David A., Vice-President, The Dangel Co., Winthrop

New York

DIVINE, Bradford H., President, Divine Brothers Co., Utica

PROMOTION FROM ASSOCIATE-MEMBER

Illinois

MAHER, Eugene E., Contracting Engineer, Lea-Courtenay Co., Chicago

Michigan

ANTON, James E., Assistant Manager of Mfg., Cadillac Motor Car Co., Detroit

Ohio

GRISWOLD, Howard L., Consulting Engineer, Standard Bolt Co., Columbus

Canada

GAINES, Edward C., Engineer, Dominion Bridge Co., Montreal

PROMOTION FROM JUNIOR

District of Columbia

COOMBS, Howard A., Patent Attorney.

Georgia

O'BRIEN, Dennis J., Mechanical Expert, Galena-Signal Oil Co., Atlanta

Michigan

GLENN, Charles C., Engineer, Detroit Plant, The Solvay Process Co. (Reinstatement), Detroit

New York

GOALWIN, Harry A., Medico-Technical Engineer, New York
HENRY, William M., Treasurer and Works Manager, Henry & Allen, Auburn
YOUNGBLUTH, R. O., Managing Engineer, Architectural Department, American Radiator Co., New York

Pennsylvania

GLENN, Edward R., Production Officer, Bethlehem Steel Co., Bethlehem
KENNER, Ernest R., Mechanical Engineer, Westinghouse Elec. & Mfg. Co., Pittsburgh

SUMMARY

New applications	256
Applications for change of grading:	
Promotion from Associate	2
Promotion from Associate-Member	4
Promotion from Junior	8
Total	270

EMPLOYMENT BULLETIN

THE SECRETARY considers it a special obligation and pleasant duty to make the office of the Society the medium for assisting members to secure positions, by putting them in touch with special opportunities for which their training and experience qualify them, and for helping any one desiring engineering services. The Society acts only as a clearing house in these matters.

IN forwarding applications, stamps should be enclosed for transmittal to advertisers; applications of non-members should be accompanied by a letter of reference or introduction from a member, such reference letter to be filed with the Society. Copy for The Journal should be in by the twelfth of the month.

GOVERNMENT REQUESTS

AEROPLANE AND MOTOR CORPORATION has available a number of attractive opportunities for technically trained men as equipment, production, maintenance and woodworking engineers, and as high-grade tool and die designers. Younger men are also wanted for planning and routing work in premium department. 2589.

INSPECTORS of airplane metal and wood parts, assemblies, propellers; must be able to read blueprints and use simple instruments.

Inspectors of airplane motors with knowledge of methods of heat-treatment of metals and machine-shop or tool-room experience, preferably on engine parts.

Inspectors of electrical material. Salaries for these civilian positions at the beginning will be from $1200 to $1500 per annum. 2591.

COMMISSIONED OR CIVILIAN SERVICE. Research and development men to bring to stage of commercial production parts made of sheet metal, fabrics, rubber and die castings. Applicants must have personality to secure coöperation of manufacturers in development work along the above lines. Salary $2000 to $2500. 2592.

POSITIONS AVAILABLE

ESTIMATOR for boiler and tank work, gray-iron castings and some machine-shop work. Requires a man of stability and experience. Technical education preferred. Location Buffalo, N. Y. 089-D.

MECHANICAL DRAFTSMAN for general factory work to lay out work of a general character. Familiar with power-plant, steam-heating and electrical equipment. Good opportunity for advancement for right kind of man. Location Newark, N. J. 092-D.

ENGINEERS for Asiatic service, men above draft age up to 37, preferably unmarried but will consider married men. Men with mechanical, electrical, or chemical engineering education, preferably with sales experience. Salary $2000 or more, depending upon ability and experience. 097-D.

TECHNICAL GRADUATE or mechanical engineer for office work in connection with power plants with large manufacturing concern in Western Pennsylvania. Salary at

[illegible] State particulars of education, [illegible] and experience. 099-D.

TECHNICAL GRADUATE or mechanical engineer to enter engineering organization of large stoker company in Western Pennsylvania. Man specialized in combustion science and boiler testing work preferred. State particulars of education, experience, nationality and salary desired. Good opportunity for right man. 0100-D.

CHIEF DRAFTSMAN for large stoker company in Western Pennsylvania. Must be a good designer. Man with experience on stoker work preferred. Good opening for a capable and energetic man. Write stating nationality, age, education, experience, present responsibility and salary expected. 0101-D.

JUNIOR ENGINEER, familiar with heat transfer calculation, in the engineering department of a large steam-specialty manufacturing concern. A graduate engineer with at least two years' outside experience is desired. Location New York. 0102-D.

YOUNG TECHNICAL MAN to assist in sales correspondence and experimental work, primarily as assistant to executive. Prefer man recently graduated from technical school and exempt from military service. Excellent opportunity for growth. Location New York. 013-D.

GRADUATE of technical school with some machine-shop experience and not subject to draft, as assistant to engineer of sales department located in metropolitan district. Excellent opportunity for the right man. Apply by letter, giving full particulars. 0104-D.

MECHANICAL DRAFTSMAN in New York office, preferably one versed in mechanical refrigeration and electrical engineering. 0109-D.

TOOL DESIGNER capable of designing efficient tools for engine manufacture along modern lines. Salary from $100 to $150 a month according to ability. Location Wisconsin. 0110-D.

DESIGNER on outside installation of piping, electric lines and heating mains. Technical graduate preferred. Salary depends on ability. 0111-D.

INSPECTOR on outside installation of piping, electric lines and heating mains. Technical graduate preferred. Salary depends on man. 0112-D.

ENERGETIC YOUNG MECHANICAL ENGINEER exempt from draft, with sales ability, as business developer for an engineering company of New York City specializing in the operation of power plants in buildings. Good salary and share in profits given to the right man. State present salary and qualifications. 0113-D.

SALES MANAGER AND EXECUTIVE to manage long-established, small but high-class and prosperous business in electrical measuring instruments. Must have sales experience, good personality and proven selling ability. Good immediate remuneration and ultimate stock interest to right party. Location New York. 0115-D.

YOUNG MEN, preferably exempt from draft, to train as engineers and salesmen. Preferably technical graduates, bright, alert and of analytic frame of mind. Salary depends on men. Location Massachusetts. 0116-D.

DRAFTSMEN. Two technical graduate mechanical engineers with 6 to 12 months' experience in general mechanical drafting in an industrial plant. Advise salary expected. Location New York State. 0117-D.

SUPERINTENDENT experienced in general machine-shop practice and of good executive ability for shops employing 600 and 700 men. Location Ohio. 0119-D.

POWER ENGINEER experienced in public-service corporation or in power department of large industrial corporation, thoroughly familiar with costs, the economics of power and the technique of power transmission and generation. Man of strong personality who can grow. Require from six to eight years' practical experience after technical training. 0120-D.

SUPERINTENDENT for moderate-sized machine shop making small stampings and cast brass parts. Man with unquestionable record required. Send complete past experience with names of companies where employed and position held with each. Want man experienced in economical manufacture of small parts in quantities and well versed in modern economical production. Location Michigan. 0121-D.

MEN to take charge of construction of marine engines for which contracts have been let to small concern. Location Erie, Pa. 0123-D.

SALESMAN on railway, mining and electrical equipment. Experienced man over 31 required. Knowledge of French preferred. Salary depends on man. Headquarters in China. 0124-D.

MECHANICAL ENGINEER to take charge of engineering department of large paper mill. Man with a technical education and a successful record in the operation and maintenance of power plants and factories and also the handling of men. State age, experience and salary expected. Location Eastern Pennsylvania. 0126-D.

MECHANICAL DRAFTSMAN familiar with mill and machinery design for metallurgical and chemical plants. Advise experience, salary expected and references. Location Colorado. 0127-D.

SALES ENGINEERS for leading manufacturing concern. Men who can sell power-plant and engineering equipment, engines, pumps, air compressors, condensers, etc. An opportunity for men of character and ability. Must be draft-exempt or in Class 4. Give full details, age, education, experience, reference and salary. Location New York. 0128-D.

ENGINEERS to train and develop in the fundamentals of a firm primarily engaged in the distillation of coal tar with the resultant principal production of bituminous road and roofing materials; with the ultimate object of filling operating positions in various plants as foremen, head chemists, assistant superintendents or superintendents. Preferably men of chemical engineering training desired, but this is not essential. As contemplated work will eventually be of an executive nature; ability to handle men is a desirable asset. Location New York. 0129-D.

SEVERAL EXCEPTIONAL OPPORTUNITIES for permanent positions, both technical and operating, in a plant making a full line of non-ferrous metal products. Work now almost entirely on government orders. Location desirable. 0131-D.

DRAFTSMAN on structural and ornamental iron work. Prefer technical man experienced in shop detail. Permanent position. Location Kansas. 0132-D.

MECHANICAL ENGINEERS experienced in construction work or design for chemical plant. State experience in detail and salary expected. Location Philadelphia, Pa. 0134-D.

MACHINE-SHOP SUPERINTENDENT for small concern manufacturing interchangeable parts and automatic machinery. Technical graduate with five or six years' experience preferred. Must be above the draft age. Salary $2500-$3000. Location Illinois. 0135-D.

DRAFTSMAN familiar with boiler construction and design. Give age, experience and salary. Location Chicago. 0138-D.

MASTER MECHANIC experienced in handling machinists, pipe fitters, electricians, millwrights and tinsmiths, familiar with conveying machinery, pumps, lineshaft drives, etc. Prefer practical man who has worked in a mill. Salary commensurate with ability. Location New Jersey. 0139-D.

CONSTRUCTION ENGINEER, for work principally on power-plant machinery. Location Shanghai, China. 0140-D.

SALES ENGINEER familiar with heavy-duty crude-oil semi-Diesel marine engines. Position in the foreign office, Manila. 0141-D.

COMPETENT MAN on flue-gas analysis and power-plant fuel work. Generally good opening for the right man. Technical graduate preferred, but not absolutely required. Location Ohio. 0142-D.

SALES ENGINEER. High-grade, experienced, energetic salesman to take charge of district sales office and territory; only a hustling good salesman is desired. Technical education with experience in conveying machinery preferred, but not essential. Exceptionally fine opportunity offered. Please state full particulars of experience, age, previous employment, salary expected, etc. 0145-D.

ENGINEER thoroughly capable of selecting and installing machinery for the manufacture of steel files for a factory, and supervising manufacture after factory shall have been completed. Should be thoroughly familiar with the various processes of file manufacture. Location East. 0146-D.

OFFICE ASSISTANT. Man between 21 and 35 with knowledge of machinery, preferably with previous experience in tools and machines for sheet metals, to assist in general correspondence. State age and experience. Location Buffalo, N. Y. 0148-D.

GENERAL FOREMAN AND SHOP MAN for plant in New York State for superheaters. Man with foundry and general shop experience preferred. Apply by letter. 0153-D.

FOREMAN for small shop in New York City. Must be well informed on mechanics and able to standardize flash lamps and blow lamps. Business established over 50 years and has promise of a good future. Good opportunity for a technical graduate ambitious to prove his worth. Must be an all-round man. Salary to start $1200. Name confidential. 0157-D.

CHIEF DRAFTSMAN. Draftsman experienced in maps, broad and narrow-gage railroads, frame buildings, layout of equipment and the design of special machinery. Com-

pany will take care of U. S. Government orders entirely. It is a chance to do your bit. A man of ability will be given early recognition and a permanent position. Apply by letter, stating age, nationality, experience, references and salary desired. Location Pennsylvania. 0158-D.

SALES MANAGER for power-plant specialty business. Reply by letter. Location Pennsylvania. 0159-D.

ASSISTANT TO GENERAL MANAGER for large mill in New Hampshire. Man between 32 and 45 preferred who has had experience with the installation of scientific-management methods. Must be able to handle tactfully executives and employees. State salary, when available, and give references. 0160-D.

FACTORY SUPERINTENDENT. Prominent manufacturing corporation manufacturing light product of large variety—part stock, part special to order—requires aggressive, energetic factory superintendent thoroughly experienced in machine-shop practice and modern centralized planning control methods, capable of securing large production most efficiently and economically. To be considered, replies must fully state experience and qualifications. 0161-D.

ASSISTANT CHIEF ENGINEER. Graduate from technical college who is a good organizer and executive and capable of directing mechanical, civil and electrical forces of large manufacturing corporation. Must have considerable experience similar to above to qualify. Man 32 to 40 years old preferred. State full details of education, names of previous employers, positions held and salary desired. Location Cleveland, Ohio. 0162-D.

TECHNICAL GRADUATE for material department of firm handling all types of machinery. Purchasing and statistical experience desired. Salary to start $150 to $175, with excellent chance for advancement. Location New York. 0163-D.

SALES MANAGER. Engineer experienced in estimating and selling to hold responsible position in long-established engineering and contracting business of an incorporated company. Possible opportunity to become financially interested. Give age and experience in reply. 017-D.

SALES ENGINEER between 25 and 30 for condenser and cooling plants. State experience, salary expected, and give references. Location Philadelphia, Pa. 072-D.

SALES CORRESPONDENT. Engineering and correspondence experience such as involved in formulating proposals covering sale and calculation in steam and power-driven pumping equipment, including application of steam engines, and electrical equipment that may be employed. Applicant should supply references bearing upon a record as correspondent, closing of contracts, execution of orders and closing of accounts. Location New Jersey. 093-D.

DESIGNER for machine shop. Location Ohio. 0118-D.

ONE MECHANICAL AND ONE ELECTRICAL ENGINEER, preferably married men without children and willing to take positions at sulphur-refining factories at Marseilles and Cette, France. 2052-D.

RAPID DETAIL DRAFTSMEN AND DESIGNERS on electric furnaces, gas producers, heavy machinery for steel-plant and coke-oven equipment, coal- and ore-handling equipment and complicated structural details. Location Cleveland, Ohio. 2061-D.

TOOLMAKERS AND TOOL DESIGNERS experienced on jigs, fixtures and gages. Only first-class men need apply. Good wages and best of working conditions. 2155-D.

JUNIOR SALES ENGINEER, preferably engineering graduate with selling experience. Must be familiar with steam-specialty apparatus. Location New York. 2158-D.

DESIGNER of power-plant work. College graduate preferred. Salary $125-$180 according to man. Location New York. 2162-D.

CHIEF DRAFTSMAN to take charge of a dozen men and experienced in design of tools, jigs, and fixtures. Prefer a man from 25 to 35 years with shop experience in the manufacture of interchangeable parts and with executive ability so that he can assist the superintendent directing the technical work. Salary $200 to $250 per month to start. 2200-D.

COLLEGE GRADUATES, ENGINEERS. Men out at least a year for general shop-engineering work with growing concern. Work leads to industrial management. State full particulars. Location New Jersey. 2478-D.

MASTER MECHANIC for large central power plant. Permanent position with chance for advancement. State age, experience, salary expected and position regarding draft. 04-D.

HEATING AND VENTILATING ENGINEER to supervise design, installation and work in advisory capacity in connection with maintenance in large rubber factory in northern Ohio. Salary commensurate with training, experience, and ability to handle men. Splendid opportunity for the right man. 2561-D.

APPRAISAL ENGINEER experienced in appraisals of industrial properties. Technical man preferred. Location at start in New York and later to have charge of branch office in large Middle West city. State experience, age and salary expected. 0164-D.

INVENTORY AND APPRAISAL DEPARTMENT ENGINEER for one of the Eastern State commissions; man with technical training as mechanical engineer, and with one year or more of experience in engineering work preferred. Some knowledge of accounting and of appraisal work desirable but not essential. Present engineering staff is small; good opportunity for advancement for the right man. Location Newark. 0168-D.

INSTRUCTOR in elementary mathematics and mechanical drawing for Apprenticeship School. Candidates should have had some technical training and shop experience and should understand the handling of young men. Position offers excellent opportunities for advancement in the works and will pay an initial salary of $1200 or more per year, according to the caliber of the man. Location Connecticut. 0176-D.

MEN AVAILABLE

ASSISTANT to the president or general manager of a manufacturing corporation is a connection desired by a competent industrial engineer, age 32. Graduate engineer and accountant, engaged two years in construction and design and seven years as consultant in industrial operation. Experienced in wide range of industries, including textile, machinery, foundry and steel. Wishes now to obtain settled address. Offers convincing references. D-85.

TECHNICAL GRADUATE, associate-member, age 33, with over 10 years' experience in planning, design, erection and operation of power-plant and manufacturing equipment, desires new connection as mechanical engineer or in other executive capacity for which his ability and experience would qualify him. Complete record with best of references on request. Location preferred Pacific Coast States. D-86.

PRODUCTION MANAGER experienced on aeronautical engines and parts and high production on light-weight machinery desires position as executive on Government work. Expert tool designer; experience in shop efficiency and cost recording; understands all classes of automatic machine work, including sheet-metal stamping. Salary about $300 a month. D-87.

MECHANICAL ENGINEER AND EXECUTIVE, age 30, at present in charge of engineering department of large manufacturing concern. Good on automatic-machinery, jig, die and tool design, for interchangeable manufacture. Practical shop man who can supervise work from drawing room to completion, and is an expert on factory layouts and equipment. Salary $2500 to $3000. D-88.

EXECUTIVE SALES ENGINEER now holding responsible position for five years as sales manager desires similar position with company having larger field. Has traveled extensively and is well acquainted with automobile and machine manufacture. Graduate mechanical engineer, good executive, and of pleasing personality; alert and resourceful, and exercises well-balanced judgment in all propositions. D-89.

MECHANICAL ENGINEER, age 44, with 12 years' manufacturing experience, desires a change. Expert in the design of special machinery for economical production, making investigations and experiments, and following work through to completion. Resourceful, tactful, and successful as an executive. Minimum salary $3000. D-90.

MECHANICAL ENGINEER, age 34, desires to locate in Brooklyn or near New York City. Twelve years' experience in industrial plants, covering design, maintenance and construction work. Salary commensurate with ability. Only permanent position will be considered. D-91.

GENERAL MANAGER OR PRODUCTION SUPERINTENDENT. Member, American, age 46, with 23 years' technical training, practical shop experience and shop management manufacturing steam and gas engines, electric motors and generators, mining and transmission machinery, dairying machinery, pumps, shrapnel and high-explosive shells, time and graze fuses. Shop training covers production from design through shops to assembly, test and shipping. Technical covers building and plant extension, hydraulic-pneumatic, electric and steam power plants, machine-tool design. Office experience covers routing, costs, time study, wage systems, estimating and purchasing. Organization, systematizing, correct arrangement of machinery, proper routing of material, rapid, accurate production with unskilled labor by means of foolproof jigs and tools with coordination of departments has always shown increased output and reduction of costs. D-92.

MECHANICAL ENGINEER with 15 years' experience in the design of power plants, industrial plants, heating, ventilating, etc. Has had charge of men and shown executive ability. At present holds responsible position but has very little work to do. Willing to consider responsible and permanent position only. D-93.

YOUNG MECHANICAL ENGINEER. Technical man with 5 years' practical experience as designer and engineer desires change. Experienced on tools and equipment for manufacturing both large and small interchangeable parts. D-94.

PUBLICITY ENGINEER. Technical graduate who is over draft age and thoroughly experienced in advertising and cataloguing mechanical appliances desires permanent position with high-class manufacturing concern. American, good health and appearance clean record. D-95.

SUPERINTENDENT machanically trained and educated, thoroughly conversant with today's methods of production, and experienced in laying out the proper lines to follow in economical and interchangeable manufacture. Twenty years' successful practical experience in the manufacture of fine tools, reamers, dies, etc., light automatic machinery, hand screw machines, and cylindrical grinding machinery. Capable of taking entire charge of entire factory, but willing to accept position as assistant to high executive in large plant. Now employed as general superintendent. D-96.

MECHANICAL ENGINEER who has specialized on drop forgings desires to make a change—reasons on request. Age 32, married, American-born of American parents. Desires permanent position with reliable concern. Salary $2500 to $3000. D-97.

MECHANICAL ENGINEER. Technical graduate, age 25, married, desires position April 1. Has had one year of factory and shop experience and three years' intensive experience in the practical operation, maintenance and erection of Diesel oil engines, producer-gas engines and high-duty steam pumping engines. D-98.

FACTORY EXECUTIVE. Member, American, age 40, married. Technical college training and 18 years' successful experience with largest manufacturing concerns as chief draftsman, superintendent and manager in developing, organizing and producing. Six years in present position. Best of references. Responsibility of full authority. Salary $6000. D-99.

WORKS MANAGER OR GENERAL SUPERINTENDENT. Broad-gage, fully trained executive, age 36, desires connection with large plant making any product from automobiles to clocks. Experienced in plant layout, best shop practice, management control methods, systems and man training: successful in all jobs through production, design and control divisions. Man whose vision is equal to possibilities of business and accustomed to make plans become facts. D-100.

GENERAL MANAGER OR GENERAL SUPERINTENDENT wants position on either Atlantic or Pacific Coast. Thoroughly versed in design and construction of marine engines and boilers and stationary engines. Varied practical and theoretical training and experience. Accustomed to responsible positions. Satisfactory reasons for desiring change from present position. D-101.

TURBINE DRAFTSMAN. Junior member, age 27, married, desires position with small, growing concern in engineering or sales department. College graduate with 6 years' turbine experience. At present employed as assistant to chief draftsman. Salary to start $150. D-102.

SKILLED OPERATING ENGINEER, experienced in design, construction, and operation of modern power plants, will consider a position to take full charge of a plant of 5000 kw. or larger. Can show results in the boiler room and get the best results from the equipment. At present mechanical engineer for a group of properties. D-103.

JUNIOR MEMBER, age 29, married, desires position as assistant professor of drawing and mechanical engineering. M. E. degree from a prominent eastern university. Some executive experience serving as director of department for one year. Location eastern college or university preferred. D-104.

ASSISTANT SUPERINTENDENT OR ASSISTANT ENGINEER. Associate member, age 35, with three years' experience as assistant engineer and engineer of tests on Diesel oil engines. Over six years mechanical engineer for large textile concern in charge of all mechanics, buildings, machinery and building construction and yard improvements. D-105.

EXECUTIVE OR ASSISTANT TO SUPERINTENDENT OR MANAGER. Member, American, age 50, married; practical mechanic, draftsman and designer. Thirty years' manufacturing experience, covering pattern, forge, iron and brass foundry, and machine shops; also 5 years' erecting experience throughout New England. Can handle correspondence, make estimates, figure costs, etc. Especially familiar with hydraulic work, comprising pump, tank and pipe problems. Well versed in plant upkeep, purchasing, etc. Location desired eastern New England. Salary $2500. D-106.

INDUSTRIAL AND PRODUCTION ENGINEER. M. E., age 31, married, with 12 years' active shop, field and office experience in the design, manufacture and production of industrial machinery and plants. Good organizer and tactful executive to introduce, develop or maintain bonus, cost and stock systems, standardization, scheduling, routing, and other production problems, to meet actual conditions. Good reasons for leaving present connection of five years, with large corporation in above capacity. Salary $3600. D-107.

SUPERINTENDENT, PRODUCTION MANAGER, EFFICIENCY ENGINEER, MASTER MECHANIC. High-grade executive with 22 years' practical and technical experience in manufacturing, covering every branch of the metal and wood manufacturing line, including the business end. Expert on equipment and system. Have had charge of plants employing up to 6000 men. At present employed as consulting and efficiency engineer. Thoroughly versed in gray-iron and brass foundry practice. Desires permanent position where efforts will be recognized. D-108.

MECHANICAL ENGINEER. Member, technical graduate, American, desires position as assistant engineer or chief draftsman. At present employed as designer, estimator and testing engineer. Sixteen years' experience, including testing, designing excavating machinery, tractors, derricks, hoisting engines, cargo winches, steering engines, anchor windlasses, and miscellaneous machinery, office engineering, machine-shop and steel-foundry practice. Location Middle or Far West preferred. D-109.

MECHANICAL ENGINEER. Junior member. Cornell graduate, M.E., age 27, American, married, classified in 4th class of Federal draft. At college, specialized in design of internal-combustion engines; since then employed as draftsman and assistant office executive, in which position duties consisted of testing steam power plants, adjusting complaints on coal, and handling correspondence. At present employed in the latter capacity. Minimum salary $2100 per year. Location preferred, New York. D-110.

EQUIPMENT ENGINEER. Graduate of English college of recognized standing, age 27, married. Experienced in the manufacture and inspection of interchangeable parts and design of equipment. Can take charge of drawing room and would like to get in touch with a firm concerning a permanent position. At present employed. D-111.

MECHANICAL-ELECTRICAL ENGINEER. Michigan graduate, age 32. Four years' experience in consulting engineering, designing, testing, estimating and writing reports on power plants and power equipment and four years' experience in selling electric and steam power service for central station. Available in two weeks. Salary $2500-$3000, depending on location. D-112.

EXECUTIVE MECHANICAL ENGINEER. Member, age 41, American, married. Twenty years' practical experience as designer, chief engineer, general manager, and consulting engineer. Thoroughly conversant with all details of shipbuilding—medium-sized steel and wooden steamers, machine and foundry business, manufacturing special machinery and tools, steam engines, boilers, hoisting machinery, dredging and excavating machinery, marine auxiliaries, and repairs to same. Desires change, preferably with new company on war contracts, ships, engines or special machinery. Permanent executive position considered, or temporary war business on a consulting basis. D-113.

MECHANICAL ENGINEER. Member, age 44, with 17 years' experience with steam railroads and 3½ years on valuation work, desires to make change. Technical graduate, now employed. Salary $4800 or better. D-114.

DESIGNING ENGINEER. Graduate mechanical engineer, 37 years old, with 14 years' varied engineering experience, principally on the design of power machinery and machinery location plans. At present employed but desires a permanent position. Replies desired only from those actually in need of a man for permanent position. D-115.

ASSISTANT GENERAL SUPERINTENDENT OR WORKS MANAGER, OR GENERAL MANAGER OR ENGINEER OF SMALL PLANT. Young mechanical engineer who has successfully held similar responsible positions and served adequate time in shop and drawing office. Specialized on production work, having full charge of designing and building internal-combustion engines and automatic machinery. Capable executive, thoroughly practical and aggressive, at present employed as chief draftsman of a large concern. 33 years of age, married. 18 years' total experience. D-116.

EXECUTIVE OR MANAGING ENGINEER. Member, age 43, married, 20 years' engineering experience. Good organizer and executive, experienced in design of locomotive engines, cars and heavy machinery, as well as in the direction of shop, drafting-room and office forces. Familiar with estimating and sales engineering. Highest-class references. Salary $5000 or equivalent on bonus or commission plan. Eastern location preferred. D-117.

ENGINEERING SURVEY

A Review of Engineering Progress and Attainment in Mechanical Engineering and Related Fields, Including a Digest of Current Technical Periodicals and Selected Titles of Engineering Articles

Research Information Committee Formed

The following statement is authorized by the Council of National Defense:

1 By joint action the Secretaries of War and Navy, with the approval of the Council of National Defense, have authorized and approved the organization, through the National Research Council, of a Research Information Committee in Washington with branch committees in Paris and London, which are intended to work in close coöperation with the officers of the Military and Naval Intelligence, and whose function shall be the securing, classifying, and disseminating of scientific, technical and industrial research information especially relating to war problems, and the interchange of such information between the allies in Europe and the United States.

2 The Washington committee consists of—

a A civilian member, representing the National Research Council; Dr. S. W. Stratton, Mem.Am.Soc.M.E., Chairman.

b The Chief Military Intelligence Section.

c The Director of Naval Intelligence.

3 The initial organization of the committee in London is—

a The scientific attachè representing the Research Information Committee: Dr. H. A. Bumstead, attache.

b The military attaché, or an officer deputed to act for him.

c The naval attaché, or an officer deputed to act for him.

4 The initial organization of the committee in Paris is—

a The scientific attaché representing the Research Information Committee: Dr. W. F. Durand, Mem.Am.Soc.M.E., attaché.

b The military attaché, or an officer deputed to act for him.

c The naval attaché, or an officer deputed to act for him.

The headquarters of the Research Information Committee in Washington is in the offices of the National Research Council, 1023 Sixteenth Street; the branch committees are located at the American Embassies in London and Paris. (*Official Bulletin*, March 8, 1918, p. 8.)

New U. S. Bullets Deadly to Planes

Special bullets, designed for aerial work, that combine armor-piercing and incendiary qualities, and also armor-piercing and tracing, have been developed by the War Department to a point fully equal to or surpassing those used abroad.

Armored-airplane construction, adopted since the European war started, brought the necessity for a new type of bullets. The necessary type was developed for use against the gasoline tank of enemy machines, the most vulnerable spot, and the tracer bullets enable the aviator to judge the result of his fire just as well at night as in daylight. The size of the bullet has been kept to 0.30 caliber, and types have been perfected that gave splendid results in tests.

"With the progress of the war," says the War Department statement, "the more vital parts of the airplane were protected with light armor, so that it became necessary to introduce the armor-piercing bullet.

"As the gasoline tanks were particularly susceptible to explosion, it was necessary to procure a bullet containing an inflammable substance ignited upon discharge, which would carry the spark of flame into the tank when piercing it.

"As the target was within range for only brief moments at a time and as there was no means of determining the fire effect, as on land, a tracer bullet containing a bright-burning composition was introduced. The composition is set on fire upon discharge and the bullet flies through the air as a bright spark, plainly visible to the machine-gun operator.

"At the outbreak of the war further information was promptly gathered from the Allies and this subject was studied by those responsible for this work in the United States. Of course, on account of the difficulties of the problem, none of the special bullets possessed by any country is entirely satisfactory, or what might be termed 'perfect' in operation.

"The bullets developed by the United States Ordnance Department have been tested on land and from airplanes to see if there is any difference in their performance when fired from a quickly-moving airplane in the upper atmosphere and when fired on land. These tests indicate that the United States has developed a class of special cartridges with a performance fully equal to or surpassing that attained abroad." (*Philadelphia Public Ledger*, March 4, 1918, p. 6.)

The Liberty Motor

Several official statements have been made to the effect that the Liberty motor is in production. In fact, it has been stated that the various companies now engaged in its production, such as the Packard Company, the Lincoln Motors Company, etc., have or soon will reach a daily production of 250 engines a day.

The aeroplanes shipped to France have been equipped with the Liberty motor. Likewise, in the early part of March, the first fighting seaplanes built in America have been accepted for service. These seaplanes, which are said to be substantially similar in construction to the British flying boats, are each equipped with two Liberty motors giving a useful output of about 700 hp.

In the final tests and refinements of the motor the Aircraft Board was assisted by a supervising committee consisting of D. McCall White, Mem.Am.Soc.M.E., and Henry M. Crane, Mem.Am.Soc.M.E.

A bit of light has been thrown on the history of the Liberty motor by Emden S. Hare, president of the Packard Motor Company of New York, in an address at the dinner of the Sphinx Club in New York. According to this statement the Liberty motor was the outcome of three years' work on the part of the Packard engineers. The company offered this engine to the Government. At the time, the Aircraft Board felt that it would be best in the furtherance of their war plans not to put this motor out under the name of the Packard Company, and the company patriotically sacrificed its private interests in the motor and consented to let its work be merged under the name of Liberty motor.

Conjoint Board of British Scientific Societies

A report on the work of the Board for the first year of its existence, 1916-1917, has been issued.

On March 22, 1916, at the instance of the Council of the Royal Society, a conference was held with representatives of the leading scientific societies at which it was decided to organize such a conjoint board.

The Board was eventually organized for the purpose of promoting the coöperation of those interested in pure and applied science; supplying a means by which the scientific opinion of the country may, on matters relating to science, industry and education, find effective expression; taking such action as may be necessary to promote the application of science to industries and to the service of the nation; in discussing scientific questions in which international coöperation seems advisable.

The Board consists both of purely scientific societies, of engineering organizations, such as the Institutions of Civil, Electrical, Mechanical, and Mining Engineers, semi-engineering organizations like the Geological Society, and organizations of the type of the Physical and Zoological Societies. Even the Biochemical Society and the Psychological Society have found a place in the wide scheme of organization of the Conjoint Board, which thus represents the scientific and engineering mind of the country in the broadest and best sense of this term.

As regards financing, the Royal Society extended to the Conjoint Board the hospitality of its rooms and guaranteed the expenses of the Board to the sum of £200 during the first year. In addition to this, the constituent societies each contributed sums varying from £10 to £50. A number of important sub-committees were appointed and a majority have presented final or interim reports.

Thus the Sub-Committee on the Application of Science to Agriculture has, among other things, initiated a careful census in districts where there are various classes of agriculture, the object of the census being to ascertain the amount of produce sent out from, and the raw materials conveyed to, these districts; the time when such transport is effected, as well as the time occupied in seasonal operations on the lands. It is hoped from this detailed information to obtain valuable data on which to build practical estimates of the power required and cost of operation and compare the relative advantages and costs of steam engines, internal-combustion engines and electrically operated machinery.

The question of application of electrical machinery to agriculture has received particular consideration, the Sub-Committee emphatically believing in its great future. In fact, the Sub-Committee believes that electrical power can be distributed to farms at prices which would pay the farmer. Electrically propelled plows and other agricultural machinery would be simpler in construction and easier to handle and inspect than oil-driven machinery. Further, electricity may be used for intensive cultivation, as is indicated by some recent experiments.

Another sub-committee is instrumental in drawing attention to the need of national instruction in technical optics.

A Watching Sub-Committee on Education has been instituted in order to keep the Board of Scientific Societies informed on any matters in education which might arise from time to time and might have a bearing on the relation of education in science to national needs and to the special requirements of scientific industries. Its chief attention has been occupied so far with an attempt to secure unity of purpose between those anxious to insure that natural science shall, in the future, form a more important part in early education than has been the case in the past and those who have had their interests more particularly concerned with the development of literary and linguistic studies.

A Metric Sub-Committee was organized in 1917 and is now engaged in the preparation of a report. Other sub-committees are apparently vigorously at work.

Boston Society of Civil Engineers

FOUNDATIONS OF THE NEW BUILDINGS OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY, CAMBRIDGE, MASS. A paper with this title was presented at the December meeting by Charles T. Main, President, Am.Soc.M.E., and H. E. Sawtell. The purpose of the paper was to describe the geological conditions found at the site of the Massachusetts Institute of Technology and the methods used in determining these conditions, the selection of the type of foundations and the pile tests, load tests and designs of portions of the foundations. Because of lack of space only the latter part of this interesting paper can be reported here.

Two considerations led to the selection of wood piling in preference to concrete piles. First, it was found that wood piling would be considerably less expensive than concrete piles, because of the fact that the permanent water level was high and hence it was unnecessary to place any concrete in addition to that required for the foundations to meet the heads of the wood piling. Further, large piles do not prove economical where flexibility is required for light as well as heavy loads. In this case it was decided that heavy concentrated loads should be avoided, which in itself precluded the use of concrete piles.

In order to determine the kind and length of wood piles to use in different parts of the site, a sufficient number of tests became necessary, a rather difficult task owing to the great variety of soil conditions present.

The complete data of these tests, especially valuable because of the wide ground covered, are given in a series of tables. Some of the piles (spruce) were driven into the "glacial gravel," in this instance a well-compacted and deep bed of material, commonly known as coarse sand and gravel, to various depths, and upon being pulled were all found to be broomed or both broomed and broken.

This showed that spruce piles could not be driven with safety into the harder portions of the glacial deposit, and the use of spruce was confined to those places where friction was largely depended upon to give the bearing value and very little dependence placed on point bearing. Also it was decided not to use spruce piles when sudden changes in the hardness of the soil were found or expected.

On the other hand, tests proved that first-class oak piles could be driven without injury into well-compacted coarse sand or fine to a resistance giving a value of 18 tons or more. Hence, oak piles were used when the driving was hard and when the supporting value of the piles was to be gained largely from point bearing and relatively small embedments in the hard stratum.

The varying conditions of the ground made it necessary to take particular care to design the pile foundations on the basis of as nearly uniform settlements as possible. Such

uniformity is highly desirable in order to prevent overstressing the more or less continuous concrete floor of beams and slabs used in the superstructure of the buildings.

It was considered necessary that the piling have a safety factor of not less than 2.5 of tonnage, based on the limit of ¼-in. settlement.

An effort was made to keep the piles in the glacial deposit, even where it thinned up, as it was desirable to use this stratum as a medium for spreading the loads over the clay under it.

It was endeavored to have a minimum of at least 3 ft. of gravel under the points, even where it became thin, in order to make the spreading of the load somewhat effective.

Regarding the safe working values, the tests have shown that the piles driven into sand and dependent upon friction for support could be used at their formula valne (the so-called *Engineering News* formula is referred to), but not much higher than the limits of settlements and safety factors assumed. On the other hand, piles embedded in the clay found at this site showed an ability to carry test loads in excess of the formula value when using drop hammers.

A feature in the design of these foundations which was given some consideration was the matter of vibration due to external and internal forces. It was expected that the greatest vibration would come to the structure from external sources, such as freight trains, electric cars, etc., conveyed to the buildings by means of the comparatively hard top film which lies over the stratum of mud, silt and peat.

As a matter of fact, nearly the entire site of the new buildings has a stratum of mud, silt and fill above the glacial deposit and clay. The buildings have a foundation of piles, which have their entire length above the part embedded in sand and gravel or clay, pass through a material affording very little support, and it is known that structures supported in this way not only readily send out vibrations but are strongly affected by vibrations from other sources, if situated above the same strata.

One method of partially resisting such a tendency is to drive the piles well into the supporting stratum rather than resting them on the surface or with a foot or two of penetration, but as a fair embedment was necessary anyway to get the bearing values desired, the question of stiffness was solved automatically.

Working rules for governing the driving of piles are given. (*Journal of the Boston Society of Civil Engineers*, vol. 5, no. 1, January 19, 1918, pp. 1-38, 16 figs., *de.*)

U. S. BUREAU OF STANDARDS

Central Hot-Water Heating. The Bureau has made studies of central water-heating systems in fifteen cities in the Middle West, for the purpose of formulating technical standards of service for such central heating systems. The work is carried on in close coöperation with the engineers of the Indiana Public Service Commission and with the Educational Committee of the National District Heating Association. The results will be embodied in a circular entitled Standards of Service for Central Heating Plants, similar to the circulars already published by the Bureau of Standards on Standards of Gas Service and Standards for Electric Service.

Gas Engineering. The readjustment of gas quality and rates is an acute question in several states. This situation enabled the Bureau to render prompt service by the application of the experimental results obtained by the Bureau last year. The appointments of a number of additional gas engineers are now pending. These will enable the Bureau to take up pressing problems in gas engineering.

Military Research. Confidential investigations are in progress on gun-firing measurements, sound ranging, battleship telephony, lighting, optical instruments, signaling, aeroplane construction, thrust and torque, use of concrete for ships, and many other similar subjects of importance in the war. The nature of these problems is, of course, confidential, so that the results will not be known until the close of the war or until published by the Military Departments. A new laboratory, somewhat larger than any of the existing bureau laboratories, is to be constructed in the immediate future.

Electrolysis Survey. The Bureau of Standards is preparing the report on a survey of the city of New Orleans, in which the electrolysis conditions were very carefully investigated. The request for this survey was made jointly by the city of New Orleans and the utilities companies concerned. The report will give the recommendations to the city and to the utilities for ameliorating the unfavorable conditions found.

Inspecting and Testing of Electric Lamps. The Bureau's work during the past six months has been nearly three times the amount for the previous year. The great demand has led some factories to deliver lamps of lower quality than heretofore, but this has been corrected in the recent deliveries.

Infra-Red Spectroscopy. Hundreds of new lines have been discovered by the Bureau in the infra-red spectroscopy of iron, cobalt and nickel. The investigations have been completed as far as the apparatus and photographic methods permit. Many of the newly discovered lines of wave lengths are greater than 10,000 angstrom units. The reports have been prepared for publication.

Weathering of Optical Glass. The effects of the collection of water vapor and resistance to the weathering action by different types of optical glass are being investigated by the Bureau. It is expected that these investigations will develop means of producing a better quality of optical glass. Large numbers of optical parts and optical apparatus are being tested for the military departments and special problems are under investigation, especially those which have arisen from the use of American-made optical glasses.

Engineering Instruments. Typical examples of calibration work in this division included during the past month water-current meters, pressure and vacuum gages, relief valves, and a fatigue test of a pressure gage in an investigation using 30,000 lb. per sq. in.; pressure tests of metallic tubing and copper spheres, fire extinguishers, and similar lines of engineering tests.

Tensiometer. The Bureau has devised an instrument and constructed it for the purpose of measuring the loads on cables. The test was successfully completed and the instrument calibrated. Large numbers of woods, metals and structural parts have been tested on the large Emory testing machine for military purposes.

Building-Stone Investigation. The automatic freezing and thawing apparatus which has been in continuous operation during the past month has subjected to alternating freezing and thawing a number of sandstones and limestones, as high as seven hundred and fifty alternations in some cases. Most of the samples showed visible signs of disintegration. The aim is to ascertain the effect of frost action on building stones,

concrete, etc., and establish the relative durability of the various types. The specimens are shifted automatically between a cold chamber and a warm chamber at suitable intervals to permit freezing and thawing. In this manner the freezing equivalent to years of exposure may be obtained in a comparatively short time.

Effect of Calcium Chloride on the Strength of Concrete. This investigation was undertaken to determine the effect of using solutions containing small amounts of calcium chloride as the gaging water in mixing concrete on the rate of increase in strength of concrete. Results to date, including tests of concrete a year old, show that an aqueous solution of from 4 to 6 per cent of calcium chloride used as the gaging water of portland-cement concrete will increase the strength at two or three days from 50 to 100 per cent over concrete of the same proportions and age gaged with plain water. No detrimental effect has as yet been noted on the concrete in which the calcium chloride has been incorporated.

Tests of Leather. An investigation of the wearing qualities of the different grades of leather in actual service and as tested by the Bureau of Standards leather-testing machine is now being carried out on a much larger scale than before. The District of Columbia postmen have been furnished with shoes with sole-leather and fiber-composition soles. One is placed on one foot, the other on the other. The test is being extended to include soldiers at Camp Meade. A careful record is kept of their behavior, the nature of wear, weather conditions, etc. A representative of the Leather Section of the Bureau makes weekly inspection trips to Camp Meade.

Optical Glass. The Bureau's work on optical glass is progressing satisfactorily. During the month sixteen melts were made, ten in pots manufactured at the Bureau and two in porcelain pots. The glasses made included a dense flint of fine color, the usual medium flints, light crown, boro-silicate and light barium crown glasses. The tests of porcelain and semi-porcelain glass pots are being continued. The large porcelain pots have proven to be very successful.

Tile Investigation. Nine full-size hollow-tile walls were tested in the 10,000,000 lb. compression machine. The walls varied from 6 to 12 in. in thickness, were each 4 ft. wide and 12 ft. high, and were laid in cement mortar tempered with lime hydrate. The walls were laid up with the flues horizontal instead of vertical, which distinguishes this series from the previous one. These walls showed only about 36 to 50 per cent of the strengths when tested vertically and with the vertical flue walls carrying from 300,000 to 600,000 lb. load. The tendency to local fracture in the outer webs of the tile is the rule when the flues are laid horizontal, although there is a better bonding. A great deal of interest has been shown by building code experts and tile manufacturers in the tests. About thirty walls have been tested thus far and the tests are being continued with the coöperation of manufacturers.

This Month's Abstracts

In the next issue of The Journal will appear one or more abstracts from *La Technique Moderne*. This important French publication was discontinued soon after the beginning of the war, but is starting again. This is a welcome sign, showing that not only is the technical life of France getting back on its feet, but also that the general situation in the country cannot be very bad if an expensive technical journal finds enough subscribers to keep it going.

In the section Aeronautics, Lieut.-Col. Crocco of the Italian Arm presents an interesting discussion on the resistance of air when the matter is considered not as a perfect fluid, but, on the contrary, as a dissipater of energy. Certain aerodynamic phenomena are then considered from the point of view of valuation of momentum communicated to the air, which was originally immobile.

In the section Engineering Materials are reported the cardinal features of an investigation on the strength of sewer pipe.

In the same section will be found a discussion of the properties of wire rope for aircraft of particular interest in that it brings out how the method of manufacture, especially the speed in stranding and closing the rope, affects its ultimate physical properties.

A paper read before the Kentucky Ice Manufacturers' Association by W. D. Stuckenberg and J. F. Kohout presents some interesting features in connection with storage and weathering of coal. A point of particular interest brought out is the influence of outside sources of heat on the spontaneous ignitability of coal, including the influence of sun heat.

In the section Fuel is also described a new method of burning powdered coal, the distinctive feature of which is that the arrangement is such that the powdered fuel, thoroughly dried, is conveyed practically as if it were a fluid. This permits the use of a comparatively small size of piping of long length and at any necessary tilt or angle. An interesting system of regulation of the supply of coal is provided.

From the *Journal of the Society of Chemical Industry* is taken a brief report of an investigation on the melting points of coal ash. In the original paper a table is given of melting points of a number of ashes.

In *Power*, Sanford A. Moss, Mem.Am.Soc.M.E., describes a method of measuring high pressures of gases with dead weight as used at the Lynn Works of the General Electric Company. The dead-weight pressure gage is said to be more precise than the Bourdon gage, while quite simple in operation and calibration.

The description of a new hydrometer is indirectly taken from a German paper.

In the section Mechanics a lecture by Sir James Dewar before the Royal Institution is abstracted, giving interesting details of his recent studies of liquid films.

In a paper before the Society of Automotive Engineers, Arthur B. Modine discusses the principles of tractor-engine cooling, and, among other things, emphasizes the fact that the rate of cooling effected in the radiator is a function not only of the rate of flow of the air through the radiator, but also of the rate of flow of water.

An extensive discussion of electric boiler heating for steam locomotives is abstracted from a German publication.

Through the *Railway Age* is abstracted an extensive report on the study of railway track under load carried out by a special joint committee of the American Society of Civil Engineers and the American Railway Engineering Association.

In the section Steam Engineering, particular attention is called to two abstracts; the first describing the 50,000-kva. Connors Creek turbines of the Detroit Edison Company, and the second discussing steam raising by electricity with heat storage, this latter being the data of an experimental investigation carried out in 1916 in Switzerland.

Several interesting abstracts appear in the section Thermodynamics, notably one of an article by H. P. Gillette, Mem.Am.Soc.M.E., in which the writer examines the gas-film theory in its relation to heat conduction.

REVIEW OF ENGINEERING PERIODICALS

SUBJECTS OF THIS MONTH'S ABSTRACTS

For Articles on Subjects Relating to the War, see Aeronautics, Engineering Materials, Machine Tools, Munitions, Varia

Aeronautics

Approximating the Static Thrust and Brake Horse Power of Air Propellers, W. Bernard Murphy. The static thrust and b.hp. of air propellers are here discussed on the basis of the formulæ for air screws developed by W. R. Turnbull and published by him in the *Aeronautical Journal* for January 1912. The article is illustrated by two charts, one giving the values of the coefficient Q in the Turnbull formula and the other the coefficient of U for flat-face sector screws. The first chart is for a two-blade and the second chart for a two- and four-blade propeller. (*Aviation and Aeronautical Engineering,* vol. 4, no. 2, February 15, 1918, pp. 89-90.)

The Influences of Standardization in War Aeronautics. The influences of standardization are discussed from two points of view: the one as they affect production and the other as they affect the developments of types. Standardization is defended as a means of increasing the speed production and attacked as possibly retarding the development of the best types. (*Journal of the Aeronautical Society of America*, vol. 2, nos. 20-24, July-December 1917, pp. 3-24.)

The Two Cardinal Principles of Aerodynamics, Lieut.-Colonel Crocco. The article discusses the resistance of the air from the point of view of considering the air not as a perfect fluid, but, on the contrary, as a dissipater of energy. Theoretical results of considerable importance are obtained in this way, even though the practical dependence of propelling power on the way in which the disturbed air circulates and loses its energy is limited to the cases in which the size of the closed spaces where the experiment is made is out of proportion to the sizes of the generated fluid jets. The writer introduces in aerodynamic phenomena a principle for the valuation of generative forces, which is that of momentum communicated to the air which was originally immobile. (*Aeronautics*, vol. 14, no. 224 (new series), January 30, 1918, pp. 104-110, 10 figs.)

Mechanics of Aeroplanes at High Altitudes. Herbert Chatley. *Aeronautics,* vol. 14, no. 224 (new series), January 30, 1918, pp. 114-116.

Dope Poisoning. *Automotive Industries,* vol. 38, no. 10, March 7, 1918, pp. 493-495.

On the Statics of Screws, Rodolphe Verduzio. *Aeronautics,* vol. 14, no. 225 (new series), February 6, 1918, pp. 128-129.

Air Engineering

Blast-Furnace Preheater. Description of new blast-furnace preheater invented by E. E. Marshall. The principle of this device is to take air coming from the blast engines and pass it through a preheating device prior to its admission into standard firebrick stoves. It is claimed that in this way a more even temperature is secured.

The construction of the preheater is the same as that of the old iron-pipe stoves used in blast-furnace practice prior to the invention of the modern firebrick stove. It consists of a combustion chamber, a pipe chamber and a draft-stack chamber. The gas and blast flow in parallel. This is done to keep the first row of pipes cool by the incoming blast, and thus protect them from warping and burning out. The blast is heated under predetermined temperature in the preheater up to 900 deg. fahr. The action of the preheater on the stoves is as follows:

The firebrick stoves coming off of gas are put on the furnace. The preheated blast is admitted through the cold-blast valve on the stoves. As the preheated blast has attained a rather high degree of heat in the preheater, the heat surface of the stoves is not cooled off as fast as it could be if cold blasts direct from the blast engines were admitted to the same heat surface. Hence the reduction in stove temperature during the period that the stoves are on the furnace is not large, and the blast gets a more uniform degree of heat. It is claimed that because of this small variation in the blast temperature the amount of fuel is reduced. It is also stated that with the preheater connection on the stoves, the checkers in the stoves do not accumulate dirt as they do without this adjustment.

It is stated that such preheaters have been installed at Newport, Pa., and at the Lochiel furnace at Harrisburg, Pa., with satisfactory results. (*Iron Trade Review*, vol. 62, no. 9, February 28, 1918, pp. 541-542, 1 fig., *d*)

First Report to the Council of the North-East Coast Institution of Engineers and Shipbuilders on Certain Methods of Producing High Vacuum, Edwin L. Orde, C. W. Cairns and J. Morrow. *Transactions of the North-East Coast Institution of Engineers and Shipbuilders*, vol. 34, pt. 2 February 1918, pp. 83-132, illustrated.

Ventilateurs Sulzer. *Bulletin Technique de la Suisse Romande,* 44 annee, no. 2, January 26, 1918, and no. 3, February 9, 1918. Description of Sulzer blowers made in Switzerland (to be continued).

Blast Furnaces (See Air Engineering)

Engineering Materials

THE STRENGTH OF SEWER PIPE. An abstract of Bulletin No. 47 of the Engineering Experiment Station of the Iowa State College of Agriculture on the supporting strength of sewer pipe in ditches and methods of testing sewer pipe in laboratories to determine their ordinary supporting strength.

It has been proved that the pipe in the ditch is so much more rigid than the ditch filling at each side of the pipe, that even with careful tamping the pipe carries practically all of the vertical load at the level of the top of the pipe caused by or transmitted through the ditch filling.

The width of the ditch at the elevation of the end of the top 90-deg. quadrant is the width factor that affects the load on the pipe. The ditch may widen indefinitely above this level without increasing the load on the pipe appreciably.

The following formula has been deduced for the loads on pipes in ditches where the trench is hollowed to conform to the bottom quadrant of the circumference of the pipe:

$$W = Cwb^2$$

where W = load on pipe in ditch, lb. per lin. ft.
C = coefficient (see Table I in original article).
w = weight of ditch-filling material, lb. per cu. ft.
b = breadth of ditch a little below the top of pipe, ft.

In computing the ordinary supporting strength of pipe per unit of length, the net inside length of the pipe from the bottom of the hub socket to the extremity of the spigot end should be used as a divisor. For calculating the modulus of rupture of sewer pipe from the ordinary supporting length, the formulæ already adopted for drain tile by the American Society for Testing Materials should be used, as follows:

$$M = 0.20rW/12, \text{ and } F = 6M/t^2$$

where M = maximum bending moment in the pipe wall of the barrel of the pipe, lb-in. per inch of length.
r = radius of the middle line of the pipe wall of the barrel of the pipe, in.
W = ordinary supporting strength of the pipe, calculated as described in the preceding paragraphs, lb. per lin. ft. of pipe.
F = modulus of rupture of the pipe, lb. per sq. in.
t = average thickness of the pipe wall of the barrel of the pipe in inches at either the top or the bottom, the lesser value being used.

In computing M, for "sand" bearings add 5/8 of the weight of the pipe per linear foot to W, provided such addition exceeds 5 per cent of W. For "two-point" or "three-point" bearings add 3/4 of the weight of the pipe. (*Western Engineering*, vol. 9, no. 2, February 1918, pp. 57-59, 2 tables.)

SEVEN-YEAR TESTS SHOWING THE EFFECT OF AGE AND CURING CONDITIONS ON THE STRENGTH OF CONCRETE, M. O. Withey. In this investigation it has been found that the more pronounced variations in the strengths of the neat-cement test pieces are due largely to the embrittling of the specimens with age. Furthermore, neat-cement specimens stored in air are probably much more weakened due to surface defects than are mortar or concrete test pieces stored under similar conditions. The major portion of the strength of concrete appears to be secured at an age of six months to one year. At the age of seven years water-cured concrete is slightly stronger than concrete cured out of doors and considerably stronger than concrete cured in the cellar.

It has been found that the effect of differences in the humidity of the storage condition is much more pronounced at the age of seven years than it is at the age of six months, which emphasizes the importance of maintaining the water contained in the concrete at all ages if maximum strength is to be secured. (*The Wisconsin Engineer*, vol. 22, no. 5, February 1918, pp. 183-188, 2 figs., 1 table.)

ANNEALING OF CARBON STEELS, R. B. Fehr. *The Pennsylvania State College Bulletin*, vol. 11, no. 11, October 1, 1917, pp. 81-101, 7 figs., 6 tables.

LA DURETÉ DES ALLIAGES MÉTALLIQUES INDUSTRIELS, P. Ludwik. *La Technique Moderne*, tome 10, no. 1, January 1918, pp. 30-33, 5 figs., 5 tables. Deals with the hardness of industrial metal alloys.

MANUFACTURE OF ELECTRIC TOOL STEEL, E. A. Suverkrop. *American Machinist*, vol. 48, no. 9, February 28, 1918, pp. 351-358, 16 figs.

THE MANUFACTURE OF STEEL SHEETS, Clement F. Poppleton. *The Iron Age*, vol. 101, no. 11, March 14, 1918, pp. 676-679, illustrated (to be continued).

NOTES ON PREPARED PAINTS FOR METAL SURFACES. *Transactions of the Institute of Marine Engineers*, vol. 29, session 1917-1918, January 1918, pp. 339-345.

OCCLUDED GASES IN FERROUS ALLOYS, Gellert Alleman and Chas. J. Darlington. *Journal of The Franklin Institute*, vol. 185, no. 2, February 1918, pp. 161-198, 4 figs., 5 tables (to be continued).

PRINCIPLES OF THE GENERATION AND APPLICATION OF HEAT IN STEEL TREATING, A. F. MacFarland. *Proceedings of the Steel Treating Research Society*, vol. 1, no. 6, January 1918, pp. 9-15, 8 figs.

WIRE ROPE FOR AIRCRAFT. Discussion of the properties of wire rope for aircraft and certain special methods resorted to in order to give it the desired properties.

Wire rope is frequently the weakest link in otherwise strong engineering structures. It is claimed that elasticity is fully as important as tensile strength, and a tensile test alone is not sufficient for judging the wire. There is a possibility that in the future a simple form of streamline fairing will be developed, which will eliminate the so-called vibrant strains. Fairing reduces not only the vibration in the wire, but also the head resistance. In fact, it is claimed that a small wire vibrating rapidly offers as much head resistance as a flat surface, the width of which is equal to the amplitude of the vibration.

All rope specifications should provide for not only torsion, bending and tensile tests of the individual wire after drawing, but also for the material in rod form before drawing, as good wire can only be made from material of proper quality. Further, specifications of wire rope must also specify the elongation.

Hardness may be intensified by very high machine speed in stranding and closing the rope. If the elastic limit is not exceeded in the drawing operation no hardness results, but if the drawing subjects the material to stresses beyond the elastic limit, a certain amount of permanent set is produced and hardness is the result.

Hardness can be kept within reasonable limits in three ways: viz., first, by giving careful heat treatment during manufacture; second, by carefully drawing down the wire by quarter to half sizes; and third, by using moderate speed for stranding and closing the rope. A certain amount of hardness is desirable because a given hard-drawn steel wire will support

a heavier load than untreated steel, but increased tenacity is obtained at the expense of elasticity and may be carried to the point where the material becomes dangerously brittle. Fig. 1 shows how hardening the material raises its tensile strength and reduces its plasticity. The relation between Brinell hardness numbers and the tensile strength of drawn steel is expressed by the following equation:

Tensile strength, tons per sq. in. $= 0.213 \times$ Brinell number $+ 5$.

Certain tests of wire rope in rod form and finished form are recommended. (*Aeronautical Engineering*, January 9, 1918, abstracted through *Automotive Industries*, vol. 38, no. 7, February 14, 1918, pp. 366-367, 3 figs., *p*)

Fuel and Firing

Storage and Weathering of Coal, W. D. Stuckenberg and J. F. Kohout. The question of storage of coal becomes of particular importance at the present time, when it may be possible that large consumers will have to accept their coal in equal monthly shipments, or receive a large share of it during the summer months, so as to relieve possible future railroad congestion.

Broadly speaking, the larger sizes of coal from about No. 3 nut on up through the various sizes of nut, egg and lump store without giving any trouble. Anthracite and semi-bituminous coals store well in any size. Black lignite or sub-bituminous coal from the West is hardly suitable for storage.

Difficult to store are the finer sizes of coal, which are used principally for power purposes; these are generally high in moisture and iron pyrites, and also, because of their smaller sizes, expose a great number of small surfaces to the air. These several factors all tend to initiate oxidation and to speed it along once it has started. Eastern coals are purer and lower in moisture and pyrite than western coals.

The speakers discussed in detail the conditions producing oxidation and rise of the temperature of the coal pile. In this connection they claim that the effect of external sources of heat is of extreme importance. In fact, without the aid of heat from some external source, the initial stages of oxidation either would not appear or their rate would be extremely slow. These sources of heat may be steam pipes in the ground or near the pile, or heat from boilers, especially in the case of bunkers on vessels. When coal is unloaded by dumping on the ground from a car or a high trestle, and then is piled up to almost the level of the car floor, as is frequently done in coal yards, the heat of impact and of pressure constitutes a positive danger to the coal.

Absorption of heat from the sun will also raise the temperature of the coal to a surprising degree. In the case of a certain shipment from a plant in Indiana, the coal carried a rather large amount of moisture and pyrite, but was taken out of the ground only about ten days before delivery. When received it was so warm that the hand could not be kept in contact with it for more than a few seconds. The reason for this was discovered to be the fact that it was shipped in steel cars, which stood on sidetracks exposed to the direct rays of the sun for about two days. If this coal had been placed in storage in the condition in which it was received, it would certainly have fired spontaneously in a short time. (Paper read before the Kentucky Ice Manufacturers' Association, abstracted through *Power*, vol. 47, no. 7, February 12, 1918, pp. 234-235, *p*)

A New Method of Burning Powdered Coal. Description of a fuel system in which the fuel is delivered from the pulverizing plant to the point of combustion by means of air pressure in distinction from systems in which continuous helical-screw conveyors are used, or systems in which the coal is carried by high-velocity air with the coal dust in suspension.

This new system has been applied to the plant of Dilworth, Porter & Co., Inc., Pittsburgh, Pa. The plant is noteworthy for the distances which the powdered fuel has to be carried, for the large size of the furnace, and for the type of feed control. It is of interest to note that the present equipment has replaced natural gas and that it has been operating with complete success throughout the recent severely cold weather.

The present scheme of conveying coal is based on the fact that powdered fuel when thoroughly dry acts as a fluid and thus allows for using piping of long length at any necessary tilt or angle. The powdered coal collected in tanks at the pulverizing station is subjected to air pressure in the upper part of the tanks and forced as needed from the bottom of the tank through the coal-delivery or transport pipes. Coal has thus been delivered for a length of 1500 ft., at a speed depending in part upon the air pressure. For example, 4 tons have been actually carried through a 550-ft. line in 5 min. with air at 40 lb. gage pressure. The coal is pulverized to pass 95 per cent through a 100-mesh sieve and 85 per cent through a 200-mesh sieve.

To introduce the powdered fuel into the air-transport system proper two blowing tanks are provided, each of a capacity of 5 tons per charge. Compressed air is supplied by a two-stage motor-driven air compressor fitted with feather valves which delivers into air receivers from which the air is admitted to the blowing tanks. An aftercooler is provided to remove moisture from the air as it leaves the compressor, as well as cool the air as it is being stored. In the head of the blowing tank there is a valve operated from the floor and controlling the flow of coal into each tank as well as preventing the escape of air when closed.

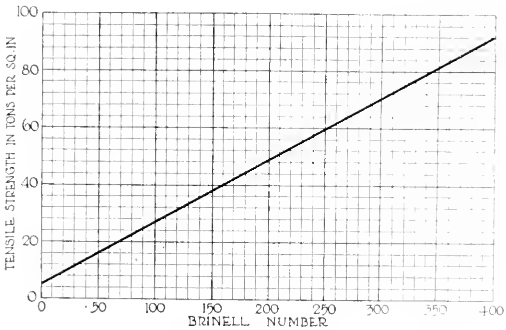

Fig. 1 Curve Showing Tensile Strength as a Function of Brinell Hardness

The powdered coal is directed into bins at the furnace when required by means of special switching valves operated from the floor by the hopper conveyor. The hoppers vary from 1 to 8 tons in capacity according to the furnace consumption.

Fig. 2 shows the plan of the air-transport system to the several groups of heating surfaces. The scale indicates the long distances traversed from the powdered-coal mill to the furnace. It is of interest to note that the transport lines through which the powdered coal is brought are 4 in. in diameter throughout the plant. It is believed that this fact is conducive to greater economy, as compared with screw conveyors or large-cross-section air mains now in use.

To regulate the powdered coal fed to the furnace, controllers are provided at the bottom of the hopper, one for each burner (Fig 3). The controller consists of a cast-iron hopper casting bolted to the opening with a spiral screw which feeds the fuel accurately to a cast-iron screen housing spaced from the hopper casting by a steel pipe. At the front of the hopper casting the thread of the spiral screw is interrupted in order to admit of the movement of two simultaneously operated gates controlled by levers on the outside, which regulate the amount of coal carried to the burners by varying the gate opening. By this device exact feed of fuel is accomplished, and it is stated that a controller of 500-tons-of-coal-per-hour capacity has been adjusted to feed a minimum of 26 lb. per hour.

The burner is composed of a large cast-iron pipe with a specially shaped elbow. The coal-dust pipe is concentric

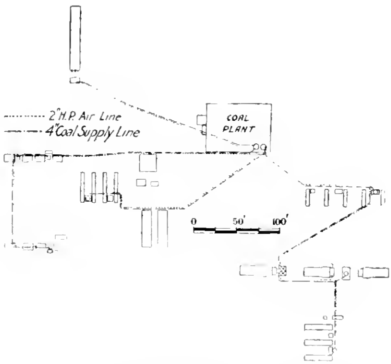

Fig. 2 Plan of Air-Transport System to Several Groups of Heating Furnaces

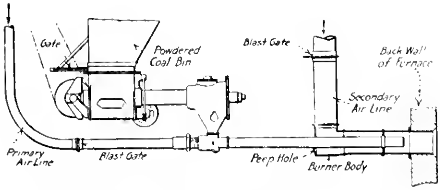

Fig. 3 Apparatus for Regulating Fuel Fed into Burner

within it and extends almost to the furnace wall. The air for combustion enters through the elbow under 1.25 oz. pressure, and the air transporting the coal under a pressure of 6 oz. expands down to 1.25 oz., mingling with the combustion air at that pressure as it burns.

The furnace temperature is regulated by the amount of coal passed into the burner through the gate controller and by the quantity of air. It is stated that air firing at the low pressure of 1.25 oz. is desirable as it reduces the abrasive action on the brickwork. (*The Iron Age*, vol. 101, no. 9, February 28, 1918, pp. 545-549, 7 figs., *e*)

The Melting Point of Coal Ash, J. T. Dunn. A brief report of a highly interesting investigation giving the melting points of a number of ashes.

It has been found that the melting point of ashes is essentially determined by the quantity of basic oxides, especially alumina and silica, and the molecular weight of same, so that if one adds to the given mixture of alumina and silica a quantity of another metallic oxide the amount by which the melting point is lowered is almost independent of the nature of the material, provided its quantity is proportionate to its molecular weight; and that if a number of different oxides are mixed together with the alumina and silica mixture at the same time, the reduction of the melting point depends upon the number of molecules of the oxides which have been added to the given number of molecules of alumina and silica. (*Journal of the Society of Chemical Industry,* vol. 37, no. 1, January 15, 1918, pp. 15 T-16 T.)

Testing and Standardization of Motor Fuel, E. Lawson Lomax. The writer begins by giving an interesting classification of the hydrocarbons present in motor fuel. He proceeds then to the description and discussion of comparative merits of testing. In connection with the determination of the boiling point he thus discusses the methods of Sir Boverton Redwood and a modification of the Engler method for the valuation of crude petroleum, and also submits his own method, which combines the ease of manipulation of the Redwood test with the precision of the Engler test.

He also describes a method for approximately determining the sulphur compounds in the fuel, a matter of importance, because sulphur frequently reacts with the metal of the carburetor.

The determination of the hydrocarbon characteristics is discussed in considerable detail; while in connection with the determination of the spontaneous-ignition temperature only, the Moore method is described, which is a test consisting of allowing one drop of the fuel to fall into a platinum crucible heated to a desired temperature and observing whether an explosion occurs. (*Journal of the Institution of Petroleum Technologists*, vol. 4, no. 13, December 1917, pp. 6-25, 2 figs.)

Dry and Wet Coal in House-Heating Boilers, J. J. Light. *The Pennsylvania State College Bulletin,* vol. 11, no. 14, November 15, 1917, pp. 148-152, 2 tables.

Empirical Method of Analysis of Coal, J. P. Calderwood. *The Pennsylvania State College Bulletin,* vol. 11, no. 14, November 15, 1917, pp. 127-147, 6 tables.

How Fuel May Be Saved. *Power,* vol. 47, no. 9, February 26, 1918, pp. 306-308.

Furnaces

Gas Furnaces as Re-Heaters of Iron Piles, etc., George Carrington. *The Iron and Coal Trades Review,* vol. 96, no. 2606, February 8, 1918, pp. 150-151.

Hydraulics

Determination of the Duty of Water by Analytical Experiment, W. C. Hammatt. The purpose of the paper is to show a method used in the determination of the quantity of water required for the growth of certain crops, where it is impracticable to measure it directly. In this case it was desired to determine the duty of water for the propagation of certain wild grasses in southeastern Oregon, under conditions making it impracticable to segregate certain measured areas and determine the actual use of water. Therefore some other method had to be devised, and the analytic method was selected as probably the best.

This method consisted in dividing the water into its various uses and making a separate determination, as far as possible, of each use. In this manner any of the determinations which were based on estimates, or for which the data were inadequate or unreliable, would affect only the particular item concerned, and not the whole duty of water. Also, by a study of different factors making up the analysis, it is believed that unnecessary or reparable losses may be discovered.

In this case the water was to be used for plant growth. In a strict sense the only water actually so used is that taken in through the roots and either remaining as a component part of the plant or evaporated through its leaves. However, it is impossible to deliver water to the roots directly, and as the water has to pass through the soil, both on its way to the plant and in order to pick up the salts necessary for plant growth, the uses of water are subdivided into the following four classes: (1) Soil moisture; (2) Soil evaporation; (3) Plant use; (4) Soil losses.

The writer proceeds to the analysis of each one of these items in a manner which cannot be reported here through lack of space.

The writer claims that while the method here described is not always superior to that of direct trial, it is useful in cases where the latter is impracticable, and even where direct trial is possible it may be used as a check on the economy of consumption of water for irrigation purposes. (Paper presented on March 20, 1918, before the American Society of Civil Engineers, abstracted from *Proceedings of the American Society of Civil Engineers*, vol. 44, no. 2, February 1918, pp. 307-357, 23 figs., *ep*)

Internal-Combustion Engines

The Engines of the Zeppelin and the Gotha. *The Engineer,* vol. 125, no. 3243, February 22, 1918, pp. 157-160, 19 figs.

Fuel Consumption of Low-Compression Oil Engines. L. H. Morrison. *Power,* vol. 47, no. 11, March 12, 1918, p. 367.

Lubrication

Lubrication of Ball Bearings, Otto Bruenauer. The present article begins by setting forth the principal characteristics of oils and greases such as may be used for lubrication of bearings, especially ball bearings, and then proceeds to the description of various types of designs for grease, oil and dirt-proof houses. The article, which is apparently the beginning of a series, is liberally illustrated and is of considerable practical interest.

As regards the intervals at which the ball bearings must be lubricated, the writer states that in shaft hangers, in industrial motors, wheel hubs, gear cases, pumps and machines operating under similar conditions a fresh charge of lubricant twice a year is ample and in some cases once a year will be found sufficient. Exposure of the machine to heat will make more frequent lubrication necessary. Also for railway motors, journals and such machines as are constantly exposed to the influence of weather and outdoor conditions a fresh charge of lubricant four to six times a year is recommended. (*American Machinist*, vol. 48, no. 8, February 21, 1918, pp. 316-322, 18 figs.)

On the Lubricating and Other Properties of Thin Oily Films, Lord Rayleigh. *The London, Edinburgh and Dublin Philosophical Magazine and Journal of Science,* Sixth Series, vol. 35, no. 206, February 1918, pp. 157-163. An experimental investigation of great interest, an abstract of which will be given in an early issue.

Machine Shop

Grinding Hobs to Remove Distortion. Edward K. Hammond. *Machinery,* vol. 24, no. 7, March 1918, pp. 585-589, 13 figs.

General Thread Cutting Practice in the Lathe. Franklin D. Jones. *Machinery,* vol. 24, no. 7, March 1918, pp. 634-639, 9 figs.

Effect of Improved Mechanical Contrivances on the Conservation of Men. *Railway Review,* vol. 62, no. 7, February 16, 1918, pp. 231-233.

Étude sur la Fabrication des Centres de Roues de Wagons par l'Emploi d'un Laminoir a cinq Cylindres. M. Leon Geuze. *Revue de Métallurgie,* 14e Annee, no. 6, November-December, 1917, pp. 717-729, 12 figs. Description of a method of machining railway carwheel hubs by means of a special device described in the article.

Machine Tools

Gag Punch for Structural Punch Press. J. V. Hunter. *American Machinist,* vol. 48, no. 7, February 14, 1918, pp. 274-276, 6 figs.

Cutter for Spur and Helical Gears. W. F. Mallory. *The University of Colorado Journal of Engineering,* vol. 14, no. 2, January 1918, pp. 37-43, 3 figs.

Differential Motions and Planetary Gear Combinations, Franklin D. Jones. *Machinery,* vol. 24, no. 7, March 1918, pp. 600-604, 9 figs.

Measurements

Measuring High Pressures with Dead Weight. Sanford A. Moss, Mem.Am.Soc.M.E. Description of the use of a dead-weight pressure-gage tester for measuring pressures during tests, as used in the Steam Turbine Department of the General Electric Company, Lynn, Mass.

The difficulty with Bourdon pressure gages when extreme accuracy is desired, is that frequently the calibrations before and after the test disagree, and even where the calibrations do agree there is often a question as to whether the temperature effect has been properly taken care of. In addition, most Bourdon gages are not accurate to one per cent, and therefore have to be read by estimation between the graduations.

The dead-weight pressure gage consists of an accurately bored cylinder, usually having an area of 1/8 sq. in., with a closely fitting piston, at the top of which is a platform on which are placed weights sufficient to keep the gage floating. For use in direct measurement of pressure a stop must be added to prevent the piston from rising out of the cylinder, and an oil trap and reservoir, so that there should at all times be oil in contact with the cylinder and piston. The platform and piston must always be spun by hand when the apparatus is in use.

This gage when attached directly to the pipe where pressure is being measured gives without any difficulty whatever readings accurate to within 0.25 of one per cent. Fig. 4 shows the

apparatus used in the Turbine Department of the General Electric Company's works at Lynn, Mass., where there are about fifteen outfits, all in more or less regular use. Fig. 5 gives a sectional view through the dead-weight pressure gage.

The writer describes in detail several measurements where the dead-weight pressure gage is used. He states in particular that in orifice tests of pumps for air compressors it is necessary to have two dead-weight gages; or one dead-weight gage and one mercury column, since there are two distinct pressures. One of these is a discharge pressure measured in the pipe between the throttle valve and the machine; it gives

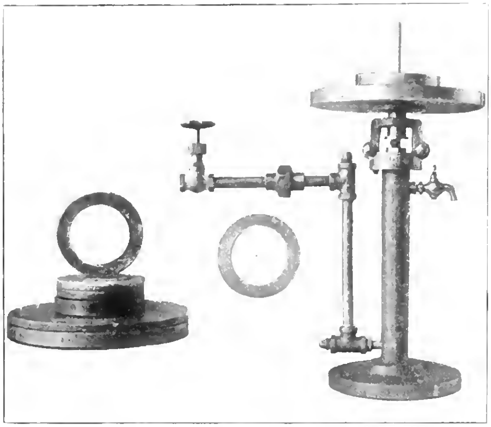

FIG. 4 DEAD WEIGHT PRESSURE GAGE

the pressure with which the machine is to be credited in computing performance, efficiency, etc. The throttle valve cuts down this pressure so that any desired pressure can be had on the orifice, the volume or amount of flow being computed from the orifice pressure. This orifice pressure may be measured by means of a static hole in the pipe wall with the pipe connecting to the dead-weight gage or mercury column, or an impact tube may be used on the jet discharged from the orifice, as explained in a paper by the author, entitled The Impact Tube (Trans.Am.Soc.M.E., December 1916).

When, in the test with the dead-weight gage, the pressure variation is such as to require constant adjustment by an attendant, a throttle valve must be provided at a convenient location and the gage must be piped nearby. The attendant then has one hand on the throttle valve and with the other hand spins the dead weight gage. The purpose of this spinning is to keep the gage floating.

The writer gives two tables from which the necessary corrections in the readings may be made, as well as directions to avoid errors in readings. (*Power*, vol. 47, no. 9, February 26, 1918, pp. 286-288, 3 figs., *dA*)

NEW "TOTAL IMMERSION" HYDROMETER, A. Ångstrom and H. Pettersson. (*Zeits. Instrumentenk*, 37, pp. 177-180, September, 1917). To a glass bulb, weighted with shot, and of about 25 cm. external volume, is attached a fine chain about 40 cm. long. The chain is made of doubly-gilded brass and contains about 500 links of equal weight. When a bulb and chain are put into a glass cylinder containing a liquid of such density that the bulb is totally immersed, the bulb will sink in the liquid and the chain will coil up on the bottom of the cylinder until a position of equilibrium is reached. The cylinder containing the liquid is so graduated that the density of the liquid in it can be determined from the position of the pointed upper end of the glass bulb. It is shown that the maximum error in the density is less than the accuracy with which the divisions on the cylinder can be read, the average error not exceeding 0.02 per cent. If the bulb is made of quartz, the chain of gold, and a Dewar vacuum vessel is used to contain the liquid, an accuracy of about 0.002 per cent can be obtained. It is convenient to have a glass cylinder with a false bottom on which the chain coils up. The bottom of the cylinder is drawn out to a tube and fitted with rubber tubing and clip so that the liquid can be conveniently run out. (*Science Abstracts*, Section A—Physics, vol. 21, pt. 1, no. 241, January 31, 1918, p. 1)

FLOW MEASUREMENT IN A WATER COLLECTING GALLERY BY THE CHEMICAL METHOD, D. H. Maxwell. *Journal of the American Water Works Association*, vol. 4, no. 2, June 1917, pp. 192-199, 3 figs.

Mechanics

HOW TO PROPORTION UNSYMMETRICAL CONCRETE ARCHES, Jos. P. Schwada. The writer develops a method and formula for determining the dimensions of the two halves of an unsymmetrical concrete arch.

One of the steps in the design of an unsymmetrical concrete arch is the proportioning of the arch ring. This consists of the determination of the position of the crown with respect

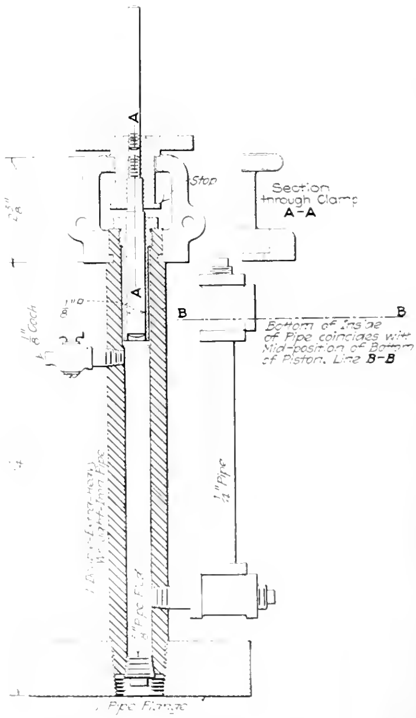

FIG. 5 SECTIONAL VIEW THROUGH DEAD-WEIGHT PRESSURE GAGE

to the springing lines and the selection of a proper crown thickness, the curvature of the arch axis and the thickness of the arch ring from the crown to the springing lines. An empirical method is here offered for determining these dimensions. This method is based on a consideration of an unsymmetrical arch ring as made up of half spans of unequal symmetrical arches, located so that when treated as the half spans of symmetrical arches, the crown thrusts for dead load only will be equal. Hence, the position of the crown will be at the point of zero shear, and the crown thickness, curvature of the arch axis and the thickness of the arch ring may be obtained as for symmetrical arches.

The writer derives an expression for the length of the shorter segment of the unsymmetrical arch of given span, and also an expression for the other determining magnitudes. A comparison between the crown thrust for a given unsymmetrical arch determined according to the elastic theory, and the crown thrust for the symmetrical arches, with half spans equal to the segments of the unsymmetrical arch, determined according to both the empirical formula and the elastic theory, shows the general reasonable correctness of the empirical formulæ. (*Engineering News-Record*, vol. 80, no. 9, February 28, 1918, pp. 415-416, 3 figs., *pe*)

Studies of Liquid Films, Sir James Dewar. Last year Sir James Dewar delivered a lecture before the Royal Institution on liquid films (soap bubbles), and showed the great importance of research in this direction. He pointed out at the time that the work was threatened by the restriction of the departmental staff. While his two men actually remained in with him, the research was frequently interrupted.

The speaker explained the manner of blowing the soap bubbles and means for prolonging their life, the most important in this latter respect being the absence of dust, and especially of greasy dust specks. He further explained the mechanics of the bubble: namely, thinning of the film through the draining off of the liquid of the bubble and the condensation of water vapor on the film, resulting in the washing out of the soap.

The gas pressure inside the bubble was always a little greater than the pressure outside. Owing to the surface tension, the bubbles contracted and the gas was forced outward through the film.

In order to produce large bubbles of long life, the speaker attempted to purify one of the cellars of a building of all dust and blow bubbles from outside through the wall. The cool, steady temperature of such a space was supposed to be an advantage. Actually, however, the attempts failed. Yet Sir James succeeded in producing films, one half black and another wholly black, in a bottle about a foot and a half in diameter. One of these films lived for 56 days, in spite of all the vibrations of the laboratory.

Two methods have been applied to prevent the spontaneous contraction of a bubble and to prolong its life. One is to replenish the gas forced out of the bubble, and the other to produce the bubble in a high-pressure atmosphere, so as to have a high pressure both inside and outside of the bubble. Thus, in the case of a bubble in a glass vessel at ten atmospheres pressure, ten times the amount of gas would have to get through the film to produce the same contraction as would result in a container at atmospheric pressure, while in a container at 100 atmospheres the bubble would practically be permanent. Rates of transference of hydrogen through bubbles under a pressure of 1 atmosphere and 6.5 atmospheres were determined.

Sir James also made numerous experiments on the production of chains of bubbles, showing how bubbles united. One of the ways of determining this was as follows:

By forcing air through a tube he produced a soap bubble on a plate of glass smeared with glycerine, the bubble being more or less hemispherical. When a second bubble was planted next to the first, the second united with a plane common face; a third bubble added led to the formation of three common faces meeting at 120 deg., and so on. When the plate was illuminated from below to show the arrangement in the plan, it was seen that five bubbles would group themselves about a pentagon; six bubbles would form a hexagon, etc. When the plate was blown upon, the films collapsed and flattened out, but the geometric pattern remained discernible for a few moments.

In another series of tests, a chain of bubbles was suspended from a tube forming quite interesting structures, including catenaries of strange complexity built up of multitudes of bubbles in regular patterns. For example, an inclined catenary in which photographs of natural colors showed both the spherical and the color plane faces. (Lecture before the Royal Institution, January 18, 1918, abstracted through *Engineering*, vol. 105, no. 2717, January 25, 1918, pp. 98-99, 1 fig., *etA*)

La Détermination Graphique des Engrenages Hélicoidaux, P. Massot. *La Technique Moderne,* Tome 10, no. 1, January 1918, pp. 8-13, 4 figs. Graphical determination of helicoidal gears.

Metallurgy

The Viscosity of Blast-Furnace Slag and Its Relation to Iron Metallurgy, Including a Description of a New Method of Measuring Slag Viscosity at High Temperatures, Alexander L. Field. *Transactions of the Faraday Society*, vol. 13, parts 1 & 2, December 1917, pp. 3-35, 8 figs., 10 tables.

Les Formules Nouvelles en Métallurgie Le Long-Fourneau pour la Production de la Fonte, Amédée Sébillot. *Revue Scientifique, Industrielle et Commerciale des Metaux & Alliages*, 11th year, no. 1, January 1918, pp. 1-3, 1 fig. Discussion of some new formulæ in metallurgy. The present investigation is based on the formula developed just before the war by the Russian metallurgist, Prof. Groun Grzimailo. On the basis of this formula the writer has developed a new type of blast furnace.

Motor-Car Engineering

Principles of Tractor-Engine Cooling, Arthur B. Modine. Discussion of the factors involved in tractor-engine cooling. While the paper is specifically devoted to tractor engines, it discusses the subject in a broad manner, which makes it fully applicable to the case of motor-engine cooling generally.

The principal variables affecting the cooling in addition to the radiator size pertain to radiator type, radiator core, thickness or degree of cooling capacity, rate of water circulation, size, type and speed of fans, and the economic characteristics of the engine to be cooled.

It is obvious that in order that the cooling should be efficient, the air has to be capable of taking away the heat delivered in the water to the radiator. This heat to the radiator, as the author states in his introductory formula, is equal to heat input minus heat equivalent of horsepower developed and

heat losses, which he divides into two groups, viz.: exhaust loss, and engine radiation and convection losses.

The following equation is given as derived from observed average performances:

$$\text{Heat to radiator} = 0.40 \times \text{heat input} \times F$$

where F is a variable with the value of 1.0 in the case of L-head engines ranging from 25 to 50 hp. and 0.8 in the case of valve-in-head engines of the same power range, both values applicable to tractors. The writer shows further that in the case of a tractor, the heat loss to the radiator per minute per horsepower is equal to about 100 B.t.u. It may be stated here that the average heat loss to the radiator in motor-car engine design is assumed to vary from 50 to 60 B.t.u. per min. per hp.

The writer derives the following formula for the frontal area of the radiator in sq. ft. per hp. output of the engine:

$$\text{Area} = \frac{6000}{v(T_1 - T_2)}$$

where v is the air velocity in ft. per min. and $T_1 - T_2$ is the temperature rise of air (in deg. fahr.) due to its passage through the radiator.

This indicates that for a given radiator the problem of cooling resolves itself into two factors—the temperature rise of the air and the velocity of the air.

The writer considers the subject of temperature rise in its relation only to two variables—rate of water delivery and air velocity; and shows, first, that the velocity of flow of water through the radiator is of very great importance, the faster flow producing much better cooling; and second, that the heat taken up by convection by air increases nearly directly in proportion to the velocity.

The paper presents also an interesting discussion as to fan power requirements, and presents a plea for larger fans and slower speeds than those in present average practice. (*Journal of the Society of Automotive Engineers*, vol. 2, no. 2, February 1918, pp. 148-151, 4 figs., *et*)

Traction on Bad Roads or Land, L. A. Legros. *Engineering*, vol. 105, no. 2717, January 25, 1918, pp. 86-89, 13 figs. (to be continued).

Camion Automobile pour le Transport des Ordures Ménagères et de Matériaux Quelconques, L. Archinard. *Bulletin Technique de la Suisse Romande*, 11e Année, no. 1, January 12, 1918, pp. 1-6, 15 figs. Description of a European design of a motor truck for the conveyance of sewage.

Munitions

Formulæ for Trajectories of Anti-Aircraft Shells, G. Manetti. The formulæ used in the present article are expressed in the notation used in the works on ballistics by Siacci and by Ronca, published in Italy. These works are not available in the Library of the Engineering Societies.

Consider the two trajectories in Fig. 6, such that $X = W$, $OC = OD$ and the initial velocity V is the the same in both cases. Then from the equations cited by Ronca, the writer deduces the following equations:

$$X = \frac{V^2 \sin 2\phi_r}{g} G_y(Z) \ldots\ldots\ldots\ldots\ldots [1]$$

$$W = 2V^2 \frac{\cos(\varepsilon + \alpha)\sin\alpha}{g\cos^2\varepsilon} G_y(z) \ldots\ldots\ldots [2]$$

From the condition stated above, namely, $OD = OC$, the writer deduces $OB = x = X\cos\varepsilon$, but knowing that approximately $\beta = \sec\phi$, he further deduces that the ballistic coefficient of the trajectory OC is equal to the ballistic coefficient of OD multiplied by the same $\cos\phi$. Hence, $z = Z$, and $G_y(z) = G_y(Z)$.

After simple reductions the following formula is obtained:

$$\sin 2\phi_x = \frac{2\cos(\varepsilon - \alpha)\sin\alpha}{\cos^2\varepsilon} \ldots\ldots\ldots\ldots [3]$$

and by an analogous method, assuming that T_w represents the duration corresponding to W, he obtains

$$T_w = T \cdot \frac{\cos\varepsilon\cos\alpha}{\cos(\varepsilon + \phi_x)} \ldots\ldots\ldots\ldots\ldots [4]$$

These are the formulæ which have already been deduced by another method, namely, by a consideration of the analogy with motion in vacuum by Obermeyer, Schmidt, Clausen and others, together with the following formula which is correct only for vacuum:

$$\tan\theta = \tan(\varepsilon + \alpha)\frac{\sin 2\phi_x \cos\varepsilon}{\cos^2(\varepsilon + \alpha)} \ldots\ldots\ldots [5]$$

But knowing that $\nu = \varepsilon - \theta$, Clausen advises to substitute the value of the angle of arrival of the aerial trajectory when ν is calculated by these vacuum formulæ and to multiply the result by ϕ_x, ω_x, a procedure which has no analytic justification, but is permissible in an approximate calculation. (Compare *Journal of the United States Artillery*, November-December 1916).

The preceding formulæ represent the best approximative solution of the problem of anti-aircraft ballistics, because of their marked simplicity, and in computations give sufficiently satisfactory results, which may be improved to any desired degree by means of the following methods:

From [3] it is easy to obtain equation

$$\frac{2d\phi_x}{\tan 2\phi_x} = \left[\frac{1}{\tan\alpha} - \tan(\varepsilon + \alpha)\right] d\alpha \ldots\ldots\ldots [6]$$

a formula to the application of which it is possible to give a precision equal to that which is secured with its integral. This can be proved in the same manner as has already been done with respect to the function G. Since it is known that $\frac{2d\phi_x}{\tan 2\phi_x} = \frac{\tan\omega_r}{\tan\phi_x}\frac{dX}{X}$, which is true because by assumption $X = W$, and hence $dX = dW$, we have

$$\frac{\tan\omega_r}{\tan\phi_x}\frac{dW}{W} = \frac{1}{\tan\alpha} - \tan(\varepsilon + \alpha)d\alpha \ldots\ldots\ldots [7]$$

which is the differential equation of projection on the plane and is of great value in the calculation of tables of fire.

From the equality of $G(z) = G(Z)$ is derived also the equality of their partial derivatives $\frac{\partial G}{\partial V} = \frac{\partial G}{\partial \frac{x}{G}}$ and hence by the usual differentiations of [1] and [2] it is easy to prove that approximately the following two equations always hold good:

$$\frac{\partial W}{\partial V} = \frac{\partial X}{\partial V} \ldots\ldots\ldots\ldots\ldots\ldots [8]$$

$$\frac{\partial W}{\partial C'} = \frac{\partial X}{\partial C'} \ldots\ldots\ldots\ldots\ldots\ldots [8a]$$

These equations are of the greatest utility for direct application and still more for purposes indicated below.

It is known that

$$\frac{\tan\omega_r}{\tan\phi_r}\frac{dX}{X} = \frac{2d\phi_r}{\tan 2\phi_r} + \frac{\tan\omega_r - \tan\phi_x}{\tan\phi_r}\frac{dC'}{C'}$$

Knowing that

$$\frac{2d\phi_x}{\tan 2\phi_x} = \frac{\tan\omega_x - \tan\phi_x}{\tan\phi_x}\,\frac{d\delta}{\delta}$$

and introducing this value into Equation [6], we obtain

$$\frac{\tan\omega_x - \tan\phi_x}{\tan\phi_x}\,\frac{d\delta}{\delta} = \left[\frac{1}{\tan\alpha} - \tan(\varepsilon+\alpha)\right]d\alpha$$

which permits improving the result obtained by the application of [3] (which may be done in practice by using a nomographic slide rule) by applying the angles of elevation directly in order to take care of the variation of density in the vertical direction.

Professor Fubini has succeeded in an original and ingenious manner to establish the following equations:

$$d\phi = g\,\frac{dy - \tan\theta\,dx}{V^2(\tan\phi - \tan\theta) + \frac{\partial x}{\partial V}\tan\theta\left(g\tan\phi + \frac{\delta i}{C}F(V)\frac{1}{\cos\phi}\right)}$$

from which we get by writing $dy = 0$, ...[9]

$$V^2\left(1-\frac{\tan\phi}{\tan\theta}\right) = g\,\frac{\partial x}{\partial\phi} + \frac{\partial x}{\partial V}\,V\left(g\tan\phi + \frac{\delta i}{C}\,\frac{F(V)}{\cos\phi}\right).\ [10]$$

By using the same method the present writer succeeded in obtaining

$$V^2\left(\frac{\sin\alpha}{\tan\nu} - \cos\alpha\right) = g\cos\phi\,\frac{\partial W}{\partial\alpha} + V\left(g\sin\phi + cf(V)\right)\frac{\partial W}{\partial V}$$

........[11]

in which the ballistic coefficiency for the sake of convenience in anti-aircraft fire calculations is, contrary to the usual practice, expressed by the following equation:

$$c = 0.896\,\frac{a^2}{p}\,\delta_m i$$

where δ_m is the average density; 0.896 i is the "form" coefficient as applied to a projectile of the type having a complete ogive of two radial calibers.

The three formulæ, [9], [10] and [11], are of the greatest utility for purposes of calculation.

In tables of anti-aircraft firing preëminent importance must be given to fuse timing. Hence, while the above formulæ may be considered to have the same values as if they were expressing at the same time a formal solution of problems of anti-aircraft ballistics, they cannot be correctly applied to the case of formula [4]; that is, to the calculation of all "time" elements.

In the Italian *Rivista di Artiglieria e Genio* two papers concerning the above matter were published in 1916 and 1917, first by the author and then by the well-known artillerist, Bianci. In the present article the author proceeds to give a more simple and direct solution than any given in the two papers cited above.

If we consider that at P, Fig. 7, is projected some point of an anti-aircraft trajectory which is being calculated, then by adhering to the hypothesis of direct resistance and by applying the Siacci formulæ for retardation as given in Ronca's Ballistica (in formulæ 54 on p. 149), and finally by resolving the force of gravity into two forces—one parallel to, and the other at right angles to, the direction of motion, the writer applies the principle of conservation of energy and obtains

$$\frac{dv}{dt} = \frac{vdv}{ds} = -cf(v) - g\sin\theta$$

and for centripetal acceleration

$$\frac{v^2}{\rho} = \frac{v^2 d\theta}{ds} = -g\cos\theta$$

where ρ is the radius of curvature. From this we easily deduce

$$ds = \frac{-vdv}{g\sin\theta + cf(v)}$$

$$dt = \frac{-dv}{g\sin\theta + cf(v)}$$

$$d\theta = \cos\theta\,\frac{gdv}{v[g\sin\theta + cf(v)]}$$

Substituting for $\frac{c}{\sin\theta}$ the expression, $c_1 = \frac{c}{\sin\theta_m}$ where θ_m is the average value of θ, we obtain

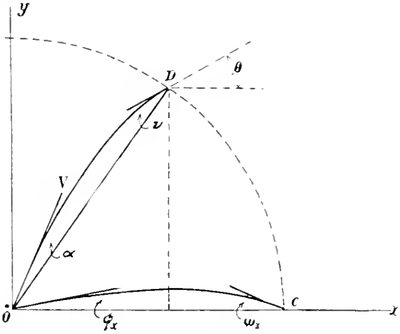

FIG. 6 TRAJECTORIES OF ANTI-AIRCRAFT SHELLS HAVING THE SAME INITIAL VELOCITY

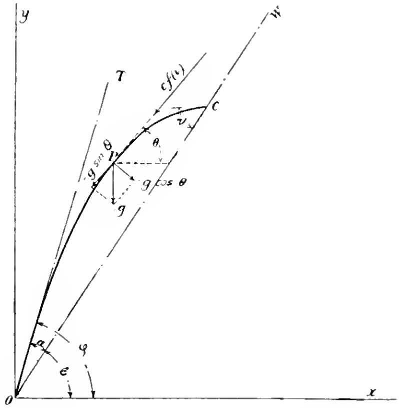

FIG. 7 ANTI-AIRCRAFT SHELL TRAJECTORY

$$\log_e\frac{\cos\theta}{\cos\phi} = \int_V^v \frac{-gdv}{v[g + c_1 f(v)]}$$

Then, using the notation

$$B(v) = \int_v^{1200}\frac{gdv}{v[g + c_1 f(v)]}$$

and further using the notation $e^{B(v)} = I(v)$, the writer obtains

$$\cos\theta = \cos\phi\,\frac{I(v)}{I(V)}$$

Likewise it is easy to deduce

$$s = \frac{1}{\sin\theta_m}\left[S(v) - S(V)\right]$$

$$t = \frac{1}{\sin\theta_m}\left[T(v) - T(V)\right]$$

where

$$S(v) = \int_{v}^{1200} \frac{v\,dv}{g + c_1 f(v)}$$

$$T(v) = \int_{v}^{1200} \frac{dv}{g + c_1 f(v)}$$

Now, since $dy = \sin\theta ds$ and $dx = \cos\theta ds$
we have $y = \sin\theta_m s$

$$\text{and } dx = \cos\phi \frac{I(v)}{I(V)} \frac{v\,dv}{g \sin\theta + c f(v)}$$

and hence

$$x = \frac{\cos\phi}{I(V)} \frac{1}{\sin\theta_m} \left[A(v) - A(V) \right]$$

where

$$A(v) = \int_{v}^{1200} \frac{I(v)\,v\,dv}{g + c_1 f(v)}$$

There is no difficulty in calculating and tabulating with respect to v and c_1 the functions I, A, S and T, and this will give a complete solution of the problem provided the method of calculating the average function $\sin\theta_m$ be given.

The writer considers it unnecessary to try to solve this far more difficult part of the problem, since, from a practical point of view, the results would be of little value. As a matter of fact, tables can be constructed so as to make the interpolation very easy, and it is always possible in practice to use such a subdivision as would make it possible to give with reasonable correctness to $\sin\theta_m$ such a value that the function $\sin\theta$ may apply to the origin of the required arc. (*Rivista Marittima*, vol. 50, no. 10, October 1917, pp. 29-38, 2 figs. *tmA*)

Manufacture of the U. S. 75-Millimeter Shell, Erik Oberg. *Machinery*, vol. 24, no. 7, March 1918, pp. 590-596, 15 figs. First installment of a very interesting series of articles. The discussion is of a purely practical nature.

Gas Warfare, S. J. M. Auld. *Scientific American Supplement*, no. 2200, March 2, 1918, pp. 142-144.

Poisonous Gas in Warfare: Application, Prevention, Defense, and Medical Treatment. *Professional Memoirs, Corps of Engineers, United States Army and Engineer Department at Large*, vol. 9, no. 48, November-December, 1917, pp. 758-784.

The Manufacture of the Lewis Machine Gun, Frank A. Stanley. *American Machinist*, vol. 48, no. 7, February 14, 1918, pp. 265-273, figs. 12-20 (Part 2). Continuation of description of the details of manufacture of the Lewis machine gun, a valuable contribution of a practical nature.

The Madsen and Bergman, 1915, Models of Automatic Rifles Used by the German Infantry. *Professional Memoirs, Corps of Engineers, United States Army and Engineer Department at Large*, vol. 9, no. 48, November-December, 1917, pp. 706-707, 2 figs.

Manufacturing Time Fuse Rings, Donald A. Baker. *Machinery*, vol. 24, no. 7 March 1918, pp. 612-614, 6 figs.

How Semisteel Shells Are Being Made in France, E. Ronceray. *The Foundry*, vol. 46, no. 3 (whole no. 307), March 1918, pp. 93-96. *The Iron Trade Review*, vol. 62, no. 11, March 14, 1918, pp. 666-668. Paper on the manufacture of cast semi-steel shells, based on the French.

Tests of Browning Machine Guns. *The Iron Age*, vol. 101, no. 10, March 7, 1918, p. 629.

Manufacturing Base Plugs for the 80 Mark VIII Time Fuse, John Campbell. *American Machinist*, vol. 48, no. 10, March 7, 1918, pp. 414-417, 18 figs.

Pressure, Statical and Dynamical, F. W. Jones. *Arms and Explosives*, vol. 26, no. 305, February 1, 1918, pp. 20-22, 2 figs. The question of the statical and dynamical pressures is here applied to the design of lead crushers. The article is an interesting contribution to this comparatively little known subject.

Manufacture of the 75-mm. High Explosive Shell, S. A. Hand. *American Machinist*, vol. 48, no. 11, March 14, 1918, pp. 435-439, 9 figs.

Heat-Treating 3-In. Shrapnel Shells. *American Machinist*, vol. 48, no. 11, March 14, 1918, pp. 441-442, illustrated.

Power-Plant Engineering

Waste Prevention in Power Plants, Victor J. Azbe. *The Iron Trade Review*, vol. 62, no. 7, February 14, 1918, pp. 421-428, 13 figs.

Ninety-Five Thousand Kilowatt Addition to Northwest Station. *Power*, vol. 47, no. 11, March 12, 1918, pp. 354-358, 6 figs.

Pumps

Reliability of Pumping Station Design, Clarence Goldsmith. *Journal of The American Water Works Association*, vol. 4, no. 4, December 1917, pp. 432-446.

Some Costs of Maintenance of Motor-Driven Deep-Well Pumps, Melvin L. Enger. *Journal of the American Water Works Association*, vol. 4, no. 2, June 1917, pp. 190-191, 2 tables.

Some Tests on Motor-Driven Deep-Well Pumps, I. W. Fisk and P. S. Biegler. *Journal of the American Water Works Association*, vol. 4, no. 2, June 1917, pp. 239-251, 9 figs.

Railroad Engineering

Electric Boiler Heating for Steam Locomotives, W. Kummer. (*Schweiz. Bauzeitung*, 1917. *Elektrot. u. Maschinenbau*, 35, pp. 434-435, Sept. 9, 1917. Abstract). This article suggests that electric boiler heating offers economic advantages on Swiss steam railways; there are also criticisms by other writers. Kummer considers that electric heating can compete with coal firing for boilers at the present price of coal in Switzerland. Any kind of current may be employed so long as it is transmitted at high enough pressure. The accompanying table gives data for three types of Swiss steam railways referred to traffic in ton-km. (total weight).

Assuming feedwater at 30 deg. cent., the heat expenditure for steam as used on locomotives averages 635 kg-cal. per kg. for saturated steam and 700 kg-cal. per kg. for superheated steam. On the basis of 1 kg-cal. = 1.16 watt-hr., and allowing 86 per cent efficiency for saturated steam or 81 per cent for superheated steam between the line feeding point and the steam

raised, we have an energy consumption of 857 watt-hr. per kg. with saturated steam, and 1000 watt-hr. per kg. with superheated steam. Lines 3 (*a*), (*b*) in the table show the much higher efficiency of direct electric drive, compared with electric heating of steam boilers. Lines 4 (*a*), (*b*) are based on lines (1) and (3), and on coal at 100 fr. per ton and electrical energy at 1.5 Rp. per kw-hr. Under these conditions electric heating is 10 per cent cheaper than coal firing. Allowing 0.043 to 0.055 Rp. per ton-km. for working line costs, and from 0.015 to 0.01 Rp. per ton-km. for the conversion of steam locomotives to electric heating, the cost of electric heating would be practically equal to that of coal firing. Kummer suggests that tests be made on an electric railway with a steam locomotive fitted for electric heating.

	Rhaetian Railway	Gotthard Railway	Swiss Mountain Railways, Circuits 1 to 4
1 Coal consumption, kg. per ton-km.	0.100	0.080	0.075
2 Steam consumption, kg. per ton-km.:			
(*a*) Using saturated steam	0.700	0 560	0.525
(*b*) Using superheated steam	0.600	0.480	0.450
3 Electrical energy at feeding-point of the line, watt-hr. per ton-km.:			
(*a*) Steam boiler heating	600	480	450
(*b*) Direct electric drive	48 1	46 to 47	45 to 46
4 Cost of steam, rappen per ton-km.:			
(*a*) Coal firing	1 00	0 80	0 75
(*b*) Electric boiler heating (excluding working cost for line, and loco. conversion)	0 90	0.72	0 675

L. Thormann criticises the practicability of the proposed system. This writer allows 1 kw-hr. per kg. of steam at working pressure; and an energy consumption with electric boiler-heating equal to about 10 times that with electric locomotives. If there is a heating surface of 250 m.^{2} already available on the locomotive to be converted, approximately another 650 m.^{2} would have to be provided, with a construction weight of 52 tons. Probably the extra weight of the electrically heated boiler would be 60 to 80 tons, excluding transformers, which would probably be necessary, and would add another 80 tons to the dead weight. The crucial point seems to be the heating surface required. Thormann's estimate is much higher than Kummer's, owing partly to his assuming that there is no considerable heat storage, so that the heat equivalent of electrical energy supplied would have to correspond with the instantaneous steam demand. Thormann concludes that the weight of an electrically heated boiler and locomotive would be two or three times that of an ordinary steam locomotive; the former would be costly and increase materially the specific energy consumption, so that energy would have to be obtainable at 1.5 centimes (rappen) per kw.-hr. to compete with coal firing. This price, at the line wire, cannot be realized.

In his reply, Kummer asserts that 2750 kw. at the line would provide 417 hp. at the wheel rim of an electrically heated locomotive, sufficing to propel a total weight of 350 tons at 25 km. per hr. up a 1:100 gradient. Thormann's assumption of 917 m.^{2} heating surface for 1036 hp. (at rim) corresponds to 1.13 hp. per m.^{2}, whereas 4 to 6 hp. per m.^{2} is commonly obtained with locomotive boilers providing saturated steam, and 6 to 8 hp. per m.^{2} with superheated steam. Kummer does not agree that the locomotive weight would be much increased by electric heating; as compared with plain electric drive, the electrically heated boiler would be able to accumulate energy during station stops and while running downhill.

A. Trautweiler suggests that surplus electrical energy if available free, could be used advantageously to preheat feedwater for locomotives up to 90 deg. cent. or so in stationary plants at depots. At a medium-sized depot 250 m.^{3} of feedwater might be required daily for 20 locomotives. If 5000 kw. spare capacity be available for 5 hr. each night at an adjacent power station, this could be utilized (at 80 per cent efficiency) to warm the 250 m.^{3} of feedwater through 70 deg. cent. This would correspond to a saving of 3000 kg. coal per diem. Even on the basis of peace prices for coal, this saving would cover the costs and charges on the preheating equipment. (*Science Abstracts*, Section B—Electrical Engineering, vol. 21, pt. 1, no. 241, January 31, 1918, pp. 1-2)

A Scientific Study of Railway Track Under Load. Progress report of investigations carried on for a period of over five years by a special joint committee of the American Society of Civil Engineers and the American Railway Engineering Association.

The proper conception of the fundamentals underlying the action of track under load may be had only by considering the track as an elastic structure under load. The wheel loads are applied on the top of the rails; the rails are flexible beams which rest on flexible supports (ties); and the ballast and roadway on which the ties rest are themselves yielding or flexible. Due to the stiffness of the rail and the yielding of its supports, the load from a wheel will be distributed over a number of ties, and the amount of yielding of the supports affects the values of the moments and stresses developed in the rail.

The properties of elasticity and stiffness in the rail, the tie, the ballast and the roadway enter in a complex manner into the development of the stresses in a track structure, the relative stiffness of the various parts affecting the results in any one part. The spacing of the wheels of locomotives and cars longitudinally along the track also influences the division of the load, and hence the value of the stresses developed in rails, ties and ballast.

The method of analysis of track action, which is based on the assumption of a continuous elastic support under the rail, has been found to be the most convenient and most comprehensive in its applications to the present investigation. The assumption of a continuous support in place of tie supports is not an element of serious inaccuracy for the close tie spacing and large rail sections used on the American railroads.

A new term, "modulus of elasticity of rail support," has been introduced to measure the vertical stiffness of the rail support, and may be defined as the pressure per unit of length of each rail required to depress the track one unit. It represents the stiffness and ability to yield of tie, ballast and roadway, but does not involve the stiffness of the rail. As applied to ordinary track, the load on one rail required to depress one tie one unit, divided by the tie spacing, will give the modulus of elasticity of rail support.

The fundamental condition on which the analysis is based is that the track depression at any point and the upper pressure of the rail per unit of length at the same point are directly proportional to each other: in other words, $p = uy$.

The following notation is used here (compare Fig. 8):

P = wheel load on a rail at the point which will be used as the origin of abscissæ

E = modulus of elasticity of steel

I = moment of inertia of section of the rail

y = depression of rail at any point, x, it being assumed that there is no play or backlash in the track; downward displacement of a rail is negative; however, in the applications to track, the ordinary downward depressions of track will be spoken of as positive

p = upward pressure against rail per unit of length of rail at any given point

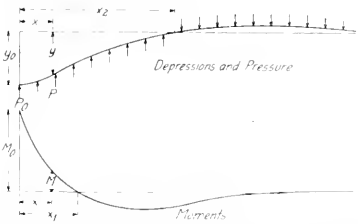

FIG. 8 DISTRIBUTION OF DEPRESSION AND BENDING MOMENT FOR A SINGLE LOAD

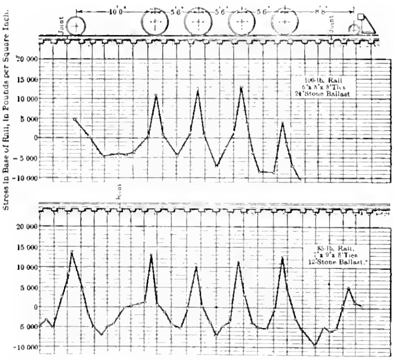

FIG. 9 STRESS-DISTRIBUTION DIAGRAMS FOR STATIC-LOAD TESTS WITH MIKADO LOCOMOTIVE

u = an elastic constant which denotes the pressure per unit of length of each rail necessary to depress the track (rail, tie, ballast and roadway) one unit; for the system of units ordinarily used, it will be expressed in pounds per inch of length of rail required to depress the track 1 in.; u represents the stiffness of the track, and involves conditions of tie, ballast and roadway; it is termed the modulus of elasticity of rail support

M = bending moment in rail at any point.

The formulæ for the bending moment in the rail, the shear and the intensity of the pressure (p) against the rail are obtained from the differential equation of equilibrium of a beam. To find the effect of a combination of wheel loads on the track depressions and the pressures and the bending moment in the rail as may occur with the given type of locomotive, the equations and diagrams for a single wheel load may be applied by the use of the principle of superposition; that is, by considering that at the given point along the rail the combined effect of two or more wheel loads is the algebraic sum of the effects of the individual wheel loads.

Two main types of tests were carried out: namely, static-load tests and moving-load tests. In all moving-load tests, except at very low speeds, steam was shut off as the locomotive approached the test section of the track. It was found that the tractive effort of the locomotive produced an appreciable effect on the rail stresses which was somewhat variable, and it was decided to eliminate this variable when the effect of speed only was studied.

As regards depression of track, little difference was found in the depression for the load over a tie and for the load midway between ties, though both in the one-axle and two-axle loads the depression is generally somewhat greater for the load overhead tie. There is a marked difference, however, in the magnitude of depression, according to the condition of the track, freshly tamped track having a smaller depression under load than track which has been subjected to the action of traffic for a considerable time after surfacing.

Load-stress diagrams for gage lines at the point of application of load in the case of one-axle load and at the points of application of load in the case of two-axle loads were secured and the average of the stresses at the two points being plotted in the latter case. Here again little difference is to be found in the rail stress under the load for a load over a tie and for a load midway between ties, but rail stresses differ noticeably, according to the condition of the track, freshly tamped track giving small stresses. For a rail of 85-lb. section, the stress in rail in an untamped track was found to be as much as 6000 lb. per sq. in. more than in a freshly tamped track.

An interesting series of static-load tests was carried out with a Mikado locomotive on rails of 85-lb. and 100-lb. sections. The static distribution diagrams shown in Fig 9 have been derived from these tests. It is found that the maximum stresses in the rails are directly under the wheels, positive moment being developed at these points and negative moments at points between the wheels. The stress under the inner two drivers and that under the front driver is generally somewhat greater than that under the real driver.

Values of the modulus of elasticity of support were calculated from the track depressions expressed in pounds per inch of rail length necessary to depress the track one inch.

There seems to be some tendency toward a higher value of the modulus in the track having the heavier strain. It is apparent that the character and condition of the track greatly influences the magnitude of the modulus of elasticity of rail support.

Tables were compiled showing the effect of speed as a percentage of the stress in the rail at 5 m.p.h. for each mile-per-hour increase of speed greater than 5 m.p.h. In this connection it appears that heavier rail sections give a somewhat higher proportional increase of stress with increase of speed than the lighter sections; also the heavier rail gives a much higher bending moment coefficient than the lighter. (*Proceedings of the American Society of Civil Engineers.*)

NEW 2-6-4 TYPE TANK LOCOMOTIVE SOUTHEASTERN & CHATHAM RAILWAY. *The Railway Gazette,* vol. 28, no. 6, February 8, 1918, pp. 159-164, 7 figs.

SCREW SPIKES UNSATISFACTORY ON PENNSYLVANIA LINES. *Engineering News-Record,* vol. 80, no. 9, February 28, 1918, p. 413.

CAUSES OF SPLIT-HEADS IN RAILS. *The Iron Trade Review,* vol. 62, no. 9, February 28, 1918, pp. 544-547, 6 figs.

WHEEL CONTACTS ON RAILHEADS, George H. Barbour. *Proceedings of The Engineers' Society of Western Pennsylvania,* vol. 33, no. 8, November 1917, pp. 489-522, 22 figs.

A New Scale Test Car, A Christopher. *Railway Age*, vol. 64, no. 7, February 15, 1918, pp. 371-372, 1 fig.

Internal Strains in Steel Rails, James E. Howard. *New England Railroad Club*, January 8, 1918, pp. 279-305. Further presentation of the valuable results experimentally secured by the present writer.

La Contre-Vapeur sa Puissance son Emploi Actuel, M. A. Herdner. Description and extensive discussion of a counter-pressure brake. This brake, while practically unknown on British and American railways, has still a certain amount of application on French and especially Spanish and Italian lines. It operates by using the engine as an air compressor driven by the weight or momentum of the train, and is of some value on railroads operating with head grades. *Mémoires et Compte Rendu des Travaux de la Société des Ingénieurs Civils de France,* Bulletin de Juin-Septembre 1917, 8 Serie, 70 Annee, nos. 6-9, pp. 523-631, 67 figs., 10 tables.

The Kearney High-Speed Railway, E. W. Chalmers Kearney. *Journal and Transactions of the Society of Engineers,* vol. 8, no. 12, December 1917, pp. 307-356, illustrated.

A New Locomotive Superheater Header. *The Railway Gazette,* vol. 28, no. 7, February 15, 1918, p. 188. Description of a simplified header in which there are no special fastening device, fittings and appliances for the insertion and removal of steam tubes.

Dynamic Augment—Need and Means of Reducing It, E. W. Strong. *Official Proceedings of the New York Railroad Club,* vol. 28, no. 4, pp. 5183-5229, 6 tables.

Intensive Locomotive Development, O. S. Beyer, Jr. *Railway Mechanical Engineer,* vol. 92, no. 3, March 1918, pp. 131-133 (to be continued).

Resilient Chairs and Ferro-Concrete Sleepers. *Engineering,* vol. 105, no. 2721, February 22, 1918, pp. 191-193, 16 figs.

Refrigeration

Relation between Efficiency of Refrigerating Plants and the Purity of Their Ammonia Charge, F. W. Frerichs. An extensive experimental investigation in which it is shown that the quality of the ammonia charge has an important bearing upon the operation of the ice plant. In order to minimize considerable losses due to operation of absorption in ice machines with impure ammonia, the writer recommends using liquid anhydrous ammonia of known purity and pure distilled water for charging absorption plants. He calls further attention to the fact that the question of purity of water is of real importance. (*The Journal of Industrial and Engineering Chemistry,* vol. 10, no. 3, March 1, 1918, pp. 202-211, 7 figs., 4 tables.)

The Economy of a Refrigerating Power Plant, Victor J. Azbe. *Journal of The Engineers' Club of St. Louis,* vol. 3, no. 1, January-February 1918, pp. 6-21, 11 tables.

Research

The Aerodynamic Laboratory at Leland Stanford Junior University and the Equipment Installed, with Special References to Tests on Air Propellers, Prof. Wm. F. Durand. *Aerial Age Weekly,* vol. 6, no. 24, February 25, 1918, pp. 1070-1072.

U. S. Metals Refining Co.'s New Laboratory at Chrome, N. J., B. B. Hood. *Engineering and Mining Journal,* vol. 105, no. 10, March 9, 1918, pp. 451-454, 5 figs.

Industrial Research Laboratories, F. K. Richtmyer. *The Sibley Journal of Engineering,* vol. 32, no. 6, March 1918, pp. 80-81.

Research and the Industries, P. G. Nutting. *The Sibley Journal of Engineering,* vol. 32, no. 6, March 1918, pp. 81-84.

A Mixed Pressure Steam Turbine. *Power Plant Engineering,* vol. 22, no. 5, March 1, 1918, pp. 195-197, 2 figs.

Steam Engineering

A 50,000 Sq. Ft. Condenser. Description of a surface condenser serving a 30,000-kw. turbine. One of the interesting features of its construction is the use of a special design of expansion joint, shown in Fig. 10. It is 13 ft. in diameter and consists essentially of a fairly close-fitting cast-iron sleeve, so formed as to permit a manometric column of mercury to make a seal to prevent air leakage and at the same time permit of a free motion of the upper and the lower halves of the joint relative to each other. The upper part of the joint is built so that if, for any reason, the mercury arrangement should fail, an ordinary slip joint with soft packing could be used, the place for it being indicated in the figure as "Rope for Packing."

The dotted portion marked "Expansion Joint Clamping Block" at the lower left part of the figure is not used when the joint is in service. It is simply an arrangement whereby the two portions of the joint can be fastened together for shipment, and is removed after the joint is in place.

Some such type of joint was necessary, because the great vertical distance between the condensers and the turbines entailed an extraordinarily great expansion in case the apparatus should be much changed in temperature. The mercury expansion joint can take up an indefinite amount of expansion, whereas a copper joint might ultimately fail with the great distortion necessary. (*Power,* vol. 47, no. 9, February 26, 1918, pp. 282-285, 4 figs., *d*)

The 50,000-Kilovolt-Ampere Connors Creek Turbines. The Connors Creek plant of the Detroit Edison Company was planned to contain six 25,000-kva. machines. Three of them were installed between 1915 and 1917, but when the fourth unit came up for consideration it was found that the development of large turbine units had progressed to such a point that it would be desirable to install a unit of greater capacity than originally planned. Hence, instead of the original contemplated 25,000-kva. units it was decided to install two 50,000-kva. machines, one of which is now being placed.

This turbine is of the disk type. It has twenty-one stages as against nine in the smaller machines, but is only 15 ft. longer overall than are the smaller machines. Other dimensions are also much smaller than one would expect from a direct comparison of capacities. The weight is only about 40 per cent greater than that of the earlier models, while the speed of 1200 r.p.m. is the same.

The small physical size in comparison with the earlier units is partly due to refinements in design, which have made it possible to greatly decrease the distance between wheels and also

to generate higher voltage, viz., 12,200 instead of 4600. The tremendous capacity in a single turbine barrel and in a single generator is given by the size of the exhaust opening, which is rectangular and measures 12 by 18 ft. in the clear. The unit is supplied with steam through two lines, each 14 in. in diameter, and the steam from the exhaust passes directly downward through a short expanding neck into the condenser, which, like the turbine, is the largest yet attempted in a single shell. It is also unique among condensers of this general class in that it is arranged for but one water pass. The circulating

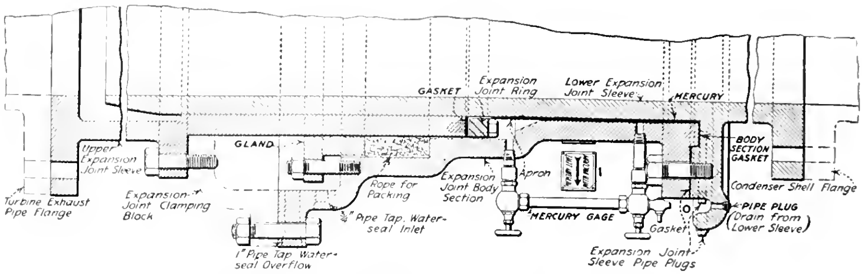

FIG. 10 DETAILS OF THE MERCURY EXPANSION JOINT FOR CONDENSERS

water enters all the tubes at one end and leaves all at the other end, flowing away over a dam, the crest of which is so located as to submerge the highest tubes.

In order to prevent an excessive cooling of the condensate, special devices called drain plates were installed. These drain plates are formed by placing light-weight metal plates in the steam space in such positions as to catch the condensate from the upper sections and lead it to the bottom of the condenser without allowing it to come in contact with the tubes in the sections through which it is led. These plates are not intended as steam guides or baffles, and their successful use depends on placing them in such positions that they do not interfere in any manner with the free flow of steam. (*Power*, vol. 57, no. 8, February 19, 1918, pp. 255-256, *d*)

STEAM-RAISING BY ELECTRICITY, WITH HEAT STORAGE, E. Höhn (*Schweiz. Bauzeitung*, 69., April 28, 1917. *Elektrot. u. Maschinenbau*, 35, pp. 316-317, July 1, 1917. Abstract). Describes tests made in October, 1916, by the Swiss Union of Boiler Owners, on a boiler in which steam was raised electrically. A horizontal cylindrical boiler with flat ends had 28 steel tubes of 27 and 28 mm. diam. and 1250 mm. free length. The effective heating surface in contact with water was 4.25 sq. m. (34 tubes), the permissible steam pressure 2.5 atmos. Each of the 34 active tubes contained a spiral nichrome wire threaded through glass beads and about 54 m. long, 0.9 mm. diam. and with a specific resistance of 1 to 1.1 ohms. For convenience in control, the heating spirals were arranged in groups of 18, 9 and 7. Approximately the current consumption was 115 amp. at 225 volts. The evaporation in two tests was 12.8 and 13.5 kg. per hr. per sq. m. heating surface, and 1.212-1.205 kg. per kw.-hr., respectively. The thermal efficiency of the boiler is 89.8-90.5 per cent.

In order to work economically, plenty of cheap electrical energy is needed; this may be secured by applying waste power to steam raising and storing heat on the principle of the fireless locomotive. The author discusses the economy of such an installation in which 100 hp. of waste power is converted to heat during 12 hours and stored in this form. As regards the size of storage necessary: If E = available energy in kw-hr., A = heat equivalent = 859 kg-cal. per kw-hr., and η = efficiency of evaporation; then heat W transferred to steam = ηEA, and if t = feedwater temperature and i = heat content of saturated steam, we have weight of steam = G kg. = $\eta EA/(i - t)$. Further, let Q be the number of kg. of water in reservoir before discharge, D the weight in kg. of steam evaporated from the accumulator during discharge, t_3 = the temperature of the feedwater, w_3 = its heat content ($= t_3$), t_2 the temperature of water and saturated steam in accumulator at pressure p_2 after discharge, w_2 and i_2 the heat contents of water and steam, respectively, t_1 the temperature of water and saturated steam at pressure p_1, after charging, and w_1, i_1 the heat contents of water and steam. Then the heat remaining in the accumulator after discharge = $Q - D$. The charging heat = $EA\eta = Q(w_1 - w_2) + D(w_2 - w_3)$. The amount of Q which can be "self-evaporated" as steam is $D = Q(w_1 - w_2)/(i_m - w_2)$. Hence $Q = EA\eta/[w_1 - w_2 + x(w_2 - w_3)]$. Knowing the weight of water, Q, the volume is easily calculated.

Applying these equations to the above numerical example, we have the heating surface = 7.5 m.^{2} corresponding to a boiler 800 mm. in diam., 1600 mm. between tube plates, with 47 tubes of 27/32 mm. diam. The accumulator water content Q = 9370 kg. and the total accumulator volume V = 11.8 m.^{3}, corresponding to a cylindrical vessel of 1.5 m. internal diam. and 6 m. high. The weight of steam removable from the accumulator is D = 1020 kg. The efficiency of the accumulator is 94-95 per cent, and of the whole installation, including boiler, 82 per cent. Of the electrically generated steam G = 1020 kg., 960 kg. can be recovered from the accumulator, corresponding to a coal economy of about 130 kg. per day. This covers interest and depreciation and leaves a small margin for current cost. If there is no direct charge for current supply, the plant may be used even to accumulate heat on Sunday for use during the rest of the week. Neither boiler nor accumulator requires any appreciable attendance. (*Science Abstracts, Section B—Electrical Engineering*, No. 24, December 31, 1917, pp. 435-436)

Thermodynamics

THE GAS-FILM THEORY IN RELATION TO HEAT CONDUCTION, Halbert T. Gillette, Mem.Am.Soc.M.E. The writer starts by citing a statement by Prof. H. L. Callendar on the adherence of gas films to solids, and the paper by Irving Langmuir (1912), where he showed that the film of quiescent air adhering to incandescent wires is 0.17 in. thick. This led the present writer to make some experiments with the view to determining the film thickness of water.

He found that at low temperatures and in water not mechanically stirred, the equivalent film thickness of water is about 0.05 in.

Next the writer undertook to determine the equivalent film thickness of steam. In this respect he has not yet secured sufficient experimental data to deduce a formula for all conditions, but claims to have established the fact that the equivalent film thickness of steam is far less than that of air, which, if correct, is of material importance.

In its simplest form, the film theory of the writer is graphically illustrated in Fig. 11. There a temperature gradient is shown from t_1 to t_4 through two gas or liquid films and a solid. This figure represents heat conduction from a gas or liquid through a solid to a gas or liquid. Heat flows from a temperature t_1 through a film of thickness d_1 to a solid, which it enters at a temperature t_2, dropping to t_3 and thence to a temperature d_3. While the actual heat gradients through gases or liquids

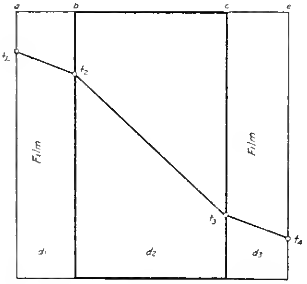

Fig. 11 Diagrammatic Illustration of the Film Theory

are not straight lines, for simplicity's sake each film is here assumed to conduct heat exactly as if it were a solid. This may be legitimized by the use of the term "equivalent film thicknesses." If by H we denote the number of heat units that pass through this system in one hour, by k_1, k_2 and k_3 the coefficients of heat conductivities of the respective films, the equation

$$d_1 = k_1 \frac{t_1 - t_2}{H}$$

will give the equivalent film thickness when the other factors are known. Usually t_2 is not known directly, but if we know H, d_2 and k_2, we may calculate $t_2 - t_3$ from the equation

$$t_2 - t_3 = \frac{Hd_2}{k_2}$$

and from this we can readily deduce t_2, or if the films are of the same gas or liquid, the drop in each film. Also, t_3 can often be measured.

The writer calculates the amount of heat which will pass through a glass window from a room whose temperature is 70 deg. fahr. to quiescent air outside at a temperature of 50 deg. fahr., assuming that the plate of glass is 1 ft. sq. and 1/8 in. thick. This calculation is based on a table reproduced in the original article and giving coefficients of heat conductivity for a large number of solids, liquids and gases. The author shows that while the total temperature drop is 20 deg., only 0.2 deg. is the share of the drop through the glass, while 19.8 deg. is the drop through the two air films, which clearly shows the extent of resistance to heat transfer offered by the air films as compared with glass an eighth of an inch thick. This result was secured, however, only by ignoring the heat lost by radiation from the surface of the glass.

Further, the influence of the air film decreases rapidly when the air is mechanically agitated, as when the wind is blowing or powerful convection currents take place. This is one of the reasons why double windows or double glazing is so effective in reducing heat losses. In a double window there are four air films instead of two, and a strong wind can reduce the thickness of only one of the four.

In his analysis of available experimental data on heat transfer, the author was struck with the slight resistance offered by steam. By deduction he secured for steam a coefficient of conductivity not greatly differing from that for air at the same temperature, but found that steam transfers heat many times faster than does air, which, in his opinion, is possibly only because the equivalent film thickness of steam is much less than that of air. Water in the ashpit of a boiler has long been known to increase fuel efficiency under certain conditions. The author believes that the reason for it is that the steam film facilitates the transfer of heat through the boiler tubes to the water and steam film on the other side.

Brief indications are given as to the method of applying the film theory as exposed here to the design of windows and heat-insulated walls. In particular, as to the latter, the writer designed a heat insulator in which the walls are hermetically sealed, and the space between filled with granular or fibrous material and a gas of low conductivity, such as CO_2 or SO_2. Such a gas-filled insulator has more than double the heat resistance of an ordinary air-film insulator of equal thickness. (*Engineering and Contracting*, vol. 47, no. 26, June 27, 1917, pp. 573-576, *etA*.)

Thermodynamics of the Throttle Valve, M. Jakob. (*Phys. Zeits.* 18., pp. 421-422, Sept. 15, 1917.) This paper is a discussion of a previous communication by R. Planck [see Abs. 146 (1917)]. From his formula [1], namely:

$$v/T = c^0_p\, 10^4 \cdot A \cdot \int 1/T^2\, (\partial A/\partial p)\, r dT + f\,(p)$$

Planck derived the following equation of state [2] for the air:

$$v = RT/10^4 \cdot p - 0.0103\,(8.9/T^{-7868}/T^2 + 15p^2/T^6)$$

and then deduced an expression [3] for the cooling produced during reduction to atmospheric pressure by the throttle valve:

$$\triangle = -17.8_p/T + {}^{250}p/T^2 - {}^{20}p^3/T^7.$$

Schames has shown [*ibid.* p. 30, 1917] Equation [2] to give false values for the volumes, and Planck's reply to his criticism [Abs. 314 (1917)] was that his empirical equations only held in the region of — 100 deg. to 0 deg. cent., and from 70 deg. to 200 deg.; even within this zone, however, v deviates too strongly from observation values and at the higher pressures by over 10 per cent. Schames has not supplied the cause of this variation in Equation [1], and in the present paper this is shown to be essentially due to the assumption made by Planck for $f(p)$. In order to modify formula [1] so as to hold between wide limits, Equation [3] must be suitably replaced by one of greater validity. Planck's assumption that $f\,(p) = R/10^4 p$, is found to be only correct when the conditions are those for a perfect gas. The author evolves a value for $f(p)$ which gives results correct in practice to 1 per cent. Schames's criticism is also met by a suitable modification of Equation [3]. (*Science Abstracts*, Section A—Physics, vol. 21, pt. 1, no. 241, January 31, 1918, pp. 26-27. The formulæ [1], [2] and [3] above are given as printed in *Science Abstracts*.—Editor.)

The Nernst Theorem and the Thermal Expansion of Solid Bodies, M. B. Weinstein. (*Ann. d. Physik*, 53, 9. pp.

47-48, October 2, 1917). In a former communication [Abs. 520 (1917)] the author has shown that on the Planck view of Nernst's theorem it does not of necessity follow that the thermal expansion of bodies, for which the theorem is valid, is nil at the absolute zero of temperature. In the present paper the author proceeds to deduce the same result from Nernst's exposition of his own theorem. The author refers to his own work on the equation of state for solid bodies, where a similar result is found for many substances. Reasons are given why Nernst's statement of his own theorem is considered preferable of that of Planck. (*Science Abstracts*, Section A—Physics, vol. 21, pt. 1, no. 241, January 31, 1918, p. 23)

On the Nernst Theory of Heat, P. S. Epstein. (*Ann. d. Physik*, 53, pp. 76-78, October 2, 1917). Weinstein has recently [Abs. 520 (1917)] investigated Planck's explanation of Nernst's theory of heat. This he has modified to the extent of finding that the entropy of a condensed body at absolute zero is not an absolute constant but may be dependent on the pressure. The present author now puts forward a thermodynamical exposition of this proposition, and this points to Weinstein's assumption being incompatible with the second law of thermodynamics. (*Science Abstracts*, Section A—Physics, vol. 21, pt. 1, No. 241, January 31, 1918, p. 23)

Heat Transmission through Building Materials, J. A. Moyer, J. P. Calderwood and M. P. Helman. *The Pennsylvania State College Bulletin*, vol. 11, no. 9, September 1, 1917, pp. 55-62, 4 figs., 3 tigs.

Varia

The Forces Which Act Upon a Transmission Line, Charles R. Harte. *Electric Railway Journal*, vol. 51, no. 8, February 23, 1918, pp. 364-366, 1 fig.

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Tables de Division, H. Chevalier. *Mémoires et Compte Rendu des Travaux de la Société des Ingenieurs Civils de France*, 8e Serie, 70e Annee, no. 6, Bulletin de Mai 1917, pp. 402-420.

The Application of Mechanical Differentiation to Engineering Problems, Armin Elmendorf. *Journal of The Franklin Institute*, vol. 185, no. 2, February 1918, pp. 269-276, 2 figs.

Offensive Against the Submarine, Joseph A. Steinmetz. *The Journal of the Engineers' Club of Philadelphia*, vol. 35-2, no. 159, February 1918, pp. 69-80, illustrated.

Splasher System Cools Artesian Water-Supply. *Engineering News-Record*, vol. 80, no. 5, January 31, 1918, p. 210.

The "Pros and Cons" of the Metric System, L. B. Atkinson. *The Journal of The Institution of Electrical Engineers*, vol. 56, no. 271, February 1918, pp. 121-128.

Thinks Federation of Strong Local Societies Needed for Engineering Unity. *Engineering News-Record*, vol. 80, no. 10, March 7, 1918, pp. 452-454.

A Case for the Adoption of the Metric System (and Decimal Coinage) by Great Britain, A. J. Stubbs. *The Journal of The Institution of Electrical Engineers*, vol. 56, no. 271, February 1918, pp. 129-135.

List of Shipbuilders. *The Iron Age*, vol. 101, no. 10, March 7, 1918, pp. 621-623.

Handling Ordnance Supplies. *American Machinist*, vol. 48, no. 10, March 7, 1918, pp. 405-410.

Deloro Smelting & Refining Co., Ltd., Deloro, Ont., The Home of Stellite. *Canadian Machinery*, vol. 19, no. 10, March 7, 1918, pp. 231-235, 14 figs.

L'Utilisation Apres La Guerre des Usines Créées pour les Besoins de la Defense Nationale, Fabrication d'Objets Agrafes, M. Lunet. *Le Génie Civil*, Tome 72, no. 8, February 23, 1918, pp. 134-138, 38 figs.

Emergency Methods of Cutting and Drilling Glass Disks, J. A. Lucas. *American Machinist*, vol. 48, no. 11, March 14, 1918, pp. 451-452, 5 figs.

Dust Prevention on Highways, H. B. Shattuck. *The Pennsylvania State College Bulletin*, vol. 11, no. 15, December 1, 1917, pp. 153-162.

The By-Product Oven—A Paradox, William H. Blanvelt. *The Iron Trade Review*, vol. 62, no. 11, March 14, 1918, pp. 659-664, 5 figs.

Charts

Alignment Charts, George L. Hedges. *Machinery*, vol. 24, no. 7, March 1918, pp. 615-618.

Farm Tractor Engineering Charts, Joseph Jandesek. *The Gas Engine*, vol. 20, no. 3, March 1918, pp. 114-116 and 118.

Alignment Chart for Feeds, Speeds and Power of Lathe Tools, A. Lewis Jenkins. *American Machinist*, vol. 48, no. 11, March 14, 1918, p. 457.

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Survey.

The city of Philadelphia has awarded the John Scott Legacy Medal and Premium to Max Ulrich Schoop, of Zurich, Switzerland, for the Schoop Metal Spraying Process. In this process, wire of some easily fusible metal, like zinc, is fed into a device called a spraying pistol. The wire passes through a tube, and at its end comes into contact with burning gas, by which it is melted, and the molten metal is sprayed by an air blast upon the surface to be covered. The use of this process has been found to greatly increase the life of patterns for castings.

LIBRARY NOTES AND BOOK REVIEWS

ARTICLES of interest from the Library of the four Founder Societies, selected list of accessions during the month, and reviews of books of special importance prepared by members of the A.S.M.E. and others particularly qualified.

WAR LIBRARY SERVICE

GOOD books are urgently needed for our soldiers and sailors here at home in the training camps, on transports, in the Navy and overseas in the trenches.

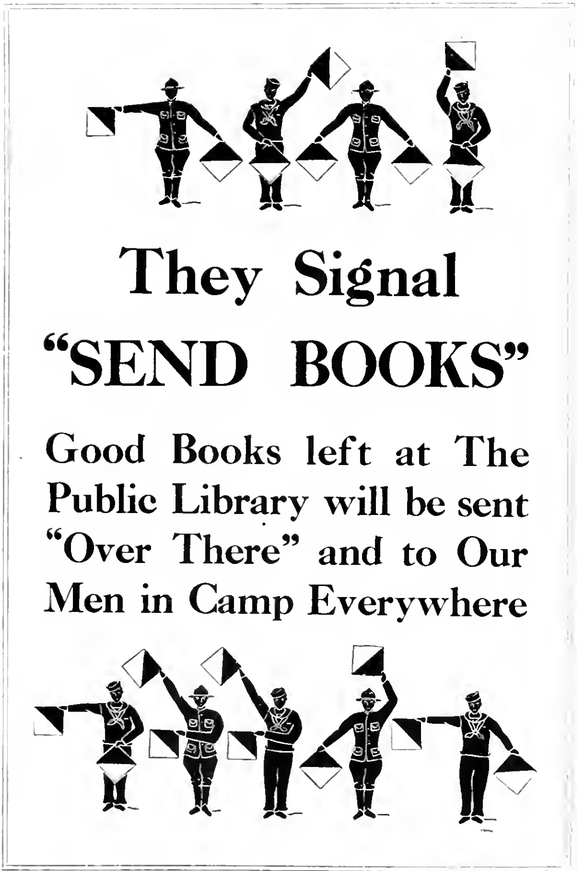
A fund of $1,700,000 has been raised by the American Library Association to build and equip thirty-four libraries in the camps, to provide trained library service, and to buy books. The service includes all Y. M. C. A., K. of C. and Y. M. H. A. huts, hospitals, Y. W. C. A. hostess houses, and many other distributing agencies. The work has grown wonderfully, and to supply the unexpectedly great demand for books and thriftily save the fund, the American Library Association calls for gifts of books from the public.

Every camp librarian reports a steady, large demand for technical works of every class. The war is an engineers' war, and the need for engineering data is acute. The American Library Association intends to devote its funds as far as possible to the purchase of scientific and technical books and other works of a serious nature, but it will appreciate greatly any gifts of this kind, as well as of recreational reading.

Over 600,000 books are now in use, but hundreds of thousands more are needed. Multitudes of good books that would be of the greatest service are standing unused on shelves in our homes. Others that are treasured would be given gladly if the great need were known. Many useful engineering works stand on office shelves, not in actual use and rapidly growing obsolete. Their presentation to the Army would be a real service. Obviously, the technical books sent should be recent editions.

To present books, all that is necessary is to mark them "War Library Service" and deliver them at any public library. They will be forwarded to the war-library storage plant and distributed to the points where they are most needed.

HARRISON W. CRAVER.



BOOK REVIEWS

The Taylor System in Franklin Management: Application and Results. By Major George D. Babcock, in collaboration with Reginald Trautschold, with a foreword by Carl G. Barth The Engineering Magazine Co., New York, 1917. Cloth, 5½x8½ in., 265 pp., 26 figs., including 4 folding charts. $3.

Aside from the real merit which this book possesses as an exposition of scientific management, it is very interesting because it gives a fairly full account of the introduction and building up of one of the best-known successful installations of the Taylor methods, namely, in the plant of the H. H. Franklin Manufacturing Company. Considerable of the subject-matter was published originally in *Industrial Management*, but it has, of course, been edited and supplemented for this volume.

The first two chapters are devoted to the conditions in the Franklin plant in 1908 prior to the introduction of the new system and to the investigation and reasoning that led to the installation of scientific management, so-called. Chapters III, IV and V treat of the methods by which the product was classified and the methods by which the flow of product was controlled. The complex-appearing control board invented by Major Babcock is described fully, as well as other features of the control and dispatching system.

Chapter VI discusses employment and rate fixing. Chapter VII describes the Franklin organization, while Chapter VIII discusses how changes in product and method are handled.

Chapter IX, entitled Changes That Have Affected the Men, is most interesting in that the author concludes that the Taylor system as operating at the Franklin plant is far from a mechanical system, so far as men and women are concerned, as is usually supposed. On the other hand, he claims that it is distinctly human and brings out the best there is in all workers. The concluding chapter shows how the results of the plant operations are depicted graphically.

In addition to these chapters there are two appendices. The first, entitled Wage Rates in the Franklin Shops, gives some specific experiences with the wage system discussed in the chapter on employment and rate setting. The second appendix is devoted to suggestions concerning the best form of scientific management for repair shops, small-part factories and plants with uniform manufacture.

One of the most interesting chapters is that on employment and rate fixing. It describes an interesting though complex attempt to fix the worker's compensation by taking account of all the variables such as the percentage of increase in cost of living. Like all such efforts it rests upon the prevailing wage rates, and the author very sagely points out that no successful attempt has as yet been made to fix an accurate base rate. The important feature of the chapter, however, is the attempt on the part of the management to do what was fair. Perhaps this attempt had considerable to do with the success of the whole plan.

The book is filled with useful information for those who wish to study these new methods. It is true that the conditions of manufacture in the Franklin shops lend themselves more readily to the Taylor system than do many others, but all manufacturers and students of efficiency can read this book with profit.

Dexter S. Kimball.

The Taylor System of Scientific Management. By C. Bertrand Thompson. A. W. Shaw Co., New York, Chicago and London, 1917. Flexible cloth, 9x11 in., 175 pp., 43 illustrations and 22 forms, charts and diagrams. $10.

Mr. Thompson's book, as its name implies, is a report, or rather a review, of the Taylor system of management, with an account of some of the results that have been accomplished and a discussion of methods to be pursued in securing results with this system. His findings are based upon his own long and intimate experience with scientific management, supplemented by a personal investigation, covering a large part of four years, of nearly all the installations of the Taylor system in this country prior to 1915.

Considerable of the subject-matter has appeared in the magazines *System* and *Factory*, and in The Library of Factory Management. All of this matter has been thoroughly edited and revised. The aim of the author has been to make clear the differences between the Taylor system of management and other systems, and to present in a clear manner the general principles and most important mechanisms of the Taylor system as found in actual practice. It would appear that he has succeeded admirably in accomplishing his purpose. The book is tastefully illustrated and liberally provided with marginal notes that are helpful in grasping the most important parts of the discussion. It is bound in manual form, and provision is made for comments and memoranda by the reader.

The discussion is non-technical in character, and is written in a simple, readable manner, the aim being apparently to present the Taylor system clearly to those who know little about it, and to managers who may be desirous of finding out more concerning it with a view of installing efficiency methods. It is suited, therefore, to elementary students of efficiency methods, factory managers, and superintendents and general readers who are curious concerning the Taylor system, but who have neither the patience nor preparation to read Mr. Taylor's original writings.

The book is naturally somewhat biased in favor of the Taylor methods, and, like many books on this or other modern efficiency systems, it is liable to give the impression that all that is good in modern management came in with these modern methods. It hardly makes clear that many of the ideas and mechanisms employed by Mr. Taylor and his contemporaries in this work were in actual use before they launched their crusade.

However, Mr. Thompson makes some very convincing arguments, and his statements concerning the number of installations that have been successful, and his analysis of the reasons why some of them have failed, are well worth considering. Aside from this, also, the book will be interesting reading to those who are well informed on these matters, as it is the statement of one who has had long and intimate connection with the Taylor methods.

Dexter S. Kimball.

Applied Motion Study. A Collection of Papers on the Efficient Method To Industrial Preparedness. By Frank B. Gilbreth, Mem.Am.Soc.-M.E., and Lillian M. Gilbreth, Ph.D. Sturgis & Walton Co., New York, 1917. Cloth, 5x7½ in., 220 pp., 17 illustrations and 1 folding chart. $1.50 net.

This book, as its subtitle implies, is a collection of papers presented by the authors before different scientific societies or printed in the Annals of the American Academy of Political and Social Science. The titles of the several papers are: 1. What Scientific Management Means to America's Industrial Position. 2. Units, Methods and Devices of Measurement Under Scientific Management. 3. Motion Study as an Industrial Opportunity. 4. Motion-Study and Time-Study Instruments of Precision. 5. Chronocyclegraph Motion Devices for Measuring Achievement. 6. Motion Models: Their Use in the Transference of Experience. 7. Motion Study for the Crippled Soldier. 8. The Practice of Scientific Management. 9. The Three-Position Plan of Promotion. 10. The Effect of Motion Study upon the Workers.

Mr. (now Major) Gilbreth is the father of modern motion study. He began it on July 12, 1885, when he studied the motions of two expert bricklayers who undertook to teach him their trade. He has been studying motions ever since, and now holds a commission as Major in the U. S. Army, with the special duty of utilizing motion study in the training of crippled soldiers for productive work and in modifying and adapting the work to the capabilities of the cripple. We quote the following from an introduction by Mr. George Iles:

> This is a book written from the heart as well as from the brain. Its good will is as evident as its good sense. Frank B. Gilbreth is a versatile engineer, an untiring observer, an ingenious inventor, an economist to the tips of his fingers: first and chiefly he is a man. To his wife, co-author with him, this book owes much. Every page has taken form with the aid and counsel of Mrs. Gilbreth, whose Psychology of Management is a golden gift to industrial philosophy. And thus, by viewing their facts from two distinct angles we learn how vital phases of industrial economy present themselves to a man and a woman who are among the acutest investigators of our time.

The greater part of the book is devoted to descriptions, in popular style, of the several inventions that have facilitated motion study. The following, in the words of the authors, is a brief outline of these descriptions:

> Scientific management is simply management that is based upon actual measurement.
>
> Motion study, time study, micromotion study, fatigue study and cost study are important measures of scientific management.
>
> Micromotion study consists of recording the speed simultaneously with a two- or three-dimensional path of motion by the aid of cinematograph pictures of a worker and a clock that shows divisions of time so minute as to indicate a different time of day in each picture in the cinematograph film.
>
> Motion study consists of dividing work into the most funda-

mental units possible; showing these elements separately and in relation to one another, and from these studied elements when timed, building methods of least waste.

The chronocyclegraph method of making motion study consists of fastening electric-light bulbs to the fingers, or to any part of the operator or of the material whose motion path it is desired to study. If the direction, relative time and relative speed are to be noted, the path of light, through controlled interruptions of the current, is made to consist of dots or dashes, or a combination of the two, with angle-pointed ends, the point showing the direction. Through the micromotion studies and the chronocyclegraph studies the expert formulates the standard method.

By taking the photograph stereoscopically we were able to see this path in three dimensions, and to obtain what we have called the stereocyclegraph. The time element is obtained by putting an interrupter in the light circuit that causes the light to flash at a known number of times per second. This gives a line of time spots in the picture instead of a continuous cyclegraph light line. Counting the light spots tells the time consumed.

The next step was . . . to find the right combination of volts and amperes for the light circuit and the thickness of filament for the lamp to cause quick lighting and slow extinguishing of the lamp. This right combination makes the light spots pointed on their latest, or forward, ends.

The points, thus, like the usual symbol of arrow heads, show the direction. The result was then, of course, stereochronocyclegraphs showing direction.

Wire models of cyclegraphs and chronocyclegraphs of the paths and the times of motions are now constructed that have a practical educational value besides their importance as scientific records.

We have a double cinematograph, that one part may record while the other moves from one exposure to the next.

For such cases [where there is an objection to the presence of an observer] we have designed an automicromotion study which consists of an instantaneous modification of the standard micromotion apparatus, and also the autostereochronocyclegraph apparatus. This enables the operator to take accurate time study of himself.

Through a method of using the same motion-picture film over and over again up to sixteen times . . . we have been enabled to cut down the cost of making time and motion study, until now the most accurate type of studies, involving no human equation in the record, can be made at less cost than the far less accurate stop-watch study.

The penetrating screen makes it easier to visualize and to measure the elements of the cycle being studied. A cross-sectioned screen of known dimensions can be introduced at any place where it will enable one to secure a more accurate record of the motion.

The data ascertained by these motion devices are placed on the simultaneous motion cycle chart. This analyzes a motion cycle into its component parts, and indicates graphically by which member of the body, and in what method, each portion of the cycle is performed. By the comparison of the analyzed motion model with the data on the chart, the possibility of the transfer of work from one working member of the body to another is indicated. The simultaneous motion cycle chart....has been presented by the writers for the benefit of the crippled soldiers in whose interests they are at present engaged.

We heartily commend this book to the attention of all those who are interested in the latest developments in scientific management, and especially in that branch of it that relates to the elimination of waste motion. The book, being merely a collection of papers and addresses, lacks, of course, the unity and systematic method of a logical and scientific treatise, such as it is to be hoped the Gilbreths may publish after the war is over, when they may find the time for its preparation.

A "final note," at the end of the book, informs us that the authors requested that it be printed in accordance with the forms of spelling recommended by the Simplified Spelling Board, but the publishers ruled otherwise. We congratulate the publishers upon their ruling. The authors are geniuses, of course, and must be allowed to have some of the eccentricities of genius, but they should not be allowed to give offense to their readers by flinging reformed spelling at them. If they wish to save ink and paper they can save a hundredth of one per cent by reformed spelling, but they can save a thousand times as much by blue-penciling their manuscript and cutting out ten per cent of it, and the "boiling down" would improve its quality.

William Kent.

The American Year Book: A Record of Events and Progress for 1917. Edited by Francis G. Wickware, B.A., B.Sc., with the cooperation of a supervisory board representing national learned societies. D. Appleton & Co., New York and London, 1918. Cloth, 5x7¾ in., xx+822 pp. $3 net.

In the present edition of this important and comprehensive digest, that which has been accomplished during the past year in the great departments of learning and human activity—history, politics, government, legislation, foreign relations, industry, science, engineering, the arts, the professions, literature, etc.—has been tersely reported by the members of a board consisting of over 100 accredited representatives or members of some forty American learned and scientific societies. The 31 sections of the work include articles on hundreds of topics, many of them relating to the war, ready reference to which is afforded by an extensive index containing nearly 6000 items. Section XXII, devoted to engineering, comprises 34 pages, eleven of which deal with progress in the field of mechanical engineering, and were contributed by Messrs. Calvin W. Rice, Secretary of the A.S.M.E., and Leon Cammen, associate editor of The Journal.

LIBRARY ACCESSIONS

Activated Sludge Process of Sewage Treatment. A bibliography of the subject. By J. Edward Porter. *Rochester, 1917.* Gift of General Filtration Company.

The Aldrich Marine Directory, Containing (A) List of Concerns which Build and Repair Vessels, (B) List of Steamship, Steamboat and other Vessel Owners Using the American Flag. Aldrich Publishing Co., *New York, 1918.* Flexible cloth, 8 x 4 in., 220 pp. $5. Gift of the publisher.

Automobile Starting, Lighting and Ignition. By Victor W. Pagé. A Complete Exposition Explaining all Forms of Electrical Ignition Systems Used with Internal Combustion Engines of all Types, also Including a Comprehensive Series of Instructions Pertaining to Starting and Lighting Systems of Automobiles. 4th ed., revised. The Norman W. Henley Publishing Co., *New York, 1918.* Flexible cloth, 5 x 8 in., 519 pp., 298 illus., $1.50. Gift of the publisher.

Aviation Engines. By Victor W. Pagé. Design, Construction, Operation and Repair. A Complete, Practical Treatise Outlining Clearly the Elements of Internal Combustion Engineering with Special Reference to the Design, Construction, Operation and Repair of Airplane Power Plants; also the Auxiliary Engine Systems, such as Lubrication, Carburetion, Ignition and Cooling. It Includes Complete Instructions for Engine Repairing and Systematic Location of Troubles, Tool Equipment and Use of Tools, also Outlines the Latest Mechanical Processes. The Norman W. Henley Publishing Co., *New York, 1918.* Cloth, 6 x 9 in., 589 pp., 253 illus., $3. Gift of the publisher.

Aviation Pocket Book for 1917. By R. Borlas Matthews. *London, 1917.* Purchase.

Axial Aberrations of Lenses. (U. S. Bureau of Standards. Scientific Papers, no. 311.) *Washington, 1917.* Purchase.

Central Stations. By Terrell Croft. McGraw-Hill Book Co., Inc., *New York, 1917.* Cloth, 6 x 8 in., 332 pp., 306 illus., $2.50. Gift of the publisher.

COLORADO. Mining map showing the distribution of the main geological periods from the Archean to the Tertiary with the occurrence of the various metals therein and some of the non-metals, as oil, coal, etc., compiled by R. L. Chase. Gift of Bradley Stoughton.

COMPARATIVE TESTS OF PORCELAIN LABORATORY WARE. (U. S. Bureau of Standards. Technologic Papers, no. 105.) *Washington, 1917.* Purchase.

CONTINUOUS CURRENT MOTORS AND CONTROL APPARATUS. By W. Perren Maycock. A Practical Book for all Classes of Technical Readers. Whittaker & Co., *New York, 1917.* Cloth, 8 x 5 in., 331 pp., 150 illus., $2.25. Gift of the Macmillan Co.

CORRECTION TABLES FOR THERMODYNAMIC EFFICIENCY. Calculated by C. H. Naylor. *London, 1917.* Purchase.

CREOSOTED WOOD STAVE PIPE AND ITS EFFECT UPON WATER FOR DOMESTIC AND IRRIGATION USES. (University of Washington, Bureau of Industrial Research. Bulletin No. 1.) *Seattle, 1917.* Gift of University of Washington.

DESCRIPTIVE GEOMETRY. By Ervin Kenison and Harry Cyrus Bradley. The Macmillan Company, *New York, 1917.* Cloth, 5 x 8 in., 287 pp., 332 illus., $2. Gift of the publisher.

DETERMINATION OF ABSOLUTE VISCOSITY BY SHORT TUBE VISCOSIMETERS. (U. S. Bureau of Standards. Technologic Papers, no. 100). *Washington, 1917.* Purchase.

DISTRICT HEATING. By S. Morgan Bushnell and Fred. B. Orr. A Brief Exposition of the Development of District Heating and its Position among Public Utilities. Heating and Ventilating Magazine Co., *New York, 1915.* Cloth, 6 x 9 in., 290 pp., 82 illus., 1 por., $3. Gift of the publisher.

DRYING CLAY WARES. By Ellis Lovejoy. T. A. Randall & Co., *Indianapolis*, (copyright, *1916*.) Cloth, 6 x 9 in., 166 pp., 86 illus., $2. Gift of the publisher.

DURABILITY OF CEMENT DRAINTILE AND CONCRETE IN ALKALI SOILS, CONTAINING RESULTS OF THIRD YEAR'S TESTS. (U. S. Bureau of Standards Technologic Papers no. 95.) *Washington, 1917.* Purchase.

EFFECTS OF HEAT ON CELLULOID AND SIMILAR MATERIALS. (U. S. Bureau of Standards. Technologic Papers, no. 98.) *Washington, 1917.* Purchase.

ELEMENTS OF PLUMBING. By Samuel Edward Dibble. McGraw-Hill Book Co., Inc., *New York, 1918.* Cloth, 5 x 7 in., 170 pp., 83 illus., $1.50. Gift of the publisher.

ENZYMES AND THEIR APPLICATIONS. By Dr. Jean Effront. English translation by Samuel C. Prescott. John Wiley & Sons, Inc., *New York*, (copyright *1902*). Cloth, 6 x 9 in., 332 pp., $3. Gift of the publisher.

EXPERIMENTAL RESEARCH ON AIR PROPELLERS. (National Advisory Committee for Aeronautics. Report no. 14.) *Washington, 1917.* Gift of National Advisory Committee for Aeronautics.

EYE HAZARDS IN INDUSTRIAL OCCUPATIONS. By G. L. Berry. *New York, 1917.* Gift of National Committee for the Prevention of Blindness.

FINDING AND STOPPING WASTE IN MODERN BOILER ROOMS. Vol. 2. A Reference Manual to Aid the Owner, Manager and Boiler Room Operator in Securing and Maintaining Plant Economy. Harrison Safety Boiler Works, *Philadelphia, 1918.* Linen, 5 x 7 in., 274 pp., 120 illus., $1. Gift of the publisher.

FIRING BITUMINOUS COALS IN LARGE HOUSE-HEATING BOILERS. (U. S. Bureau of Mines. Technical paper 180.) *Washington, 1917.* Purchase.

FRENCH FORESTS AND FORESTRY. By Theodore S. Woolsey, Jr. Tunisia, Algeria, Corsica with a Translation of the Algerian Code of 1903. John Wiley & Sons, Inc., *New York, 1917.* Cloth, 6 x 9 in., 238 pp., 20 illus., $2.50. Gift of the publisher.

GREAT BRITAIN. DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH. ADVISORY COUNCIL. Report on the resources and production of iron ores and other principal metalliferous ores used in the iron and steel industry of the United Kingdom. *London, 1917.* Purchase.

GYPSUM PRODUCTS, THEIR PREPARATION AND USES. (U. S. Bureau of Mines. Technical paper 155.) *Washington, 1917.* Purchase.

HEAT DROP TABLES, ABSOLUTE PRESSURES. By Herbert Moss, from the formulæ and steam tables of H. L. Callendar. *London, 1917.* Purchase.

KINEMATICS OF MACHINERY. By Arthur Warner Klein. A Text-Book on Mechanisms and their Properties with Many Practical Applications for Engineers and for Students in Technical Schools. McGraw-Hill Book Co., Inc., *New York, 1917.* Cloth, 6 x 9 in., 227 pp., 118 illus., 7 diagrams, $2.50. Gift of the publisher.

L'ABATTOIR MODERNE, CONSTRUCTION, INSTALLATION, ADMINISTRATION. By A. Moreau. Ed. 2. *Paris, 1916.* Purchase.

LATENT HEAT OF PRESSURE VARIATION OF LIQUID AMMONIA. (U. S. Bureau of Standards. Scientific Papers no. 314.) *Washington, 1917.* Purchase.

LE MOTEUR A EXPLOSIONS. By René Devillers. *Paris, 1917.* Purchase.

LUFTFAHRTEN NACHSCHLAGEBUCH, 1915. In Russian. By K. E. Vejgelin. *Petrograd, 1915.* Purchase.

MEASUREMENT OF GAS BY ORIFICE METER. By Henry P. Westcott. Metric Metal Works. *Erie, 1918.* Cloth, 8 x 5 in., 408 pp., 35 illus., tab., $3.50. Gift of the publisher.

METER RATES FOR WATER WORKS. By Allen Hazen. John Wiley & Sons, Inc., *New York, 1918.* Cloth, 6 x 9 in., 217 pp., 21 illus., $2.25. Gift of the publisher.

METHODS FOR INCREASING THE RECOVERY FROM OIL SANDS. (U. S. Bureau of Mines. Bulletin 148.) *Washington, 1917.* Purchase.

MODEL AEROPLANES AND THEIR ENGINES. By George A. Cavanagh. A Practical Book for Beginners. Drawings by Harry G. Schultz, with an introduction by Henry Woodhouse. Moffat, Yard & Company, *New York, 1917.* Cloth, 5 x 8 in., 152 pp., 20 illus., 19 pl., $1. Gift of the publisher.

NOTES ON MILITARY EXPLOSIVES. By Erasmus Weaver. 4th ed., revised and enlarged. John Wiley & Sons, Inc., *New York, 1917.* Cloth, 6 x 9 in., 382 pp., $3.25. Gift of the publisher.

OPTIC PROJECTION. By Simon Henry Gage and Henry Phelps Gage. Principles, Installation and Use of the Magic Lantern, Projection Microscope, Reflecting Lantern, Moving Picture Machine. Comstock Publishing Co., *Ithaca, 1914.* Cloth, 6 x 9 in., 731 pp., 413 illus., $3. Gift of the publisher.

PAINT AND VARNISH. (U. S. Bureau of Standards. Circular, no. 69.) *Washington, 1917.* Purchase.

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SPRING MEETING PAPERS

IN A RECENT ADDRESS, Past-President Hollis, who will be one of the Society's hosts at the coming Spring Meeting, expressed the relation of the engineer to the war in the following words: "We all know that this war is a problem in manufacture, business and organization. Much of it is engineering, but it is not an engineer's war, a farmer's war nor a banker's war. It is a people's war in which every individual, man, woman and child, counts for something."

While it is true that the burden falls heavily upon those whose business it is to secure mass production of the mechanical devices required by our men at the front, the first responsibility of the engineer is that of a loyal citizen, ready to answer the call for public service. It is in this spirit that the members of the Society are counseled to meet at Worcester, Mass., June 4 to 7, for conference, mutual help and inspiration. It will be a time for interchange of ideas, planning for the future and a strengthening of one's abilities so that each may return to his strenuous duties better equipped for the months which are to follow. This will be the third war convention of the Society, with a remarkable program carefully developed in all its details, and having a direct bearing on the stupendous undertakings in which the members of the Society are engaged.

Readers of THE JOURNAL are referred to page 404 of this issue for the program of the meeting, and other information of interest to those expecting to attend.

PAPERS FOR GENERAL SESSIONS

THE SPRING MEETING PROGRAM comprises a number of addresses, papers and discussions relating to the procurement and manufacture of supplies for the Government, ways and means for effecting fuel economy, and the problem of instructing and housing labor under war conditions; besides the usual number of general technical papers necessary to maintain the TRANSACTIONS of the Society. These general papers are published in abstract form in this number of THE JOURNAL, discussion upon which is solicited. Other papers contributed by the New England Sections and the Providence Engineering Society will appear in the next number. Except in a few instances, the matter relating to the war will be in the form of addresses or topical discussions, and will be published after the meeting. Pamphlet copies of the complete papers will be ready for distribution to all who desire them in advance of the meeting.

EFFECT OF MOISTURE REABSORPTION ON COMPRESSIVE STRENGTH OF AIR-DRIED TIMBER

BY IRVING H. COWDREY,[1] CAMBRIDGE, MASS.

Non-Member

THE effect of moisture on the properties of timber has become a well-established and recognized fact. Every practical man, whether he be an engineer or a craftsman, knows full well that the removal of moisture from timber, or the so-called "seasoning," produces marked changes in its strength, hardness, stiffness, resiliency and other characteristic properties. Much has been done in the way of scientific investigation by the Bureau of Forestry, The Forest Products Laboratory and various universities and technical schools to determine the effect of the progressive removal of moisture on the strength of timber of all kinds, and the results obtained have been published.

To the reversal of this process there has been given considerably less attention. There is often expressed great surprise at the rapid and very appreciable regain of moisture by wood after it is removed from the dry kiln. This reabsorption, moreover, is not confined to kiln-dried wood, but occurs as well in the case of timber which has been thoroughly air-dried. In fact, the reabsorptive power of air-dried timber is believed to be somewhat greater than is that of timber which has been properly and thoroughly kiln-dried. The effect of atmospheric conditions on the physical properties of timber through their effect on the moisture content of the wood is well exemplified by the behavior of certain beams which were subjected to a time test under load for several years in the laboratories of the Massachusetts Institute of Technology. During the summer months these beams always manifested a very noticeable stiffening and consequent decrease in deflection at the center, even though subjected to load far in excess of the proper working load for such beams. While, of course, no moisture determinations were possible under the conditions noted above, yet the common fund of engineering knowledge would point to the moisture factor as the proper explanation of this observed behavior.

PROBLEMS TO BE SOLVED

If, then, wood responds so quickly in its reabsorption of moisture under very ordinary atmospheric conditions, and in consequence thereof undergoes change of properties, how much greater will be the response and the consequent change of properties if the timber be introduced into a saturated atmosphere at reasonably high temperatures, or if it be completely submerged in water? For example, if the roof of a laundry or of the dye house or finishing room in certain textile industries be of a timber-truss or beam construction, what is the effect on such timbers of the temperature of, say, 120 deg. fahr. with saturation? Again, suppose the basement of a heavily loaded warehouse be flooded. If the supporting col-

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For presentation at the Spring Meeting, Worcester, Mass., June 4 to 7, 1918, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. The paper is here printed in abstract form and advance copies of the paper may be obtained by members gratis upon application. All papers are subject to revision.

mns be of timber, to what extent will their ability to reabsorb moisture affect the stability of the structure?

A recognition of the importance of these items and the belief that reabsorption is a factor to be reckoned with has led to the conducting of a series of investigations during the past year in the Testing Materials Laboratory of the Massachusetts Institute of Technology to determine the quantitative effect, if possible, of such conditions.

During the past few years the eastern lumber markets, as typified by Boston, have witnessed the entrance of Douglas fir (*Pseudotsuga Douglasii*) as a competitor in the field of structural timber. This fact led the experimenters to make a parallel investigation for purposes of comparing this timber with the better-known southern hard pine, which has been so long established in the structural engineering of New England. In so far as the writer is aware, this is the first work of the kind to have been done on Douglas fir. The pine used

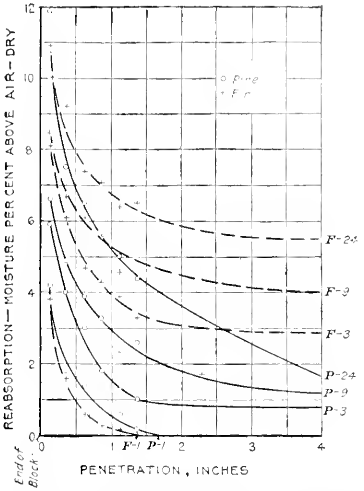

FIG. 1 REABSORPTION OF SPECIMENS WHEN EXPOSED TO SATURATED AIR AT 120 DEG. FAHR.

P-1 indicates pine treated 1 hr.; *F-9*, fir treated 9 hr.; other symbols to be similarly interpreted.

falls under the classification of "dense southern pine" according to the standards of the American Society for Testing Materials, and is very probably the long-leaf yellow pine (*Pinus palustris*).

The tests were carried out, it is true, upon small specimens, and in consequence are open to criticism such as has been made concerning much of the work which has been done by the Bureau of Forestry. It must be acknowledged that the results are scarcely to be used as constants of design, but it is believed that they may well be used as indicative of certain truths and as a means of comparison in the guidance of the users of the two timbers placed under observation.

NATURE OF THE INVESTIGATION

The investigation under discussion may be briefly outlined as follows: The stock used had been purchased in the open market without any special care in selection. In the form of 4-in. planks it remained in the testing laboratories about six months under the conditions of heat and moisture ordinarily pertaining to such localities, being open to free and complete circulation of air over and around the material.

Tests showed the moisture content to be between 6 and 8 per cent for all pieces. The timber, then, may be considered to have been thoroughly air-dried. From these planks were cut specimens which were planed to a section 2 in. by 2 in. and 20 in. long. These pieces were cut further into blocks 8 in. long, and the pairs thus obtained were used in most cases under similar conditions of treatment for check purposes. All treatments were conducted on specimens 8 in. long and tests were made on specimens 6 in. long formed by the removal of 1 in. from each end of the treated specimen.

A number of specimens of both pine and fir were tested in the air-dry condition to establish their initial properties. One set consisting of 20 pieces of pine and 20 pieces of fir was subjected for various lengths of time to a saturated atmosphere at 120 deg. fahr. Another similar set was immersed in fresh water at 70 deg. fahr. for various periods of time.

While the moisture even in so thin a block as those investigated will doubtless vary from surface to surface, yet it seems sufficiently accurate for the purposes of this paper to take the average value as representative of the conditions at the center of the section. These values have been so assumed and are plotted in the curves of Figs. 1 and 2.

The water present in wood may exist (*a*) as free water within the cellular spaces, the canals and ducts, and possibly to some slight extent in the intercellular cavities; and (*b*) as water which has been actually absorbed by the material which constitutes the cell walls.

It is commonly supposed that the absorption of water from moist air at least is first an absorption by the cell walls, and that later under some conditions there occurs a partial filling of the cell cavities. The maximum water content possible without the presence of free water in the cells and canals is known as the "fiber-saturation point." When water is absorbed because of the actual immersion of the wood it is very likely that free water may exist in the cells without the cell walls having absorbed a quantity sufficient to produce fiber saturation. For most of the commoner timbers this fiber-saturation point occurs at a moisture content of approximately 25 per cent.

Most writers consider that it is only this second form, or "imbibed" water, as it is sometimes called, which affects the strength. No satisfactory theories have been advanced to elucidate the phenomenon. It would seem to the writer as though perhaps there may occur some of the effects of colloidal solution, which may to some extent be borne out by the fact that a very complete kiln-drying at high temperature prevents or markedly decreases certain effects commonly produced by reabsorption of moisture such as swelling, increase of pliability, etc.

Again, the writer would hold that the free water in the cells and canals may also have a weakening effect, due to re-solution of some of the salts which are undoubtedly deposited within the cells as the sap dries out, or in the case of heart wood by infiltration during the life of the tree. These crystalline deposits, it would seem, must have a stiffening effect, and, if present in sufficient quantity to fill completely the cell or to bridge it at any point, should add quite materially to the rigidity of the cell, as latticing adds to the rigidity of structural compression members.

RELATIVE RATES OF MOISTURE PENETRATION LONGITUDINALLY

Only the rate of penetration in the direction of the fiber was investigated. The specimens, in the form of blocks 2 in. by 2

in. by 8 in. were subjected to the desired treatment for periods ranging from one hour to 117 hours. At the end of the period of treatment the moisture content was obtained as previously described.

Reabsorption When Exposed to Saturated Air at 120 Deg. Fahr. The specimens were treated by placing them on a grid just above the surface of hot water in a covered steamer freely vented to the air. The temperature of the vapor in the steamer was maintained within the limits of 2 deg. fahr. variation during the longest period of treatment, namely 24 hours.

Fig. 1 shows the reabsorption of the specimens during periods of 1, 3, 9 and 24 hours of treatment. It has seemed best to plot the reabsorption in terms of the moisture content in excess of that present in the air-dried condition rather than the absolute moisture content. This was done to eliminate if possible any variation of hygroscopic action inherent in the specimen due to structural peculiarities.

Referring to curves *P*-1 and *F*-1 representing the conditions at the end of an hour's treatment, it will be noticed that no reabsorption was manifest beyond a point approximately 1½ in. from the end. The curves *F*-3 and *P*-3, showing the effect of 3 hours' treatment, clearly indicate some absorption, even at a distance of 4 in. from the exposed end grain. This furnishes a very striking example of the extreme rapidity with which moisture will penetrate along the grain of timber when it is exposed to the action of hot, moist air.

It should be noted that in none of the treatments did the reabsorption become greater than 12 per cent average moisture in the first ¼ in. from the end. With the air-dry condition of 8 per cent of moisture or less, giving total moisture 20 per cent or less, it would seem that the fiber-saturation point was not attained. However, the point plotted represents the average only for the first ¼ in., and as the plots show, the moisture content decreases very rapidly at first; hence it seems fair to presume that the walls of the cells immediately adjacent to the surface may have reached the point of saturation. From this it might be inferred that saturated air at 120 deg. fahr. is capable of producing fiber saturation. It seems also reasonable to suppose that if the treatment were continued for a period of sufficient length this condition might extend throughout the timber regardless of size. The logical conclusion to be drawn from this leads to the statement that *timbers subjected to the action of saturated air at 120 deg. fahr. must be designed on a basis of constants determined from tests on green timber.*

Reabsorption When Completely Immersed in Fresh Water at 70 Deg. Fahr. Reabsorption tests were made at the end of 1, 24, 48, 72 and 117 hours. The observations were all concordant, and hence only the data obtained from the 24-, 48- and 117-hour periods have been plotted in Fig. 2. Here the relative reabsorptive powers of pine and fir are much more nearly alike than in the case of the treatment in saturated air. Yet even here it will be noted that in all cases the reabsorptive power of the fir is slightly greater than that of the pine.

While the time required for fiber saturation is not definite in the case of timber immersed in water, yet an inspection of the curves of Fig. 2 shows clearly that such saturation undoubtedly occurs, and that it is only a matter of time, whether in the case of columns or beams of timber, even though previously air-dried, for them to be reduced to the character of green wood. It would seem, then, that conclusions relative to the design of timber liable to submersion are similar to those drawn at the close of the discussion of the effect of treatment by saturated air.

Comparison of Figs. 2 and 3 beyond the first half inch from the exposed end shows that the rapidity of reabsorption is much less when the wood is immersed in water at 70 deg. fahr. than when exposed to air saturated at 120 deg. fahr. In detail it will be noted that 24 hours in water are required to produce approximately the same reabsorption as 3 hours' treatment in moist air, and that the reabsorption after 48 hours' submersion is approximately that attained during a 24-hour exposure to moist air.

Effect of Reabsorption on the Compressive Strength

As previously noted, the blocks under investigation were 2 in. by 2 in. by 8 in. After treatment a section 1 in. thick was removed from each end, thus giving a specimen 6 in. long for the compression tests. The ends were squared in a metal

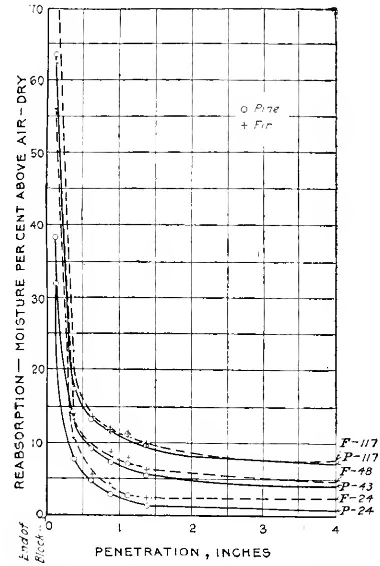

Fig. 2 Reabsorption of Specimens when Completely Immersed in Fresh Water at 70 Deg. Fahr.

P-24 indicates pine treated 24 hr.; *F*-48, fir treated 48 hr.; other symbols to be similarly interpreted.

miter box so that the faces subjected to pressure were as nearly parallel as possible. The tests were conducted on a 100,000-lb.-capacity Olsen testing machine having a ball-and-socket joint on the moving head. This should completely obviate the introduction of any eccentricity of loading, and the failure of the specimens would indicate a pure compression stress.

After failure a quarter-inch section was removed from the specimen at the point of fracture, and from this the moisture content was obtained as previously described.

Figs. 3 and 4 have been prepared to show the relations, if any exist, between the actual moisture content and the crushing strength of the two woods under discussion.

All of the fir tested, with two exceptions, showed from 12 to 17 rings per inch measured radially; the summer wood comprised from 30 to 60 per cent of the total growth; the air-dry density ranged between 31 and 36 lb. per cu. ft.

The pine under investigation showed from 7 to 10 rings per inch measured radially. The summer wood ranged from 30 to

50 per cent of the total growth. The air-dry density was between 32 and 36 lb. per cu. ft.

Pine specimens *S* (three in number, see Fig. 4) had but 6 rings per inch, showing only 25 per cent summer wood, and an air-dry density of about 30 lb. per cu. ft. It is evident that the wood from which these were cut should be classed as "sound" rather than as "dense" southern pine according to the A. S. T. M. standards.

The moisture-strength relations for the fir and pine will now be taken up separately and later compared.

Douglas Fir. The most superficial glance at Fig. 3 will very clearly show that the compressive strength of the wood falls

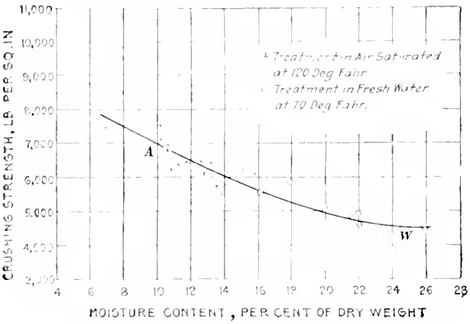

Fig. 3 Relation between Moisture Content and Crushing Strength of Douglas Fir

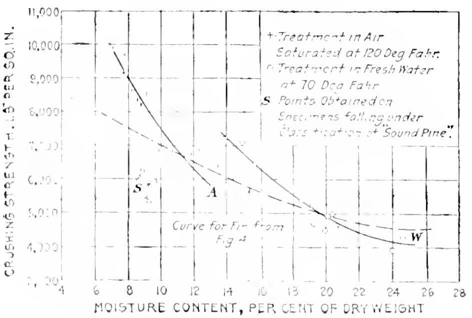

Fig. 4 Relation between Moisture Content and Crushing Strength of Yellow Pine

as the moisture content increases. The material is of organic origin and subject consequently to manifold variation. Hence it is only to be expected that the plotted points shall assume a more or less "gun-shot" arrangement. In such a case the choice of the best representative curve is open to all the elements of variation arising in the personal equation of the investigator. The curve drawn, however, is assumed by the writer to be fairly representative and is at least indicative of certain fundamental relations.

The data were obtained as previously explained from tests made on specimens subjected to radically different treatments. In the case of the fir, nevertheless, the resulting graph is evidently a continuous line. The inclination is somewhat sharper with the lower moisture contents and flattens out, becoming approximately horizontal at a moisture content of about 25 per cent. This corresponds very closely with the fiber-saturation point previously referred to and would seem to bear out the existing theory that only the "imbibed" moisture affects the strength in compression.

While it must be kept in mind that the values of the strengths here recorded are in no way indicative of the proper constants for use in design, yet it is felt that certain of the relations apparent are of fundamental truth. It will be noted that the treatment of wood by exposure to air saturated at a temperature of 120 deg. fahr. results in a compressive strength of about 25 per cent less than the strength of air-dry timber. This reduction appears at about 14 per cent moisture content.

Submersion in water at 70 deg. fahr. for a period of 117 hours produces at the point of fracture a moisture content of 26 per cent, thereby reducing the strength to a value about 40 per cent below that of air-dry wood of the same quality.

Yellow Pine. The data recorded in Fig. 4 offer certain marked variations from those shown for fir in Fig. 3, the curve for which has been transposed to this plot as a dash line. It is very obvious that the data obtained from the pine yield plotted points which cannot be satisfactorily represented by a single line. The data from the water-soaked specimen, marked *W*, yield a fairly determinate curve. The data from the specimens exposed to the moist air, marked *A*, might be reasonably well represented by a variety of lines. However, it seems fair to presume that the two lines will be of the same general type, even though they are discontinuous. Such has been the assumption used as a guide in drawing the representative lines.

The generalizations for the pine are quite similar to those drawn from the graph characteristic of the effect of reabsorption by the fir. The decrease in strength is at first quite rapid with the increase of moisture content. It later flattens, becoming nearly horizontal at about 25 per cent moisture content, again indicating this value as the fiber-saturation point.

The rate of decrease in strength seems to be more rapid for yellow pine than for fir. In the case of the specimens investigated this decrease becomes about 35 per cent after 24 hours' exposure to air saturated at 120 deg. fahr. It is only fair to suggest that this decrease may not be due entirely to moisture, which point is discussed in a later paragraph.

Due to the extremely rapid reabsorption, no points were obtained for the soaked specimens between the air-dry condition and about 14 per cent of moisture. The graph *W* as drawn, however, if extrapolated as a straight line will pass very close to the data obtained from the air-dry material. This graph shows that the moisture content of about 25 per cent which was present 1 in. from the exposed end after a soaking of 117 hours, resulted in a strength nearly 60 per cent below the strength of the air-dry material.

Reasons for the Discontinuity of the Graph. The wood treated to the moist air at 120 deg. fahr. was tested immediately upon removal from the steamer. It was warm when subjected to pressure; in some cases the temperature of the inner portions was probably at least 100 deg. fahr. Pine is a very resinous wood. At the temperatures maintained this resinous material will soften, and some of the normally solid constituents will undoubtedly become actually liquefied. The portions normally in the state of a liquid of high viscosity will undoubtedly have their viscosity considerably lowered. The effect of this action will be that of a general removal of the stiffening action of the cell contents and a possible lubricating effect tending to permit a greater freedom of movement between cells which are poorly adherent because of incidents of growth. This effect is additive to the general effect of the absorption of moisture and may well explain the sharp pitch of the curve *A*.

The temperature of the water (70 deg. fahr.) used for the soaking treatment is probably insufficient to produce the above-noted effect. In fact, the temperature is approximately that at which the air-dry specimens were tested. It would seem, then, that the temperature factor may reasonably be eliminated from a discussion of the curve W. If such be the case, it is to be expected that a given moisture content when obtained in the water at 70 deg. fahr. will show a less marked weakening effect than does the same moisture content when resulting from exposure to moist air at 120 deg. fahr. Observing the conditions at a moisture of 14 per cent, such is found to be the case. The difference between the ordinates of curves A and W at this degree of saturation may well be taken to represent the weakening effect of heat due to softening of the resinous compounds by a heating for 24 hours at 120 deg. fahr.

Since the quantity of resinous matter in the Douglas fir is much less than that in the pine, this temperature effect would doubtless be absent and the resulting graph be a continuous curve, as was found to be the case.

The specimens giving the points marked S are of considerable interest as an exemplification of the fact that wood of coarse growth, low percentage of summer wood, and corresponding lesser density yields a lower compressive strength than when the reverse conditions obtain. Though the number of pieces coming in this category is small, yet the facts point strongly toward a justification of the acceptance of the so-called "density rule" of the standards of the American Society for Testing Materials.

Comparisons and General Conclusions

In the interpretation and subsequent use of the data furnished in this paper, it must be kept in mind that the specimens tested were brought in the open market of Boston; that no special selection of material was made except so far as was necessary to obtain specimens of reasonably straight grain, free from knots and serious defects; that tests were made on small specimens, limited in number and selected from a very small initial quantity of lumber; that in consequence of the above facts the results must be considered comparative and qualitative rather than definitely quantitative.

With all the above in mind, an analysis of the preceding data as shown by the accompanying plots seems to justify the following statements:

In the air-dry condition with approximately equal moisture contents the compressive strength of hard pine is about 25 per cent greater than that of Douglas fir.

When exposed to air saturated with water vapor at 120 deg. fahr. and when immersed in fresh water at 70 deg. fahr., the moisture reabsorption of air-dried wood is greater and more rapid in the case of fir than in the case of pine.

The temperature effect on strength decrease is of more importance on pine than on fir.

Pine shows a more rapid decrease in strength with the moisture increase than does fir. [The more rapid reabsorption by fir tends to offset this effect when the time element is used as a basis, so that for a given time of treatment the pine remains the stronger, although the strengths tend to approach each other with more extended treatment.]

For moisture contents above 11 per cent when due to reabsorption from air saturated at 120 deg. fahr., the fir is stronger in compression than is the pine. The same relation appears for moisture contents greater than 20 per cent when due to soaking in fresh water at 70 deg. fahr.

EFFICIENCY OF GEAR DRIVES

An Accurate Method of Testing

By C. M. ALLEN, WORCESTER, MASS.

Member of the Society

and

F. W. ROYS, WORCESTER, MASS.

Non-Member

Apparatus for determining the efficiency of gears and other drives has recently been developed and used for making tests in the Mechanical Engineering Laboratories of the Worcester Polytechnic Institute. The fundamental principle of the apparatus consists in the direct measurement of the loss of power in the gear drive instead of the usual method of determining the input and output and subtracting one from the other.

Since the efficiency of good geared drives is relatively high, the input and output are very nearly equal, and any small errors in the measurement of these relatively large quantities will make a very large per cent error in the difference, which is the power loss.

It is therefore evident that a method by which the loss may be measured directly and independently of the input and output would be very much more accurate.

Theory of Apparatus Used in the Tests

The theory of the apparatus which was used in the tests is as follows: An electric motor is so hung in a cradle that both its armature and field are free to turn. The armature shaft is connected directly to the pinion gear shaft and the driven shaft directly to an Alden absorption dynamometer. The reaction of the motor field is balanced by the action of the absorption dynamometer through a simple lever. The arms of the lever are accurately proportioned to the ratio of the gears.

The general idea of the apparatus is as follows: An electric induction motor is hung in a cradle on double roller bearings, and an arm attached to the motor casing makes a cradle dynamometer. The motor shaft is connected directly to the drive shaft and an Alden dynamometer is put on the driven shaft. These dynamometers are so arranged that the force exerted by the end of the arms is downward. The arms of the dynamometers are of equal length and at the end of each is a fixed knife edge. A lever with three knife edges mounted upon it has the two outer knife edges adjusted so that the distance between them is equal to the distance (horizontal) between the dynamometer knife edges. The third knife edge divides this distance into segments whose ratio to each other is the same as the gear ratio. These three knife edges lie in the same straight line. The lever is now placed directly over the line between the dynamometer knife edges, and is supported by the third knife edge which rests on platform scales. The end knife edges of the lever are connected to the dynamometers in such a way that the high-speed dynamometer is connected to the long arm of the lever. A counterweight and a rider weight are mounted upon the lever. See Fig. 1.

Method of Testing

The method of testing, so far as the operation of the lever

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system is concerned, is identical for all tests, and therefore the explanation of its action is made perfectly general.

The center of gravity of the Alden brake was very nearly in the horizontal plane, so that a slight movement of the arm did not measurably affect its balance. The cradle dynamometer was so loaded that its center of gravity was only a short distance below the shaft center, and a load of 2 lb. at the end of the arm was enough to entirely upset its equilibrium. The lever was then placed in position as described above and statically balanced by means of the counterweight shown in Fig. 1. A long pointer attached to the lever showed the position of the system relatively to the initial condition of balance.

When the rider weight W was in its initial position, the load of moment, and when corrected for the speed of the apparatus it is a measurement of the power loss.

Here the input power is automatically balanced against the output, and any little change in the latter is immediately taken care of by the motor, and it is impossible for the apparatus to be out of balance except by the amount of the transmission loss. This is the feature of the method which distinguishes it from all others.

The power transmitted by the drive may be computed by noting the change in the load P_2 on the platform scales, and such computations will be shown later.

In operating it was found necessary to start the apparatus and let it run for several minutes before taking note of the

TABLE 1 DATA OF EFFICIENCY TEST OF BEVEL-GEAR DRIVE

PRACTICALLY NO LUBRICATION

R.p.m. of motor	Scale pan, lb.	P_3 lb.	$0.2122\ P_3$	x ft	$0.759\ x$	P_1	Input, $hp._{1000}$	Input, actual hp.	Rider $hp._{1000}$	Hp. loss	Output, hp.	Efficiency, per cent
1	2	3	4	5	6	7	8	9	10	11	12	13
1115	5	200	42.44	1.70	1.291	43.731	21.86	24.37	0.746	0.832	23.532	96.6
1112	5	200	42.44	1.70	1.291	43.731	21.86	24.37	0.810	0.903	23.467	96.3
1112	5	200	42.44	1.70	1.291	43.731	21.86	24.37	0.770	0.859	23.511	96.5
1112	5	200	42.44	1.70	1.291	43.731	21.86	24.37	0.820	0.914	23.456	96.3
1119	5	200	42.44	1.70	1.291	43.731	21.86	24.37	0.806	0.899	23.471	96.4
1146	4	160	33.95	1.25	0.949	34.899	17.45	19.92	0.660	0.753	19.167	96.2
1146	4	160	33.95	1.25	0.949	34.899	17.45	19.92	0.615	0.702	19.218	96.5
1141	4	160	33.95	1.25	0.949	34.899	17.45	19.92	0.620	0.708	19.212	96.4
1141	4	160	33.95	1.25	0.949	34.899	17.45	19.92	0.612	0.699	19.224	96.5
1138	4	160	33.95	1.25	0.949	34.899	17.45	19.92	0.610	0.695	19.224	96.5
1160	3	120	25.46	1.00	0.759	26.219	13.11	15.14	0.486	0.561	14.579	96.3
1150	3	120	25.46	1.00	0.759	26.219	13.11	15.14	0.490	0.566	14.574	96.2
1150	3	120	25.46	1.00	0.759	26.219	13.11	15.14	0.486	0.561	14.579	96.3
1150	3	120	25.46	1.00	0.759	26.219	13.11	15.14	0.484	0.559	14.581	96.3
1172	2	80	16.97	0.62	0.471	17.441	8.72	10.25	0.316	0.371	9.889	96.4
1172	2	80	16.97	0.62	0.471	17.441	8.72	10.25	0.310	0.364	9.886	96.4
1177	2	80	16.97	0.62	0.471	17.441	8.72	10.25	0.308	0.367	9.888	96.4
1196	1	40	8.49	0.40	0.337	8.827	4.42	5.26	0.196	0.234	5.026	95.35
1196	1	10	8.49	0.40	0.337	8.827	4.42	5.26	0.204	0.243	5.017	95.35
1190	1	40	8.49	0.40	0.337	8.827	4.42	5.26	0.204	0.243	5.017	95.35
1205	½	20	4.245	0.37	0.281	4.526	2.26	2.72	0.184	0.222	2.498	91.9
1205	½	20	4.245	0.37	0.281	4.526	2.26	2.72	0.184	0.222	2.498	91.9

P (see Fig. 1) was noted as the initial reading of the platform scales.

The variables entering into the balance of this apparatus are then the forces P_1, P_2 and P_3, and the displacement of the rider weight. P_3 may be measured at any time while the apparatus is in operation, and so may the displacement of the rider weight.

It should be noted here that the amount of P_2 has nothing to do with the calculation of the power loss, which is found as follows:

METHOD OF MEASURING POWER LOSS

It will be seen from the preceding description and from Fig. 1 that $P_1x = P_2y$ for 100 per cent efficiency; but since the efficiency is never 100 per cent, P_1x must exceed P_2y by the amount necessary to overcome the loss in moment. This difference immediately upsets the balance of the lever, of course, but equilibrium may again be restored by shifting the position of the rider weight in the proper direction. This displacement of the rider weight is therefore a measurement of the change initial position of the lever. The zero reading was frequently checked during the period of testing.

EFFICIENCY TEST OF BEVEL-GEAR DRIVE

Data of Gears and Apparatus. The gears were 5 per cent nickel steel, case-hardened, 5 pitch, 1½-in. face. They were cut by the Brown & Sharpe Mfg. Co. and were mounted by them on ball bearings especially designed for testing purposes. Fig. 2 shows the apparatus set up for this test. Following are the preliminary data employed:

Number of teeth in gear.............................52
Number of teeth in pinion...........................14
Ratio, 52 ÷ 14....................................3.714
Total length of lever between outside knife edges (see Fig. 3)......................................3.95 ft.
Length of long arm of lever............3.112 ft. = 37.344 in.
Length of short arm of lever...........0.838 ft. = 10.056 in.
Length of dynamometer arms........................31.5 in.
A force of 2 lb. at 31.5 in. is equivalent to 1 hp. at 1000 r.p.m., for which the expression 1 hp_{1000} will be used.

Calculation of Horsepower Loss from Movement of Rider. Referring to Fig 3, a force of 2 lb. at $P_1 = 1$ hp_{1000}. Therefore $2 \times 37.344 =$ in-lb. of moment in lever necessary for 1 hp_{1000}, and if the rider weight is 3 lb., then for this to balance 1 hp_{1000}, $3x$ must equal 2×37.344, whence $x = 24.893$, and therefore a movement of 24.893 in. of the rider is equivalent to 1 hp_{1000} for a 3-lb. rider.

If the rider weighs but $1\frac{1}{2}$ lb., then the same displacement means only $\frac{1}{2}$ hp_{1000}. A paper scale was made according to these figures and was fastened to the lever. The readings for hp. loss were taken from it throughout the test.

Calculation for Horsepower Input. Referring to Fig. 3, since the initial load of P_3 was taken with the rider weight W already on the lever, a change in the position of W does not change P_3, but merely changes the moment. Therefore, in moment equations of the lever, regardless of where the center of moments is taken, the arm of the moment of W is always the distance from the zero position.

The force P_1 is a measure of the input power if the speed is known, and it is merely necessary to calculate this value in order to solve the problem. Considering the moment equation of the lever, we have

$$0.838P_3 - 3.95P_1 + Wx = 0$$

whence

$$P_1 = \frac{0.838P_3 + Wx}{3.95}$$

If $W = 3$ lb.,

$$P_1 = 0.2122P_3 + 0.759x$$

if $W = 1.5$ lb.,

$$P_1 = 0.2122P_3 + 0.379x$$

x being the displacement of W measured in feet.

Referring to Table 1, for accuracy of recorded data the values in column 5 (x ft.) and column 10 (rider hp_{1000}) should vary together, since they both refer to the displacement.

Column 10 is recorded for one purpose and read from the paper scale directly in hp_{1000}; while column 5 is recorded for

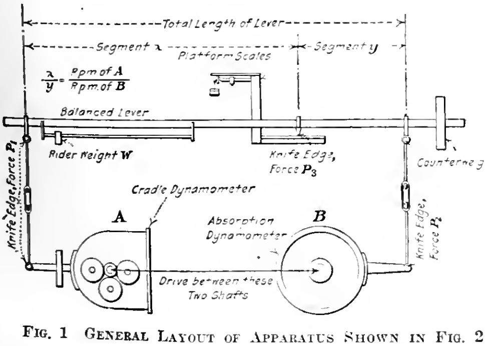

Fig. 1 General Layout of Apparatus Shown in Fig. 2

another purpose and the measurement is recorded in feet measured by an ordinary rule.

It is necessary to read the values recorded in column 10 with as great accuracy as possible, but the approximate distance to the mean position as determined in column 10 is as close as it is necessary to record the values of column 5.

The values in column 10 after correction for speed give the total loss in power and become therefore the whole of the numerator of the equation for *loss* of efficiency, namely,

$$\text{Loss of efficiency} = \frac{\text{Hp. loss}}{\text{Hp. input}}$$

These values for hp. loss are recorded to three significant figures, but the third is somewhat in doubt, and therefore the absolute accuracy is only through two significant figures.

In figuring hp. input it is necessary to use the value P_1, which is obtained by means of the equation $P_1 = 0.2122P_3 + 0.759x$, where x is the value in column 5. The maximum variation in feet from the mean position (column 10) is less than 0.1 ft., but suppose that it was 0.1 ft.; then column 5 might have been 1.8 instead of 1.7 as in the first recorded line.

To see what the effect of such a discrepancy would be,

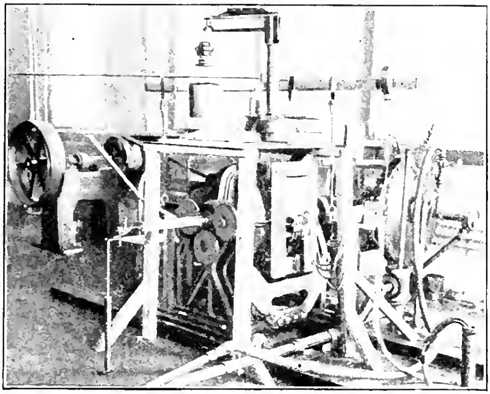

Fig. 2 Apparatus for Testing the Efficiency of Bevel-Gear Drives

the following computations have been made, taking $x = 1.8$ and $x = 1.7$, respectively:

$$P_3 = 200; \quad 0.2122P_3 = 42.44$$
$$P_1 = 42.44 + 0.759x$$
$$= 42.44 + (0.759 \times 1.8) \text{ or } = 42.44 + (0.759 \times 1.7)$$
$$= 42.44 + 1.36 \text{ or } = 42.44 + 1.29$$
$$= 43.80 \text{ or } 43.73.$$

As hp_{1000} input $= \frac{1}{2} P_1$, then hp_{1000} equals either 21.90 or 21.865, and

$$\frac{\text{Hp. loss}}{\text{Hp. input}} = \frac{\text{Rider hp}_{1000}}{\text{Input hp}_{1000}}$$

whence

$$\text{Loss of efficiency} = \frac{0.746}{21.90} \text{ or } \frac{0.746}{21.865}.$$

It is thus seen that, measuring as accurately as possible, the numerator is only accurate to the second place, the third being in doubt; and that the second place in the denominator is sure, and the third fairly sure, although considered in doubt. Therefore the denominator is as accurate as the numerator.

The numerator is as accurate as the apparatus will allow data to be read, and therefore the inaccuracy of the data of column 5 has no effect on the final accuracy of the work.

In Test No. 1, the data of which are given in Table 1, practically no lubrication was used, the gears having been washed off with gasoline. Previous to this there had been oil and graphite on the gears, and some of the graphite still remained on the teeth. However, after running for a while they were practically non-lubricated. The 3-lb. rider had to be used in this case because of the amount of the friction loss, which, by the way, was sufficient to cause the gears to heat considerably.

Table 1 gives only a few of the results actually obtained, for

the apparatus was started time after time and the balance by the rider gave the same results over and over again.

The next test was made to see how much the efficiency would be increased with good lubrication. Accordingly some heavy oil and flaked graphite were mixed and used as a lubricant. The efficiency was so much increased that the $1\frac{1}{2}$-lb. rider weight was sufficient, and again it was found that the same results were obtained time after time. Later, after the graphite and oil had become more perfectly blended, another test was made.

The efficiency curves for these three tests are all given in Fig. 4. The difference between the results of non-lubricated and lubricated conditions is perfectly clear. The test with the more perfect blending of the lubricant showed results identical with the previous one, except as indicated by the dash line at the end of the upper curve. This showed that the lubricant

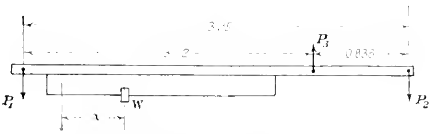

Fig. 3 Dimensioned Sketch of Apparatus

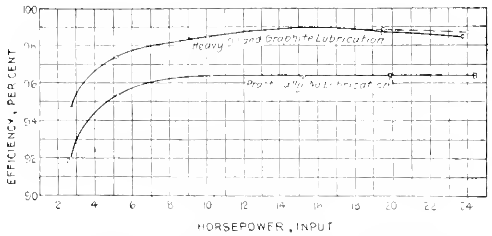

Fig. 4 Horsepower-Efficiency Curves of Bevel-Gear Drive

Gear ratio, 26 to 7; r.p.m. of pinion, about 1200

was not squeezed out from between the teeth at quite so low a pressure.

The form of the curves and the consistency of the readings convinced the experimenters that very reliable results had been obtained. This was also the case regarding tests made of the efficiency of a worm-gear drive and reported in the complete paper.

It is accordingly concluded that this apparatus will measure accurately the efficiency of any positive shaft drive where both shafts are rotating at constant speed, and that it seems to be the best method yet devised for testing gear drives for efficiency, since it measures directly the actual power loss.

While this paper has described only tests of bevel- and worm-gear drives, tests of other drives have been made, and the method is applicable to all types.

The depth of a pile seems to have a good deal to do with the development of spontaneous combustion. A 10-ft. pile is very likely safe for most bituminous coals, provided other conditions are not unfavorable; but 20 to 25 ft. is probably more or less dangerous. In the New York Edison Co.'s yard at Shadyside, N. J., where coal is stored in piles reaching heights up to 35 ft., spontaneous combustion gives trouble. (*Power*, April 16, 1918, p. 537.)

A FOUNDRY COST AND ACCOUNTING SYSTEM

By WILLIAM W. BIRD, WORCESTER, MASS.

Member of the Society

The work in Shop Management at the Worcester Polytechnic Institute is in the nature of a laboratory course, and experimental work in accounting and cost keeping is made possible by the commercial foundry and machine shop of the Institute, known as the Washburn Shops.

The object of this paper is to present an outline of the cost and accounting system which has been developed as a result of experiments carried on in connection with the foundry at the Institute.

The first problem was to determine the number of independent variables and how the dependent ones were related to them. After several years it was decided that the three most important items were Core Labor, Molding Labor, and Pounds of Castings Produced, and that each of the other items of cost was a function of some one of these three independent items.

Ledger accounts were opened for each one of the items, and by careful inventories at the beginning and end of each year the exact annual cost for each item was worked out.

The next problem was to determine a proper production credit for the individual accounts for each month, based on factors secured by previous records. The general scheme being to charge an account with the amount of the purchases for that month and credit it with a fair estimate of what ought to have been used for that month's work. These production credits are charged to another account, as will be explained later.

All expenses are charged to the Expense Account and the production credit for expense ought to be large enough to more than balance the charges, thus creating a balance to the good, known as Expense Reserve.

Core Work

The material required for core work was found to average about 30 per cent of the core labor, hence to make the production credit for core work for a month it was only necessary to secure from the payrolls the amount paid to the core makers for that month and add 30 per cent for the supplies used.

Molding

All of the items of cost in the foundry excepting the metal, melting and core work, were divided into two classes: Supplies or all the materials used in connection with molding, such as sand, facing, etc., and Expense, or all charges for management, office work, power and other overhead items, cleaning, flasks, etc.

At the present time we are basing our production credits for supplies on 6 per cent of the molding labor and the expense on 75 per cent, the molding labor for the month being secured from the payrolls, all of the molders being grouped for this purpose.

Metal and Melting

In order to secure the exact tonnage for each month it was

For presentation at the Spring Meeting, Worcester, Mass., June 4 to 7, 1918, of The American Society of Mechanical Engineers. The paper is here printed in abstract form and advance copies of the paper may be obtained by members gratis upon application. All papers are subject to revision.

found necessary to make an inventory on the first of each month of the castings on hand. This, however, is only a close estimate of the weight of these castings. A record of the castings sold during the month gives the tonnage also. Correcting this for the change in the inventory of castings, gives the production in pounds for the month.

The cost of melting was found to vary directly with the pounds of castings produced, and therefore the melting production credit for the castings produced each month is found by multiplying the pounds produced by the melting factor, which at present is 30 cents per 100 lb.

A careful record for a number of years of the castings produced and of the pig and scrap used, gives the data for the factors to be employed in making up the production credits for the metal used each month. At present we use 75 per cent of the pounds produced as the proper weight of pig iron, and 37½ per cent for scrap iron. These factors take care of the shrinkage and the defective castings, as these are replaced without credit to the foundry.

Knowing the weight and cost of the pig iron purchased each month, this cost including all charges for freight and teaming, the cost per 100 lb. is made up. Multiplying this by 75 per cent of the pounds produced, we have the production credit for pig iron. The production credit for scrap iron is worked out in the same way.

The problem of handling the difference between the material purchased and what was actually used was solved by making the ledger balance a book inventory for material accounts and a reserve for the expense account, as stated.

The next problem of how to adjust the difference between the castings sold and the castings produced was solved as follows:

Two ledger accounts were opened—Foundry Sales and Foundry Production. The first is credited with the monthly sales and charged with the factor cost of the castings sold. The balance of this account is the factor gain and gives a definite line on the profits.

Foundry Production is charged each month with the total amount of the production credits and credited with the factor cost of the castings sold, the monthly ledger balance giving the value of the castings on hand. In fact, the value of the castings on hand is worked up first from the inventory made on the first of each month, and the factor cost of castings sold is simply the amount required to make the account show the proper balance.

To show the exact working of this system, the figures for three months will be given—a good month, a fair month, and a poor one. As these months did not come in this exact order, it was necessary to make a few changes in the figures, but they are substantially an exact record.

Starting with a clear record on July 1, with no castings on hand, we have:

Balance Sheet, July 1

Assets		Liabilities	
Bills receivable..........	$13,187.20	Capital..	$20,000.00
Cash....................	6,331.06	Surplus....	3,654.13
Metal and supplies.......	1,333.03	Bills payable..	2,197.16
Equipment..............	5,000.00		
	$25,851.29		$25,851.29

The inventory on August 1 gave 3500 lb. of castings on hand, the sales record gave 122,541 lb. sold, the production was therefore 126,041 lb. The core labor was $443.89 and the molding labor $1863.84. 117,180 lb. of pig iron cost $2381.86 and the scrap iron cost $1.50 per hundred delivered in the yard. These are all of the data necessary for making up the following:

Monthly Foundry Record, July

Purchases	Division	Factor	Production credits
$443.89	Core labor..	100%	$443.89
127.00	Supplies.......	30%	133.17
1,863.84	Molding labor.......	100%	1,863.84
156.29	Supplies..	6%	111.83
1,303.03	Expense....	75%	1,397.88
612.17	Metal—melting....	30c.	378.12
2,381.86	117,180 lb. pig iron...	75%	1,918.98
737.62	$1.50 per 100 scrap iron....	37½%	708.98
$7,625.70	Total—Factor Cost of Production		$6,956.69

The factor cost was $5.52 per 100 lb. for castings produced and the castings on hand at the end of the month were valued at this rate. 3500 lb. at $5.52 gives a correction of $193.20. This is the difference in the value of castings on hand at the beginning and end of July.

Factor cost of production........	$6,956.69
Correction	193.20
Factor cost of castings sold...	$6,763.49
Sales for July...............	7,350.31
Factor gain for July..........	$586.82

The Expense Reserve is found by subtracting the charges $1303.03 from the credits $1397.88, giving $94.85 for the month.

The Trial Balance of the Ledger gives the necessary data for the following:

Balance Sheet, July 31

Assets		Liabilities	
Bills receivable.........	$13,288.31	Capital....	$20,000.00
Cash....................	6,299.50	Surplus.............	3,654.13
Castings	193.20	Bills payable.......	2,542.10
Metal and supplies.......	2,096.89	Expense reserve......	94.85
Equipment..............	5,000.00	Factor gain...	586.82
	$26,877.90		$26,877.90

On September 1 we had 4000 lb. of castings on hand, and sold in August 132,773 lb. The production was therefore 133,273 lb., as we had 500 lb. more on hand at the end of the month than at the beginning.

Monthly Foundry Record, August

Purchases	Division	Factor	Production credits
$522.61	Core labor......	100%	$522.61
45.50	Supplies...	30%	156.78
1,968.90	Molding labor......	100%	1,968.90
44.83	Supplies.........	6%	118.13
1,426.64	Expense...	75%	1,476.67
382.21	Metal—melting.......	30c.	399.82
2,759.65	107,620 lb. pig iron........	75%	2,568.84
701.70	$1.75 per 100 scrap iron........	37½%	874.62
$7,852.04	Total—Factor Cost of Production.		$8,086.37
	Inventory correction.......		$49.60
	Factor cost of castings sold...........		$8,036.77
	August sales................		8,179.51
	Factor gain—August.....		142.74
	Factor gain—July 1-Aug. 1.......		586.82
	Factor gain—July 1-Aug. 31.......		$729.56

The Expense Reserve for August is \$1476.67 minus \$1426.64, or \$50.03, making the total Reserve, August 31, \$144.88.

BALANCE SHEET, AUGUST 31

ASSETS		LIABILITIES	
Bills receivable	\$14,016 50	Capital	\$20,000 00
Cash	5,750 82	Surplus	3,654 13
Castings	242 80	Bills payable	2,394 14
Metal and supplies	1,912 59	Expense reserve	144 88
Equipment	5,000 00	Factor gain	729 56
	\$26,922 71		\$26,922 71

On October 1 we had 15,000 lb. of castings on hand and sold during September 124,557 lb. The production for the month was therefore 135,557 lb.

MONTHLY FOUNDRY RECORD, SEPTEMBER

Purchases	Division	Factor	Production credits
\$542 00	Core labor	100%	\$542 00
65 46	Supplies	30%	162 60
2,016 70	Molding labor	100%	2,016 70
144 94	Supplies	6%	121 00
1,326 58	Expense	75%	1,512 53
541 90	Metal—melting	30c.	406 67
2,834 85	116,980 lb. pig iron	75%	2,160 37
1,763 52	\$1.75 per 100 scrap iron	37½%	889 60
\$9,235 95	Total—Factor Cost of Production		\$8,111 47

Inventory correction	\$654 20
Factor cost of castings sold	\$7,457 27
September sales	7,485 76
Factor gain—September	28 49
Factor gain—July 1-Sept. 1	729.56
Factor gain—July 1-Sept. 30	\$758 05

The Expense Reserve for September is \$1512.53 minus \$1326.58, or \$185.95, which added to \$144.88 makes the total reserve \$330.83.

BALANCE SHEET, SEPTEMBER 30

ASSETS		LIABILITIES	
Bills receivable	\$13,378 81	Capital	\$20,000 00
Cash	5,374 27	Surplus	3,654 13
Castings	897 00	Bills payable	3,130 09
Metal and supplies	3,223 02	Expense reserve	330 83
Equipment	5,000 00	Factor gain	758 05
	\$27,873 10		\$27,873 10

In order to keep comparative data before the foundry officials and aid them in the analysis of the monthly records, the table of monthly averages (in the next column) is filled in as soon as possible after the first of each month.

In order to keep a line on the book inventories, the table following that of monthly averages is filled in each month. These figures show the changes in the several accounts and indicate in a way how the factors are working. If an account is steadily growing, as the Pig Iron Account shows in this table, we are either accumulating pig iron or the factor is too small. Core Supplies here shows a constantly diminishing amount, and either we are reducing our supplies or the factor is too large. An exact inventory can be made at any time to check up the book inventory and a change made in the factor if necessary.

MONTHLY AVERAGES

	Previous year	July	August	September
Production, lb.	138,605	126,011	133,273	135,557
No. of heats	24.5	24	24	25
No. of molder days	442	467	478	493
Weight per heat, lb.	5670	5250	5550	5420
Weight per molder day	314	270	279	275
Cost of molding	\$1,644 82	\$1,863 84	\$1,968 90	\$2,016.70
Avg. pay per molder day	\$3 72	\$4 00	\$4 12	\$4.09
Core work per 100 lb.	0.42	0 46	0 51	0.52
Molding and expense	2 14	2 68	2 67	2.69
Melting and metal	1 53	2 38	2 89	2.77
Production cost	\$4 09	\$5 52	\$6 07	\$5.98
Inventory correction		......	0.02	0 01
Cost of castings sold	\$4 09	\$5 52	\$6 05	\$5.99
Selling price	\$4 36	\$6 00	\$6 16	\$6 01
Factor gain	0 27	0 48	0 11	0 02
Sales total	\$6,093 60	\$7,350 31	\$8,317.51	\$7,542.46
Factor gain month	\$375 46	\$586.82	\$142.74	\$28.49
Per cent gain	6 2	8 0	1.7	0.4
Expense reserve	\$35 00	\$94 85	\$50 03	\$185.95
Rating	Good	Good	Fair	Poor

INVENTORIES—METAL AND SUPPLIES

MONTHLY CHANGES

	July	August	September
Core supplies	−6 17	−111.28	−97.14
Molding supplies	+44.46	−73.30	+23.94
Melting supplies	+234 05	−17.61	+135.23
Pig iron	+462.88	+190.81	+374.48
Scrap iron	+28.64	−172.92	+873.92
Net change	+763.86	−184.30	+1,310.43
Beginning of month	\$1,333.03	\$2,096.89	\$1,912.59
End of month	\$2,096.89	\$1,912.59	\$3,223.02

The following samples of ledger pages will show just how the bookkeeping is done:

FOUNDRY SALES

July 31	Factor cost—sales	\$6,763 49	July 31	Sales	\$7,350.31
	Balance	586.82			
		\$7,350.31			\$7,350.31
			Aug. 1	Balance	586.82

The balance of this account gives the factor gain and is the total amount from the beginning of the fiscal year.

FOUNDRY PRODUCTION

Aug. 1	Balance	\$193 20	Aug. 31	Factor cost—sales	\$8,036.77
31	Factor cost—production	8,086 37		Balance	242.80
		\$8,279 57			\$8,279.57
Sept. 1	Balance	242 80			

The balance on this account is the exact inventory of the castings on hand, valued at the factor cost for the month.

Foundry Expense

Sept. 30	Purchases....	$1,326.58	Sept. 1	Balance...	$144.88
	Balance.....	330.83	Sept. 30	Production credits.	1,512.53
		$1,657.41			$1,657.41
			Oct. 1	Balance ..	330.83

The balance on this account is the amount that the Reserve has built up during the year.

Pig Iron

July 1	Balance..........	$331.20	July 31	Production credit..	$1,918.98
July 31	Purchases.....	2,381.86		Balance.....	794.08
		$2,713.06			$2,713.06
Aug. 1	Balance........	794.08			

The balance on this account is the book inventory for the pig iron on hand.

Thus every ledger balance has a definite meaning, either an inventory, a reserve or a gain, and the complete balance sheet for each month can be made up in a few minutes from the regular trial balance. All of the work can be done by the regular clerical force and requires but a small amount of extra time. No expert accountant or efficiency engineer is needed.

The closing of the books at the end of the fiscal year introduces several interesting problems.

The Molding and Core Labor Accounts take care of themselves as the charges and credits are the same and they are therefore always balanced. The material accounts are first corrected by introducing the exact value of a carefully made inventory. This gives us the real cost for the material which has been actually used during the year. The next step is to adjust the production credit for the twelve months to the final charge. The difference between the two sides of the ledger is the amount of the adjustment and may be either plus or minus. The net result of all these factor adjustments is carried to Expense Reserve and will either increase it or decrease it, as the case may be.

Bad accounts, depreciation charges, discounts, premiums, special expenses or any other accounts which need to be absorbed, are all transferred to Expense Reserve and the net balance of the account is carried to Foundry Sales either increasing or decreasing the Factor Gain and this balance then becomes the real Sales Gain for the year.

In conclusion, we would say that the system as outlined is giving good satisfaction, the results are fairly accurate, and the comparative monthly data thoroughly reliable as a signal system.

A state testing and experimental institution for the mining industry has been formed in Minneapolis, Minn., and it will coöperate with the mining section of the University of Minnesota. Special attention will be paid to the treatment of ores with a comparatively low percentage of iron, and which at present cannot be industrially exploited with advantage, so that such ores may be enabled to play their part in the iron industry of the country. Particular attention will be paid to hematite containing 30 per cent to 50 per cent iron, to magnesite iron and to titaniferous iron ore, of which large deposits are to be found in the northeastern portion of Minnesota, and to manganese ore with a small percentage of manganese—all problems of great importance to the future of the American iron industry.

INVESTIGATION OF THE USES OF STEAM IN THE CANNING FACTORY

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It is not the writer's purpose to deal in this paper with the economies possible in the generation of steam in the canning factory. Although it would well repay the packer to inform himself on this subject, since in the boiler room any amount up to 50 per cent of his coal may be wasted, the principles of economical boiler-room operation are well understood by mechanical engineers and are no different in the canning factory from any other. The principles and the best practice in the use of steam, on the other hand, are not common knowledge, and will therefore engage the writer's attention.

Uses of Steam in Canning Factories

First in an enumeration of the various packing-house units requiring steam are engines to turn the lineshaft and operate cranes and conveyors, and, possibly, pumps for supplying water. Next in order is the apparatus to give the raw material a preliminary heat treatment. In the case of tomatoes, this is a scalder which loosens the skins; in the case of peas, beans, spinach, etc., it is a bleacher which fixes the color of the product and washes away impurities and partial decay. At this stage some goods are placed in the cans, but for others heat must first be applied in bulk in order to evaporate water and concentrate the product. For example, tomato pulp or paste must first be boiled down, as must also fruit juices in the manufacture of jellies and preserves. If the material requires such reduction, it is next introduced into a kettle supplied with a steam jacket for evaporation, or a tank supplied with steam coils, or into some form of evaporator using steam as a source of heat for evaporation. If the material does not require such reduction, it must next be sent through an exhaust box the chief function of which is to produce a partial vacuum in the capped can by expanding its contents previous to capping. The expansion is accomplished by heating the cans by direct contact with steam in the exhaust box. After the cans are capped they are packed in metal cages and placed in a "process kettle" or retort, where they again are subjected to steam heat for the purpose of sterilizing and cooking. Finally, upon removal from the process kettles, the packed cans must have their heat removed, which is usually effected by a water bath and which completes the heat processes of production.

Analysis of the Heat Distribution

An analysis of the heat distribution leads to the following conclusions: First, as a rule, the mechanical power required is comparatively small, and this limits the possibilities of exhaust steam. Second, except for products that must be reduced by evaporation, the directly useful heat functions simply by elevating the temperature of the raw material from that of the room up to whatever temperature is carried in the process kettle. Assuming, for example, that the temperature of the

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raw material is 80 deg. fahr. and the temperature of the process kettle is 212 deg., the difference is 132 deg., and the useful heat in the whole process of canning is numerically equal to the total weight of the can contents multiplied by 132 deg. multiplied by the specific heat. To this, of course, must be added the heat of vaporization when the product is reduced, which, however, is only the case for certain products.

This may seem a startlingly simple conclusion to be formed from a complex problem, and yet, truly, there is no other one. Cooking and sterilizing are merely a matter of elevating a temperature and maintaining it. Once the temperature is attained it can be held, under ideal conditions, without further consumption of heat. Heat consumed for any other purpose is either for an auxiliary process, or is a total loss through inefficiency of the main process. This principle finds an application in a small way, in domestic kitchens, in the fireless cooker. The old-fashioned stove and the more recent gas range both waste enormous amounts of heat, because after the temperature of the cooking material has been raised, heat continues to be consumed, and is wasted by radiation from the containing vessel and by convection currents.

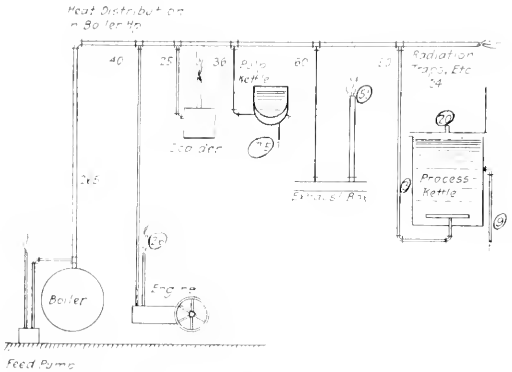

FIG. 1 DISTRIBUTION OF HEAT IN A FACTORY CANNING TOMATOES

Similarly, in the canning factory, from the time the raw material enters the exhaust box up to the time it leaves the process kettle, the one desirable effect is the elevation of temperature. In the exhaust box this is partially accomplished, possibly with the expenditure of a disproportionate amount of steam. Between this stage and the process kettle the can is being capped and packed in the crates, during which handling it may radiate some heat which will have to be restored. Finally, the sealed cans are placed in the process kettle. Heat is transferred to them and, incidentally, radiated from the surface of the kettle, blown right through the kettle (especially if an open water bath is used), and wasted through an overflow of hot water.

For the purpose of obtaining an idea of the quantitative values of these heat transfers, Fig. 1 has been prepared showing the distribution of heat in a packing house putting up tomatoes. An arrangement using steam inefficiently has been purposely shown in order to indicate the possibilities. It is assumed that this plant is equipped to handle 10,000 baskets per day of 12 hours, that the tomatoes are canned whole, and that skin-and-core pulp is put up as a by-product. A fair value for the yield is seven No. 3 cans of whole tomatoes per basket, and one No. 3 of pulp. This will make a total of 70,000 cans of the former and 10,000 cans of the latter per day of 12 hours.

Taking as the heat unit the boiler horsepower, which is equivalent to about 30 lb. of high-pressure steam per hour, or, more exactly, 33,479 B.t.u. per hr., and assuming the temperature elevation to be 132 deg., the useful heat added to the whole tomatoes amounts to 57.5 boiler hp. The pulp must not only be elevated in temperature but thickened by evaporation of some of its water. Assuming a reduction of 5:4, the boiler hp. necessary is 18.5, making a total of 76.

Of the useful heat to the whole tomatoes only 9 boiler hp. is added in the exhaust box, the remainder being added in the process kettle. The figures on the drawing enclosed in circles represent the waste heat either through exhaust steam, or hot water from drains, or radiation.

These heat quantities may seem excessive, but it should be remembered that they vary in each of the particulars very considerably in different plants. The distribution shown may be considered on the whole not unrepresentative.

A study of this example shows that there are two general methods of obtaining heat efficiency in the use of steam. First, by improvements in the construction and operation of heat-transfer apparatus, and second, by establishing a coördination of units so that what has ordinarily been considered as waste and irrevocable heat may be recovered to the fullest extent possible. These requirements do not exist independently. Let us then consider first the efficiency, or lack of efficiency, of the various steam-using units familiar in the canning factory, having special regard to the possibilities of eliminating steam wastes, and with all due respect to the paramount necessity of capacity.

BLANCHERS AND SCALDERS

Blanchers and scalders both make a heavy drain on the steam pressure. In their operation water and steam are led to a single chamber, circular or rectangular in cross-section, through which also the vegetables or fruit are fed. In blanchers

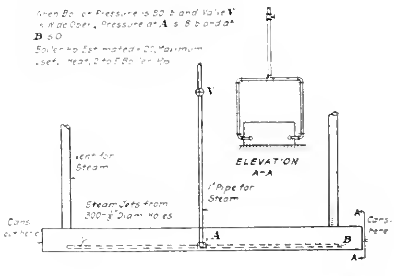

FIG. 2 HOME-MADE FORM OF EXHAUST BOX

the steam heats the water which is constantly overflowing, and excess steam is carried through a vent flue to the roof. Upon meeting the hot water, the raw material is washed free of its gummy coating, etc., which gradually contaminates the water and necessitates a continuous supply. The incoming fresh water requires more steam to maintain the temperature. Furthermore, steam must be added in sufficient amount to counteract the cooling effect of the entering food. From these considerations it becomes apparent that an exercise of judgment

is required to regulate the water and steam supply to the rate of the food material to secure the best economy with steam. The water should be fed in just fast enough to maintain the minimum degree of purity consistent with the requirements. Any greater amount of water necessitates more steam, the heat of which is wasted through the overflow. Any greater amount of steam than is necessary to maintain the temperature merely blows through the vent flue. Obviously, two or three times as much steam as is necessary may be consumed if regulation is neglected.

In the operation of tomato scalders a similar conclusion may be drawn. Here the steam and water do not mix, that is, intentionally, it being the purpose to have first the steam and then the cold water strike the raw material. Steam at 80 to 100 lb. pressure is supplied through a 2-in. pipe and passes through a series of perforated holes in pipes placed above and below a conveyor chain carrying the tomatoes. The bed of fruit is something like four to six inches thick, and it is expected that these steam jets will penetrate the mass and heat their outer skins in about ten seconds. Now, in the same chamber in which the steam is working, and just beyond the steam jets, are jets of cold water. There is no dividing partition, and the result is a splendid condenser effect. As the water must be kept cold, more of it than otherwise necessary is turned on to counteract this effect, thereby enhancing it. Provision is made through a vent flue so that if any steam escapes both water and tomatoes, it can go out through the roof.

Obviously, with the application of ingenuity and experiment the steam consumption of these machines might be materially lessened through radical structural changes without impairing effectiveness or capacity. On the other hand, and opposite to the case of bleachers, it is difficult to secure steam economy by nice regulation alone—for one reason because of the prejudice of operators.

Exhaust Boxes

Exhaust boxes are now to be considered. In the home-made form (see Fig. 2) these are long rectangular boxes made of four planks, open at the ends, and through which a conveyor

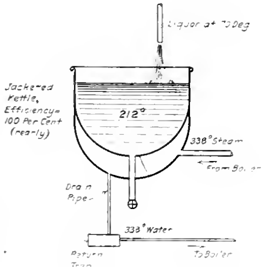

Fig. 3 Jacketed Kettle

chain passes bearing the filled but uncovered cans. Drilled pipes within the box are used as steam jets playing on the cans. At the ends of the box are flues, so that when the steam is fully turned on it will not pass into the packing room but out through the roof.

It is at once apparent that it is out of the question to obtain anything like a uniform temperature of the can contents in the small space of time that they are subjected to the steam, particularly if they are packed closely and contain little liquid. The heat consumed in the form of steam may be as much as anything between 20 and 30 boiler hp., making for a thermal efficiency of about 10 to 15 per cent. Where does the difference go? Through the roof.

The performance of the exhaust box as regards steam economy may be materially bettered by the careful regulation of the steam supply. From trials which the writer has made, involving temperature and pressure measurements, he has found that the steam can be cut down from full on to about one-half a turn of the stop valve in some cases without materially affecting the temperature elevation. That is, the heating effect is nearly as good when the steam merely trickles through

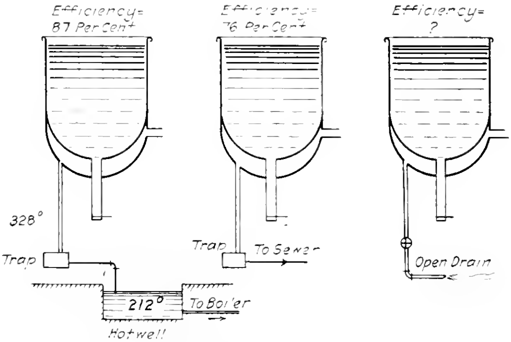

Fig. 4 Various Ways of Handling Steam in Connection with Jacketed Kettles

as when it pours through. To gain effectiveness, the time during which each can is subjected to the steam must be lengthened, and the greater the time, the greater will be the machine's efficiency. This fact is being recognized by the manufacturers of modern forms of exhaust box, which are so shaped that the length of the path through them is greatly increased, thereby increasing the time of heating (to 5 and 15 min.).

Much can be gained if the exhaust box is in part relieved of its effort by introducing whatever liquor goes with the solid part of the contents as hot as may be.

Jacketed Kettles

Turning now to a consideration of the various packing-house units used for concentrating liquid foods and food juices, which units may be termed generally "evaporators," it will be noted that there are many different forms and types. Perhaps the most elementary form, and in some ways the most interesting, is the jacketed kettle (see Fig. 3). It has a capacity of between 50 and 500 gal., and instead of having heat applied to it as an open flame, receives it from the steam jacket whence it gets its name. The jacket is tapped with one or more openings to receive the steam pipes, and another opening for the drain pipe to carry off the condensed steam.

The performance of these kettles is very interesting in many ways. In the first place, it may be observed that under approximately ideal conditions their thermal efficiency may be nearly 100 per cent, the only loss being from radiation of heat from the outside of the jacket. This assumes that the condensate from the jacket is returned to the boiler through a return trap which, however, is not always—or even often—used. Steam at 100 lb. gage pressure has a temperature of 338 deg., so if steam of this pressure is used in the jacket

of a kettle it will, after condensing in the jacket, emerge from the drain pipe as water at 338 deg. If this hot water is returned to the boiler by a return trap, none of its heat is lost (except that small amount due to radiation), and practically all of the heat given up by the steam goes to the useful purpose of evaporating water from food material.

There are, however, three other ways in which steam may be handled (see Fig. 4). First, the drain may be passed through an atmospheric trap, which necessitates that the water be reduced to below 212 deg. before it can be returned to the boiler. In this case the efficiency of the system is 87 per cent, and 13 per cent of the heat consumed is wasted. Practically the same thing may be accomplished if the drain pipe is without a trap but is supplied with a stop valve so regulated that only water will be discharged. Second, the kettle may be supplied with an atmospheric trap, or a stop valve in the drain pipe as just described, the discharge from which is *not* returned to the boiler. In this case, if feedwater at 70 deg. is used to make up the 212-deg. water which might have been used, the waste is 24 per cent and the efficiency only 76 per cent. Third, the kettle may be unprovided with a trap of any kind, and the valve in the drain pipe left so wide open as to let large quantities of steam escape as well as condensate. Here it is difficult to estimate the ensuing waste, but if one is to judge by the ascending clouds of steam, it must be enormous.

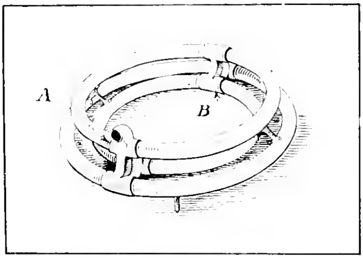

Fig. 5 Evaporator Coil of Modern Design

A jacketed kettle in full blast shows the most haphazard ebullition, and one would suppose that a much more effective rate of evaporation could be obtained if the circulation could be assisted. In spite of this, the fact is that this apparatus is a remarkably quick evaporator. Results that have come to the writer's attention show, with the use of 100-lb. steam, as high as 8.5 gal. or 70 lb. of liquid evaporated per square foot per hour after the mass has come to a boil. This corresponds to about 700 B.t.u. of heat transferred per hour per square foot per degree difference of temperature, a figure comparing very favorably with the best types of feedwater heaters and condensers, which class of steam-engineering apparatus the jacketed kettle most closely resembles as regards the matter of heat transfer.

Jacketed kettles, differently installed, show very different capacities for evaporation. The question then arises, What are the factors affecting the rate of evaporation? A study of this question shows that the total amount of water a kettle can evaporate per hour may be affected chiefly by the pressure of the steam in the jacket. The rate of heat transfer is directly proportional to the difference in temperature between the boiling material (about 212 deg.) and the substance supplying the heat, that is, the steam. Now, since the temperature of steam increases with its pressure, the high-pressure steam is more effective in rapidity. But if the steam pipes are too small, or if the kettle opening for steam is not large enough, there may be a considerable drop of pressure of the steam before it reaches the jacket, and a still further drop after it gets into the jacket. In consequence, and especially if the steam is initially wet, it falls in temperature and loses some of its effectiveness. Much can be done to improve capacity by using carefully calculated pipe sizes and by *introducing the steam into the jacket through two or more openings instead of only one*. A series of experiments with the purpose of learning the pressure within a steam jacket for different systems of piping would, it is felt, disclose facts of practical value in future design.

The capacity of a jacketed kettle may be much reduced by the cooking material caking to its sides. To avoid this condition, kettles are frequently equipped with mechanical stirrers which continuously wipe the heating surface, thus keeping it clean. This action also imparts a velocity to the boiling liquid at the heating surface which, presumably, affects the heat transfer, but just how much is not known. Similarly, the quantitative effect of high velocity of the steam in the jacket is unknown.

Coil Evaporators

The final limitation to capacity has to do with the area of the heating surface. The obvious step, then, is to add heating surface in order to increase capacity, and this has been done.

Coils offer such an attractive way of forming a compact heating surface, that they have come into favor in units which dispense entirely with the steam jacket. Any form of containing vessel may be used for the liquid to be concentrated, and the vessel may be made of any appropriate material. Jacketed kettles are commonly made of copper: the containing vessels for coil evaporators may be made of wood, thereby making a great saving of expense. Also, a wooden vessel with coils occupying a given floor space may contain vastly more heating surface than a jacketed kettle occupying the same floor space, and therefore have considerably greater capacity. In such a case the coil evaporator also loses less heat by radiation from the containing shell, but otherwise the heat efficiency of the coil may be just as good or as bad as that of jacketed kettles previously cited. The effectiveness of a single square foot of heating surface of the coil is, it is believed, possibly less than that of the jacket, particularly if the coil is not carefully designed. "Effectiveness" in this connection means the number of heat units that can be transferred per hour from the steam to the liquid contents. As mentioned before, the efficiency may be nearly 100 per cent in each case.

Fig. 5 shows a coil of modern design taking steam through the manifold at *A* and exhausting from drain *B*.

Evaporators depending upon coils or nests of tubes suffer two serious disadvantages: First, they are much more difficult to clean and to keep clean than are jacketed kettles. Mechanical wipers, as stirrers, are out of the question, and hand cleaning is awkward. Second, they are, with poor design, more apt to leak steam into the liquid to be evaporated than are jackets, whereby both heat and capacity are lost.

Vacuum Pans

In the writer's opinion, a type of evaporator which will eventually enter the canning factory is the vacuum pan, Fig. 6. The advantage which it possesses is that it can use exhaust steam efficiently, and, when live steam is employed, the pan may be so designed as to take only half or less than half the

steam required by apparatus which boils at atmospheric pressure.

The subject of vacuum pans is too large a one to enter upon here, there being many different designs and principles involved. It may be mentioned, however, that the whole subject is replete with unsolved problems which give much opportunity for successful research work.

All of the evaporators cited may meet a check in their capacity when certain products are handled, through the thickening and foaming of these products. To avoid boiling over, foaming necessitates a cutting down of the rate of evaporation. Similarly with thickening—the resulting increased viscosity of the mass causes a spattering dangerous to operators and wasteful of material. In such cases the initial rate of evaporation must be lessened toward the end of the process. The remedy is evaporators with high sides to prevent boiling over, and stirrers to prevent caking.

TABLE 1 PERFORMANCE OF EVAPORATORS

Type of evaporator	Evaporation, lb. per sq. ft. per hr.	B.t.u. transferred per sq. ft. per hr. per deg. fahr. difference in temperature
Jacketed kettle with 100 lb. steam pressure, by test	66 6	660
Jacketed kettle with 50 lb. steam pressure, assuming the same B.t.u. rate of transfer	45 0	
Jacketed kettle with 25 lb. steam pressure	29 0	
Shell evaporator, with paddles, 50 lb. steam pressure, by test	41 5	625
Coils, 100 lb. steam pressure, by test	60 0	628
Vacuum pan, single effect, 25 lb. steam pressure, on tomato paste; average, by test	40 0	313
Vacuum pan, maximum, 100 lb. steam pressure	105 0	600
Vacuum pan, with 10 lb. steam pressure, single effect, and 26 in. vacuum	64.5	600

Another item which should be carefully calculated for individual evaporators as well as a number of them together, is the drainage of the spaces supplying steam. It is very easily possible to food these spaces with water, either through too small a pipe size for the drain from the jacket or coil, or by having one unit flood another, or by a badly designed unit of which coils are a conspicuous example.

Comparative Performance of Evaporators

In Table 1 the first three lines show the effect of using steam of a lower pressure than 100 lb., the rate of evaporation in lb. per sq. ft. per hour rapidly falling off with the lower-pressure steam. The low result of the shell evaporator may be explained possibly by the effect of the design, in that the heating surface was so arranged that part of it could be flooded during operation. It is seen from the table that the best results were secured with the jacketed kettle. This fact is very much influenced by the steam connections, in that if only one is used, the rate of evaporation may be only half that obtained when two generous steam openings are used.

Table 2 is intended to show the real advantage of coils. The figures presented are obtained from a number of kettles and coils in actual operation. It is seen that as the capacity of the kettle increases the heating surface per unit of contents decreases, which is not true of the coil, the reason being that the jacket surface of the kettle increases with the square of its linear dimension, whereas the volume increases as the cube.

Process Kettles

The last item to be considered is the process kettle. In one way this is perhaps the most important of all, since the success of the pack depends upon the process kettle. Its whole function is to raise the temperature of the contents of the cans to that necessary for sterilization. Fig. 7 is a diagrammatic representation of a process kettle.

There are four methods in use in the operation of these units: First, the cans are placed in the process kettle, which is previously empty; the kettle is then closed and steam turned on so that a pressure of between 5 and 15 lb. gage is secured. Second, this same process may be used, except that the kettle

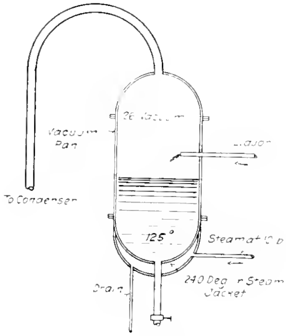

Fig. 6 Vacuum Pan

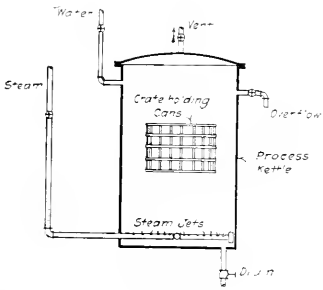

Fig. 7 Diagrammatic Representation of a Process Kettle

is previously filled with hot water and the cans are subjected to a water bath under pressure at a correspondingly high temperature. Third, the cans may be placed in a closed process kettle and subjected to a pressure very slightly greater than atmosphere, say, 1 lb. gage, there being no water in the kettle. Fourth, the process may be under atmospheric pressure but in a water bath with the lid of the kettle raised. These processes may be referred to as dry and wet, respectively, and closed and open.

In the open-bath process it is a custom of operators to maintain a violent boil of the bath so as to secure a circulation through all the interstices between the cans, which practice results in large volumes of steam being emitted into the packing room. In the closed process it is the custom to vent the valve on top of the kettle. When the process is wet, it seems that the object is twofold: first, to secure a circulation through the

interstices, and second, because it is easier to maintain a uniform temperature with the steam flowing through rapidly with this vent valve considerably open than to secure this uniform temperature with only a small vent.

Now, besides raising the temperatures of the cans in the dry process, heat has to be furnished to the kettle in the following directions, all of which is wasted:

1 To raise temperature of the metal of crates and kettle
2 To vent the kettle allowing air to escape, or to establish a circulation through the cans
3 Condensed steam drained from kettle
4 Radiation of heat from the outside surface of the kettle.

To these items, must be added, when the wet process is used, the heat necessary to raise the temperature of a mass of water

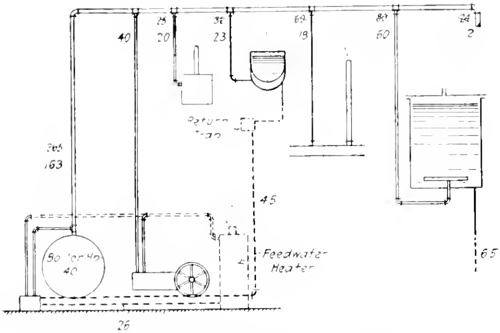

FIG. 8 POSSIBILITIES OF IMPROVING PERFORMANCE OF THE PLANT OF FIG. 1

as well as that of the cans. Table 3 gives some quantitative values, obtained in part by test, but for the most part by calculation upon the assumption of reasonably good conditions in each item. In this connection it should be remembered that radiation, venting and overflow wastes may each vary widely with different operators and units.

Comparing the boiler hp. required for the different systems it is noticed that the closed wet process takes about three times as much steam as the dry at 216 deg. On the other hand, the former is capable of twice the capacity of the latter, so that the proportion of steam per can used is as 3 is to 2.

Efforts have been made to increase the capacity of process kettles by agitating the cans during cooking, machines for this purpose being styled "continuous cookers."

There seems to be ample field for enlightenment by experiment in the case of process kettles. Among the questions to be answered are: What are the times necessary to elevate the temperature of the center of a can under the open or closed systems, and how much difference is made by circulating water instead of steam upon the time? What effect has venting the kettle different amounts? What effect has agitating the cans? If such venting of the kettles has any favorable effect, how may the steam thus lost be recovered? How does the temperature of the cans at various parts of the kettle vary? Of what value are automatic regulators to steam economy?

POSSIBILITIES OF IMPROVING PERFORMANCE OF PLANT

Referring to Fig. 8, the possibilities of bettering the performance indicated by Fig 1 are shown. The consumption of the scalder is reduced from 25 to 20 boiler hp. by careful supervision of its performance. The efficiency of the jacketed kettle is improved by means of the return trap which passes back to the boiler $4\frac{1}{2}$ boiler hp., thereby eliminating all possibility of waste in steam through the drain. The exhaust box is increased in efficiency to 50 per cent, and very probably much better than this can be secured with the more modern forms of exhaust box, the loss then largely being due to radiation. By using the dry process at 216 deg. the process kettle loses heat only to radiation in amount equal to about 5 boiler hp. and through condensate from the drain equal to about $6\frac{1}{2}$ boiler hp., the loss through the vent with automatic regulation being negligible. It is questionable how the $6\frac{1}{2}$ boiler

TABLE 2 COMPARISON OF HEATING-SURFACE REQUIREMENTS OF KETTLES AND COILS

Capacity of kettle, gal........	100	300	500	600 (tank with coil)
Heating surface per gal. of contents, sq. ft..... ....0.10	0.10	0.08	0.06	0.083

TABLE 3 AMOUNT OF HEAT (B.T.U.) REQUIRED FOR PROCESSING IN ONE KETTLE 40 IN. IN DIAM. BY 72 IN. DEEP

	½-hr. closed process at 240 deg. fahr.		1-hr. open process	
	Dry	Wet	Dry, 216 deg.	Wet, 212 deg.
To cans, from 120 deg...........	198,000	198,000	158,000	152,000
To water, from 212 deg.........	0	28,000	0	0 (?)
To metal, from 212 deg....	3,300	3,300	500	0
To vent on top..	0+	17,500	0+	35,000+
Radiation.....	9,000	9,000	15,300	14,800
Overflow, or drain........... ..	38,000	46,000	26,000	29,300
Total B.t.u.	248,300	301,800	199,800	231,100
Boiler hp..........	14.8	18.1	6.00	6.90

hp. escaping from the drain may be utilized. It might be returned to the boiler as feed if provision were made to eliminate impurities. An exhaust-steam feedwater heater is added, by means of which 26 boiler hp. is recovered, but as the exhaust steam is in excess of the requirements for preheating the feedwater, some of that available from the engine is lost through the vent. It is very possible that this excess of steam should be recovered in one of the steam-using units; for example, if a process kettle were designed with sufficiently large steam pipes and openings, exhaust steam could be used in it, or this steam could be used in a vacuum pan. There are a number of such possibilities.

GENERAL CONSIDERATIONS

Having now taken up in more or less detail the various familiar steam-using units in the canning factory, the writer would conclude with a few remarks of general application. Economy in steam means three things: increasing efficiency of units, eliminating all avoidable wastes, and utilizing all other wastes of heat as by-products. The first two can only be accomplished through measurement—it is necessary to know *how much steam* is used and wasted. The packing house should be properly equipped with measuring instruments for this purpose. The familiar and little appreciated pressure gage is almost a stranger in the packing house, and yet a judicious use of this instrument will disclose much valuable information as to how steam is being used or abused. To find

out how low the steam pressure is on some units whose inefficiency or lack of capacity has been ascribed to other causes and inspired futile remedies, will open the eyes of the superintendent. Next, when we eliminate wastes, we must eliminate *all wastes*, and not tolerate any just because we have been accustomed to seeing them and know that they are difficult to avoid. Wherever steam shows in the atmosphere it represents a waste, whether the steam comes from the jacket of a kettle, the vent of a process retort, the flue from an exhaust box or heater or scalder, or from any cause whatsoever. We have no right to shoot steam into the atmosphere, even if it is exhaust steam. We have no right to *radiate* heat to the atmosphere which might be saved by non-heat-conducting protection, and such wastes, it is necessary to say, are wantonly committed in the packing house. No steam-using units the writer has seen in such houses make the slightest provision against loss of heat by radiation. This is not only a waste of coal but a waste of human energy, since the operators cannot work efficiently in the torrid heat usually prevailing and aggravated by radiation from steam-using units. The packer objects on the ground of expense, but he should remember that each square foot of surface with steam behind it radiates to the atmosphere in ten hours an amount of heat requiring the burning of 1 lb. of present-day coal, and then, upon calculating what this aggregates to, will he realize that it is not a question of the expense of installing pipe coverings and other similar devices, but the expense of not doing so.

Finally, the question of how to utilize by-product heat requires careful study. In each factory the problem may be different, and in each it may be a separate case of proportioning the units to fit into each other. Feedwater heaters, traps, low-pressure heaters—all should be considered. Even the water used for cooling the cans, which carries away all of the useful heat transmitted, as previously defined, may be made to render up some of the heat it has removed.

AN INVESTIGATION OF THE FUEL PROBLEM IN THE MIDDLE WEST

By A. A. POTTER, MANHATTAN, KAN.

Member of the Society

The cost of producing power has increased in the various power plants of the Middle West from 15 to 60 per cent during the winter of 1917-1918. The Detroit Edison Company report that for 1917 the total operating expenses were 35 to 40 per cent greater than in 1916. The Quincy (Ill.) Gas, Electric and Heating Company, states that the increase has been 40 per cent. The cost of production in the Sioux City (Iowa) Gas and Electric Company has been increased by 60 per cent.

The increased cost of producing power has been due to:

a The increase cost of fuel

b The necessity of burning fuels of different grades with equipment suitable for one particular grade

c The greater amount of ash and other non-combustible matter

d The increased cost of labor and the poorer quality of labor available

e The increased cost of repairs, supplies and new equipment.

For presentation at the Spring Meeting, Worcester, Mass., June 4 to 7, 1918, of The American Society of Mechanical Engineers. The paper is here presented in abstract form, and advance copies of the paper may be obtained by members gratis upon application. All papers are subject to revision.

Increase in Cost of Fuel

The Commonwealth Edison Company, of Chicago, Ill., report the cost of coal per ton, for January 1916, 1917 and 1918 as \$1.78, \$2.72 and \$3.14, respectively. A large power plant in Indiana paid for coal an average of \$3.60 per ton during the winter of 1917-1918, as compared with \$1.66 during the winter of 1915-1916. A large power plant in Omaha, Neb., paid for fuel during the winter of 1917-1918 at an average rate of \$4.45 per ton as compared with \$2.85 in normal times. In Kansas power plants the cost of fuel has increased about 70 per cent as compared with normal years. The Jackson Light and Power Company, of Jackson, Miss., report an increase in the price of coal from \$2.12 to \$4.48.

Grades of Fuel Used

The majority of the power plants in the Middle West burned any grade of fuel they could secure and were forced in most cases to go to the open market for their supplies. Plants using bituminous screenings, slack and mill run were forced to burn mine run and even screened nut and lump coal. One large power company of Indiana, which ordinarily uses fourth-vein Indiana screenings, used during the winter of 1917-1918 only 40 per cent screenings and 60 per cent mine-run and lump coal. The larger sizes were purchased, partly on account of the difficulty experienced in securing any definite or uniform grade. The increased attention to coal storage was also responsible for the use of the larger sizes, as fine coal is more liable to danger from fire on account of spontaneous combustion. The use of lump coal necessitated in some plants additional expenditures for crushing before the fuel could be used with certain types of stokers.

Several plants in Illinois used coke breeze. Several plants in northern Louisiana and in the other southern parts of the Central West used wood and wood waste to a limited extent. In North Dakota greater use was made of lignite slack.

Some efforts were made in several states to use fuel oil in place of coal, but it was found more expensive than coal and in the majority of cases, more difficult to secure on account of the shortage of tank cars. In Kansas coal and oil were equally difficult to secure, except in the southeastern portion of the state where oil and natural gas are used exclusively in power plants. In Oklahoma natural gas is used ordinarily in the power plants at Oklahoma City, El Reno, Muskogee, Enid, Tulsa and other cities and towns. The power plants located near natural-gas fields experienced a great shortage of gas during the past winter and had to use fuel oil. In some plants this change meant an increase in operating costs of several hundred per cent. In the largest portion of Texas, lignite and bituminous slack were cheaper for power-plant use than fuel oil. Substitutions for coal were found impractical in most cases.

Suggestions have been made by power-plant engineers that the Fuel Administration should segregate the supplies from the different mines in such a manner that individual plants would get their supply of uniform grade. Where several hundred tons of coal of different grades are mixed and stored in overhead bunkers, it is impossible for stoker operators to adjust their firing conditions as to feed and draft to suit the fuel served. With uniform grades of fuel, operating conditions can be adjusted for best efficiency.

In several cases the fuel scarcity and high cost resulted in the greater use of coal near the producing point, but in most cases it was a question of keeping the plants going, irrespective of the price of fuel.

The fuel situation in the power plants of Iowa, Kansas, South Dakota, Texas and Oklahoma was not as serious as in the more populous states of the Middle West. Many of the smaller power plants either had considerable fuel in storage or reduced their load. The majority of the plants in the Middle West were affected more by the quality than by the scarcity of fuel.

Impurities in Coal

One large plant in Illinois reports that the coal used during the winter of 1917-1918 contained 16 per cent ash as compared with 9 per cent in former years. Several of the power plants in Minnesota reported 25 to 35 per cent ash and slate in coal during the winter of 1917-1918. The plants of Louisiana had to use coal which contained in many cases 30 per cent ash, as compared with an ash content of 5 to 10 per cent in former years. An engineer in a large power plant at St. Louis, Mo., stated that the cost of producing power in that particular plant has increased 51 per cent, 40 per cent being due to the increased cost of fuel and 11 per cent to the increased non-combustible impurities. In general, the ash content in the fuel used during 1917-1918 was at least 5 per cent greater than in former years on account of the faulty methods at the mines. Power-plant engineers feel that the high ash content is greatly responsible for the fuel shortage and for the increased operating costs. In ordinary times fuel containing more than 30 per cent ash would be condemned for use in boiler-room furnaces.

Cost of Labor

The cost of common labor has increased in the various parts of the Middle West from 25 to 100 per cent. Operators and firemen in power plants are receiving more pay, but in rare cases is the increase as great as 25 per cent when compared with normal times. The cost of manufacturing power has probably been more affected by the poor quality of power-plant operators and labor available than by the increased cost of such labor.

Effect Upon Isolated Plants

In a few cases the increased operating expenses and the scarcity of fuel had a distinct tendency to eliminate isolated plants and to transfer the load to central stations. This was especially true where the rates of central stations are maintained constant by law. The large central stations in most cases, however, were not too vigorously soliciting business on account of the increased costs of fuel, labor, material, and new equipment. Some power-plant managers insist on a coal-and-labor-cost clause in connection with contracts for power. Public utilities complain about the difficulties which they are experiencing in financing improvements.

Many power companies are more concerned on account of insufficient plant capacity than because of the increased cost of fuel. Improvements and extensions in equipment are affected by the high cost of money, by the high prices of materials and equipment and by the difficulty of securing deliveries of materials and equipment purchased. A manager of a large central station in Indiana states that they are three years behind in expansion, development and replacement.

Efforts for Better Fuel Economy

The fuel situation during the past winter has resulted in greater efforts for fuel economy. This is particularly noticeable in the small power plants of the less populous portions of the Middle West. The high cost of new power-plant equipment has some tendency to delay improvements, but it is remarkable to see power plants in towns of 2000 inhabitants, or even smaller, discarding an inefficient old steam prime mover and paying at the rate of $200 per kilowatt capacity for new units, in order to produce fuel economy. The use of draft gages and of other measuring instruments is increasing in the boiler room, greater attention is given to the utilization of exhaust steam in non-condensing plants, more pipe covering is used, greater attention is being given to boiler settings and furnaces, heating surfaces are kept cleaner, and definite efforts are being exerted for the more economical utilization of fuel in the power plant.

Work of the Fuel Administrators

The work of the Fuel Administration Boards of Iowa, of Louisiana and of Illinois, is particularly creditable. The fuel-conservation campaign in Iowa consists of:

a Inspection of boiler rooms and heating plants, with recommendations as to improvement in equipment and operation, and instruction of firemen in proper firing methods

b Talks to groups of engineers and firemen on combustion and firing methods

c Talks to general audiences on the economical use of fuel in the home, and on firing house furnaces; and

d Dissemination of information on burning soft coal in house furnaces. Inspections of house-heating plants were made to a very limited extent.

Iowa State College at Ames furnished seven engineers to carry on this work, each of whom spent during the past winter from two to twelve weeks making inspections and giving talks and demonstrations. Their services were available to any city or town in the state without charge except for traveling and hotel expenses.

Prof. D. C. Faber of the Iowa State College, who is the consulting engineer for the Federal Fuel Administration for Iowa, gives the following in his recent report:

> Thirty-four cities and towns asked for this service, including practically all of the larger cities of the state. 1354 plants were inspected, and 80 talks given to a total of 7330 people.
>
> The boiler-plant inspections were made to point out defects in equipment and operation, and to give the firemen proper instructions in firing methods. The inspectors were equipped with draft gages, CO_2 recorders, and thermometers for measuring flue-gas temperatures. The inspections varied from casual inspections to complete investigations of combustion conditions, as circumstances required. It is not possible to enumerate the defects found by the inspectors, but a few of the commonly found faults were: Leaky boiler settings; uncovered steam pipes; failure to remove soot at frequent intervals; failure to regulate fire by use of damper in uptake; fire too thick; and firing too large a quantity of coal at one time.
>
> In the talks to engineers and firemen, combustion, hand firing methods and boiler-room losses were explained. These talks were accompanied by lantern slides, charts and demonstrations.

In Louisiana an extensive campaign for fuel conservation has been undertaken under Leo S. Weil, advisory engineer for the Federal Fuel Administration for Louisiana. Mr. Weil gave a complete description of his work in *Power*, Vol. 47, No. 5. Efforts were made to have other fuels substituted for coal, but these were found impractical in most cases. The fuel consumption was decreased by shutting down some of the ice plants which operated during the winter at about one-third of their normal capacity, and the remainder of the ice plants were run at nearly normal capacity, supplying ice to those which were shut down. The attention of power-plant owners

and of operators was called to the necessity of reducing waste of coal and to the desirability of coöperation on the part of both owners and operators. Suggestions concerning reduction of coal waste were sent out to power-plant operators. Mr. Weil reports very gratifying results due to the above efforts.

The Conservation Committee of the Fuel Administration of Illinois, with Prof. H. H. Stoek of the University of Illinois as chairman, is carrying on very constructive work among the power plants of that state in the interest of fuel economy. Those in charge of power plants are being urged to go over their equipment and to make necessary improvements. The Conservation Committee has also the coöperation of the factory inspectors of Illinois, who are bringing the matter of economy to the attention of the owners and operators of plants inspected by them.

Conclusions

The power plants of the Middle West are convinced that future emergencies can be averted by more adequate fuel storage, by greater attention to fuel economy, and by the more careful regulation on the part of the Government of the quality of fuel leaving the mines and of the fuel-transportation facilities.

Several state fuel administrators are expecting to start campaigns urging the early purchase of fuel for domestic use, and greater storage of coal by power plants during the summer. The larger power plants are expecting to store greater amounts of coal than usual. Some plants expect to provide storage capacity sufficient for 30 days; many of the smaller plants expect to put in larger storage capacity. Considerable difficulty is being experienced in storing many of the middle-western bituminous coals on account of spontaneous combustion. Storage under water will be used to a considerable extent. The Nebraska Power Company, of Omaha, which uses 250 to 300 tons of coal per day, constructed two subaqueous coal storage pits of a total capacity of 8000 tons and at a cost of about $120,000. The Commonwealth Edison Company, of Chicago, devotes about 100 acres of high-priced land to coal storage. On this land are nearly ten miles of railroad tracks and other improvements, in addition to locomotives and locomotive cranes. Mr. W. L. Abbott, chief operating engineer of the Commonwealth Edison Company, states that in addition to the above investment in storage facilities there is the great expense of storing upward of a million dollars' worth of coal and carrying much of it year after year, but that the outlay and expense are warrantable from a business point of view.

In the case of power plants using natural gas, a gas-storage-tank capacity sufficient for a 10-day period is considered practical. Such a storage capacity will take care of gas shortage during extremely cold weather.

More attention will be paid in the future to the proper furnace design for high-volatile bituminous coals. The combustion chambers of the furnaces in the majority of the smaller power plants are not large enough for the air to mix with the gases given off from the fuel bed and before such gases come in contact with the comparatively cool heating surfaces of the boiler.

Some attention should be given to the use of peat in certain parts of Michigan, Minnesota and Wisconsin for domestic use and possibly also for power generation. With the increasing scarcity and higher cost of coal and oil, low-grade fuels must be given greater consideration in connection with the generation of power.

The fuel administrators of the various states should be encouraged to secure engineering assistance, particularly in connection with the campaigns for economy in the smaller power plants. Much fuel can be saved if the operators of the small power plants can be carefully instructed with reference to the overhauling of equipment, the avoidance of air infiltration through settings, proper firing methods, correct thickness of fuel bed and other operating details which lead to the economical utilization of fuel. The institution of campaigns for fuel conservation, such as have been undertaken in Louisiana and in Iowa, will result in greater fuel economy. Such campaigns are absolutely necessary in the less populous sections of the Middle West, where the majority of the power plants are small and are operated by poorly trained attendants.

E. G. Bailey, Mem.Am.Soc.M.E., advocated recently that the price of coal be regulated by the Government according to the quality of the fuel produced, in order to give the coal operator a real incentive to clean his coal as he should. He states that—

> The base price for standard quality of coal should be established by the Government as at present, with possibly different base prices and different quality standards for the several districts, taking into account the character of coal, height of seam and other mining conditions; but the main thing to strive for is to obtain the highest quality of coal and the most concentrated form of heat units in order to tide us over the coming year, which is going to be much more critical than that just past, unless some radical step is taken to apply a remedy for the basic cause of the present situation.

The United States Fuel Administration has announced that, beginning March 11, 1918, an inspection system will be effective to insure improvement in the quality of bituminous coal leaving the mines. Coal containing a high percentage of impurities will be condemned or will be sold at 50 cents per ton less than the fixed Government price for that coal. There is no definite system recommended upon which the inspector may base his conclusions as to the quality of the coal. In ordinary times the operators are forced by competition to produce a low-ash coal. It is possible that the Government may be able to improve the quality of the coal leaving the mines by enlisting all mine officials and employees in some form of industrial army for coal production. Otherwise, some definite plan of fixing prices for definite quality standards should be worked out.

A detailed study of coal-car movements in the Middle West during the past four years discloses the fact that the average time required to move cars is extremely long. In most cases cars carrying coal will average less than 20 miles per day. When to this time is added the time required for empty cars to return to the mines, it is evident that the coal tonnage handled per car per year is very limited and very much smaller than reasonably efficient operation should produce. This delay is due partly to the practice by railroads of throwing cars on sidings and into yards with unnecessary switching, instead of delivering them to their destination in one or two hauls. Pooling of engines, cars and routes can be made to substantially relieve this situation. Another relief can come by so routing coal as to avoid, as far as possible, the congested terminals at the larger cities.

To avoid the recurrence of the conditions of last winter, the power plant men will have to coöperate with the Government by providing adequate coal-storage facilities, by unloading fuel without delay after it reaches its destination, and by giving careful attention to power-plant economy. The Government will have to insist upon reasonable cleanliness of coal leaving the mines, and should give more attention to the improvement in the railroad equipment and in the methods of transporting coal from the mines to the consumer.

THE PUBLIC INTEREST AS THE BED ROCK OF PROFESSIONAL PRACTICE

A Discussion of the Objects of Engineering Societies and Their Obligations to the Public

By MORRIS LLEWELLYN COOKE, PHILADELPHIA, PA.

Member of the Society

THE members of our Society individually are doing everything in their power to help to win the war. To this end we dedicate personal convenience, financial interest, and life itself. A study of the program of this and other recent meetings of the Society indicates that collectively our aim is the same. One has but to read the technical engineering journals to realize that perhaps no other profession is so profoundly affecting the actual conduct and progress of the war as is our own. Without doubt, engineers as a class are making every possible effort, and at every possible sacrifice, to make Liberty triumph in the present struggle. In other words, there is in our conduct the clearest recognition of the paramount obligation which we owe to the Nation, and, in the last analysis, to humanity. In view of this attitude taken spontaneously in time of war, it is curious to note that our public responsibilities are almost ignored in the codes of ethics of our organized associations of engineers. Drafted as they have been to control our conduct in times of peace, these canons of professional practice carry almost no reference to the public interest as a controlling, much less as a paramount, obligation of the individual engineer, of engineering societies, and of the profession as a whole.

This is a time of stock taking and of a critical examination of the orders under which society and its constituent elements are operated. Within the church, among labor organizations, in government, in the educational field, and in the professions,—everywhere, in fact,—we find the same searching inquiry as to aims and methods. Hence, there can be no better time for a review of the codes of ethics designed to regulate the professional practice of engineers. The object of this paper is to determine what has been, and apparently continues to be, the attitude of engineering organizations toward society as expressed in our rules of conduct. It is further sought to develop the engineer's concept of his public relationships and responsibilities as contrasted with such relatively minor obligations as those to the profession of engineering, to a client, to fellow-engineers, and to himself.

The oldest, the largest and perhaps the most representative society of American engineers, the American Society of Civil Engineers, for instance, makes absolutely no mention in its Code of Ethics of any such public responsibility. The Code in full is as follows:

> It shall be considered unprofessional and inconsistent with honorable and dignified bearing for any member of the American Society of Civil Engineers:
>
> To act for his clients in professional matters otherwise than as a faithful agent or trustee, or to accept any remuneration other than his stated charges for services rendered his clients.
>
> To attempt to injure falsely or maliciously, directly or indirectly, the professional reputation, prospects, or business, of another Engineer. To attempt to supplant another Engineer after definite steps have been taken toward his employment. To compete with another Engineer for employment on the basis of professional charges, by reducing his usual charges and in this manner attempting to underbid after being informed of the charges named by another. To review the work of another Engineer for the same client, except with the knowledge or consent of such Engineer, or unless the connection of such Engineer with the work has been terminated.
>
> To advertise in self-laudatory language, or in any other manner derogatory to the dignity of the profession.

The first of these three sections refers exclusively to the engineer's relationship to the client, the second to his relationship to fellow-engineers, and the last simply deprecates advertising.

The code of the A. S. M. E. contains a section devoted to The Engineer's Relation to the Public, but it includes no recognition of the fundamental character of the obligation of the engineer to the public. Even the engineer's responsibility "to extend the general knowledge of engineering" is quite incidental. The major import of these injunctions has to do with a negative phase of the subject, i. e., the holding back from the public of inaccurate information or of too narrow statements with regard to engineering subjects. The really significant sentence in our code reads:

> The Engineer should consider the protection of a client's or employer's interests *his first obligation* [italics mine], and therefore should avoid every act contrary to this duty.

This sentence is fairly typical of what appears to be the keynote not only of this, but of every engineering code. These codes have apparently been drawn to hold up a high standard of personal integrity in relations with the client and to protect one engineer against another.

The omission of any reference to the public interest in the codes of professional practice of engineering organizations would not be so noticeable were it not for the fact that other associations of professional men have been at very considerable pains not only to express the obligation, but to insist on its paramount importance, and to phrase it in terms of lofty idealism.

The architects, whose work in many respects is quite comparable to that of the engineer, have been emphatic and successful in their efforts to govern their professional conduct along ethical lines. They have further made the effort to stress the public character of the profession, and to reward those who have made distinct contributions in the public service.

Perhaps the most conclusive statement in this matter is that which appears in the Code of the American Bar Association under the head, The Lawyer's Duty in Its Last Analysis:

> No client, corporate or individual, however powerful, nor any cause, civil or political, however important, is entitled to receive, nor should any lawyer render, any service or advice involving disloyalty to the law whose ministers we are, or disrespect of the judicial office, which we are bound to uphold, or corruption of any person or persons exercising a public office or private trust, or deception or betrayal of the public. When rendering any such improper service or advice, the lawyer invites and merits stern and just condemnation. Correspondingly, he advances the honor of his profession and the best interests of his client when he renders service or gives advice tending to impress upon the client and his undertaking exact compliance with the strictest principles of moral law. He must also observe and advise his client to observe the statute law, though until a statute shall have been construed and interpreted by competent adjudication, he is free and is entitled to advise as to its validity and as to what he conscientiously believes to be its just meaning and extent. But above all, a lawyer will find his highest honor in a deserved reputation for fidelity to private trust and to public duty, as an honest man and as a patriotic and loyal citizen.

Engineers need not be told that an axiom is undebatable. Surely no one will hold that the public interest is not funda-

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mental to all professional ethics and practices. It is not even necessary to vote on the proposition. The simple enunciation of the statement makes it so obvious that further action is in a way unnecessary. On the other hand, one must necessarily question codes of ethics and canons of professional practice which have been drafted without the clearest possible recognition of the fact that such rules and regulations must be interpreted in the light of public interest.

In much of the vital engineering of the time the determinations are inextricably interwoven with questions of public policy. In fact, enlightened public engineering is in many directions the insistent need of the hour. If the established engineering agencies fail to respond both efficiently and disinterestedly to this call for service, others will inevitably be created more in the spirit of our great time.

Practically all the questions affecting professional practice among engineers that have been raised during the last few years would have settled themselves had this one standard of the public interest been held to be fully operative while at the same time the interest of the profession as a whole, the relations of the engineer to his client and those of one engineer to another engineer, were being safeguarded as far as consistent with the public interest.

We frequently hear it said both by engineers and by laymen that this is the day of the engineer, or rather that the day is just dawning when society must become increasingly dependent upon engineering. Can this day really arrive so long as the rules and regulations for our professional conduct are so largely taken up with rather crude and in many cases debatable injunctions, which have more to do with what might be called "keeping the peace" than with our immeasurably more important task of providing such an enlightened leadership in the present as will make our dreams of the future come true?

My own feeling is that every code now in use by engineers in this country and abroad should be entirely rewritten on much broader lines and in a more inspiring key. It is useless to undertake such revision unless we have determined that we shall open every such code with the clearest possible enunciation of the principle that no considerations of professional or other special interest shall weigh for one moment against the interests of the nations and of humanity itself.

STRESSES IN MACHINES WHEN STARTING OR STOPPING

Method for Their Determination, Taking Account of Inertia and Elasticity

By F. HYMANS, NEW YORK, N. Y.

Member of the Society

A CYCLE of operation of a machine can be divided in three more or less distinct periods, namely, the start, the run at constant speed, and the stop.

The calculation of machine parts follows at present one of two methods. The first assumes a state of equilibrium, which permits the application of the known processes of statics to determine the forces acting on each machine part. The state of equilibrium, however, exists only when the machine runs at constant speed or is at rest.

In the second method all of the machine parts are considered to be rigid. The calculations are based on the external forces as they exist during stop or start, from which the forces acting on each machine part are determined by means of the dynamics of rigid bodies.

Neither of these methods leads to even approximately correct results. The first may be dismissed altogether, since no consideration whatsoever is given to the quite different phenomena occurring at start or stop. In the second such a consideration is attempted, but is based on entirely wrong premises. For, if correct, the forces acting on the machine parts merely depend on their inertia and on the magnitude of the external forces. From experience, however, it is known that the forces acting on a machine part do not only depend on the above

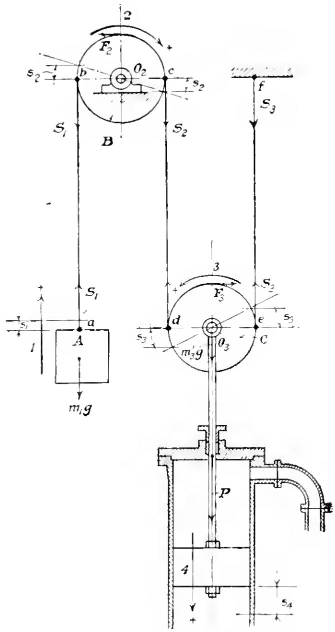

Fig. 1 Diagram of Hydraulic Machine

two factors, but, for example, also on the *nature* of the external forces. A feeble periodic force of the proper frequency, for instance, may cause the breakdown of a machine where a constant force of several hundred times its magnitude would be easily withstood. It is plain, therefore, that this method neglects the consideration of some property through which in the resulting formulæ the influence of the nature of the external forces vanishes. This property is the elasticity of the machine parts.

It is the object of this paper to present a method whereby the forces acting on the machine parts during start or stop may be determined with a degree of accuracy more than sufficient for technical purposes. While the method is explained in sufficiently general terms for ready application to any machine, it is more specifically applied to the determination of the motion and rope tensions during the starting of the hydraulic machine shown diagrammatically in Fig. 1.

As the figure shows, the machine consists of a vertical cylinder with a piston, adapted to lift the load A through the in-

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termediary of a piston rod, a traveling sheave C, a stationary sheave B, and the ropes ab, cd and ef. The force P, acting on the piston and causing the motion of the machine, will be called the motive force, in distinction to all other external forces, such as the weight of load and machine parts, and the frictional forces.

According to the foregoing, it is necessary to consider not only the inertia of the machine parts, but also their elasticity. Strictly speaking, all of the machine parts are elastic. Fortunately, however, there are always a few which have elasticity to such a predominating degree that other parts in comparison with them may be considered to be rigid. Thus any machine may be approximated by a system of parts, of which some have elasticity and others inertia only.

In the machine of Fig. 1, for example, it is at once evident

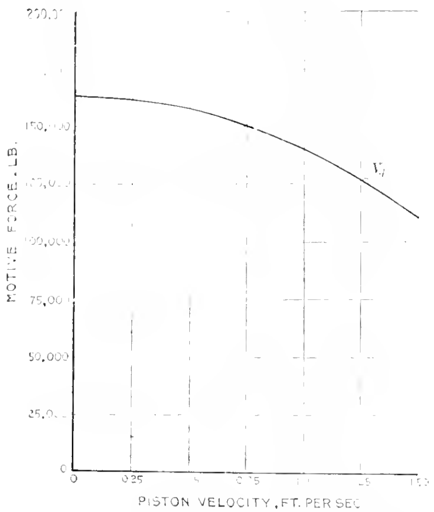

FIG. 2 MOTOR CHARACTERISTICS (MOTIVE FORCE AND PISTON VELOCITY)

that the ropes ab, cd and ef will be considered as the only elastic members. Their mass is very small and may be neglected. The remainder of the machine parts, that is, the load A, sheaves B and C, the piston and piston rod, will be considered rigid.

The author's method is based on the general energy equation of the machine, from which he derives all of the equations required in the further calculations. According to dynamics, this equation states that the gain in kinetic energy plus the gain in potential energy equals the work done by the external forces.

To derive the energy equation of the machine certain displacements are assigned to the rigid machine parts, such as s_1, the linear displacement of the load A; s_2 and s_3, the circumferential displacements of points b and c of sheave B, and of points e and d of sheave C; and s_4, the linear displacement of the piston and the parts rigidly connected thereto. Since the velocity of the rigid parts is the first time derivative of their displacements, it is quite simple to derive for each of them the expression of the kinetic energy. The kinetic energy of the machine then is the sum of the kinetic energies of its constituent parts.

The elastic machine parts—here the ropes ab, cd and ef—are the seat of the potential energy of the machine. By virtue of their elasticity they are capable of sustaining deformations, and so long as they are stressed below the elastic limit there is stored in them an amount of energy equal to the energy that produced the deformation. This energy is called the potential energy.

Considering now the rope ab, it is evident that if the end b has moved through the distance s_2, and the end a through the distance s_1, the rope has suffered an elongation equal to $s_2 - s_1$. Knowing further the elongation which a tension of 1 lb. will cause in the rope, it is merely necessary to apply the well-known laws of statics to determine the energy necessary to produce the deformation $s_2 - s_1$.

This process is also applied to ropes cd and ef, and the potential energy of the machine will be the sum of the potential energies of its constituent elastic parts. The derivation of the work done by the external forces needs hardly any elucidation.

From the foregoing it will be evident that, after having determined which of the parts shall be considered elastic and which rigid, the derivation of the general energy equation of the machine will not present any considerable difficulties. It will also be quite clear that the machine parts to be considered rigid are those wherein either the stress or the deformation, or both, are so small that the amount of potential energy stored in them is negligible. Further operation with the general energy equation is facilitated by the resolution of the absolute motion into two components, which the author calls rigid and relative motions. This is based on the following considerations.

The tension in rope ab (see Fig. 1) changes from instant to instant during the start of the machine. If the tension decreases, the rope contracts, causing points a and b to approach each other. Vice versa, if the tension increases they recede from each other. These varying elongations, however, are merely varying increments in the free length of the rope ab. It follows at once that the motion of points a and b, that is, the motion of the load A and of point b of sheave B, consists of two components.

One of these components is common to both, and is a motion wherein the linear distance between the points a and b is preserved and remains equal to the free length of the rope. The second component is superposed on the former, and corresponds to the varying elongations due to the rope's elasticity.

It will be seen that the component first named is the motion which would take place if the rope ab were non-extensible. In general, the motion of each machine part is the same as the motion which it would have if all of the machine parts were rigid, superposed by a motion relative thereto. It is this relative motion which is neglected if the calculations are based on the assumption of a state of equilibrium, or if all of the machine parts are assumed to be rigid.

The energy equations for the rigid and relative motions are easily derived from the general energy equation, and may be integrated separately. To prepare for the integration of the energy equation of the relative motion, the author makes use of the so-called theory of normal coördinates, which is explained at sufficient length in the paper for ready application to the problem in hand. By means of this theory the displacements s_1, s_2 etc., may be expressed as the sum of a number of normal displacements, each of these being the product of a normal constant into a normal coördinate. Of the normal constants and coördinates only a few general types need be determined.

Of the external forces acting on the machine, all are constant with the exception of the motive force P. Strictly speak-

ing, the frictional forces are also variable, and are really functions of the motion of the machine. On the other hand, the coefficient of friction depends on a number of factors which are only imperfectly known. In addition, the frictional forces are, as a rule, very small as compared with the other forces acting on the machine parts. There is therefore no advantage in introducing needless refinement, and it is sufficient to consider the frictional forces as constant.

If it were possible to express the motive force in an explicit function of the time, the above-mentioned integrations could be executed easily, either mathematically or graphically. For machines yet to be built this is impossible. However, there is available for the further calculations what is known under the name of the motor characteristics.

The motor in general will be that machine part which is the seat of the motive force, irrespective of the latter being

163,000 lb. For the entire duration of this interval, taken at 0.005 seconds, the motive force is assumed to remain constant at 163,000 lb. Under these conditions the various displacements, rope tensions and piston speeds are determined. At the end of the first time interval the piston speed amounts to 0.578 ft. per sec., when from Fig. 2 it is at once found that a motive force of 155,200 lb. corresponds to that speed. For the second time interval the motive force is then assumed to be constant at 155,200 lb. and the calculations are repeated.

The results of the calculations are shown in the complete paper in various graphs, of which four are here given in Figs. 3, 4, 5 and 6.

Particularly instructive in regard to the phenomena occurring at the start is Fig. 3, in which curve No. 1 represents the velocity of the piston, and curve No. 2 the velocity of the load A. Owing to the small inertia of the piston masses, it

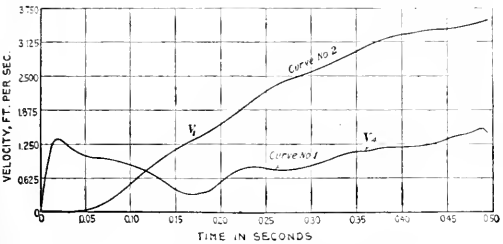

Fig. 3 Absolute Velocities of Piston (Curve No. 1) and of Load (Curve No. 2)

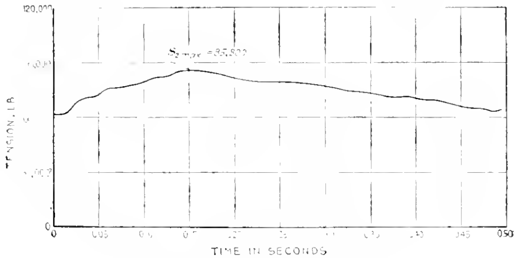

Fig. 5 Tension S_2 in Rope cd of Fig. 1

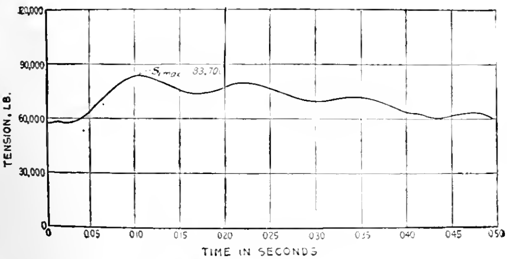

Fig. 4 Tension S_1 in Rope ab of Fig. 1

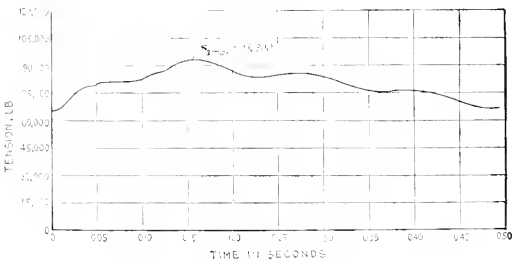

Fig. 6 Tension S_3 in Rope ef of Fig. 1

due to electric, hydraulic, steam or gas pressure. As is known, the force or torque exerted by these motors varies with the motor speed, although the manner in which these variations take place is frequently too complex to be adequately expressed in a mathematical formula. Fortunately, the latter is not necessary for the purpose in hand, since it is always possible from tests with the motor alone to derive a graph showing the variation of the motive force with the motor speed.

In the present case, the motor characteristics will be the performance of the piston alone when operating in the cylinder under the given conditions as to piping and water pressure. They are represented by Fig 2, which shows the net force P which the piston rod will exert at various piston speeds.

The calculations proceed by dividing the starting period into time intervals of so small duration that the motive force during any such interval may be considered constant, without that an appreciable error is committed.

For the first time interval, beginning with zero piston speed, it is found from Fig. 2 that the motive force P amounts to

must of course be expected that at the application of the motive force the equilibrium of the piston will be violently disturbed, while the effect on the heavy load will be less severe. This is clearly reflected in Fig. 3, where the piston speed rises from zero to 1.35 ft. per sec. within about 0.02 sec., whereas the velocity of the load after a lapse of even 0.05 sec. amounts to only 0.03 ft. per sec. That such conditions, nevertheless, do not lead to heavy stresses in the ropes is due to the nature of the motive force. Large variations in the piston velocity cannot persist, since the motor characteristics are such that an increase in the motor speed corresponds at once to a drop in the motive force (see Fig. 2), and vice versa. The motive force, therefore, has the tendency to counteract large variations in the piston speed, as witnessed by the smoother course of curve No. 1, Fig. 3, after the first violent rise. If the ropes of the machine of Fig. 1 were non-extensible, or as soon as the machine was running at constant speed, there would be a 2:1 ratio between the motion of the load and that of the piston. Owing to the elasticity of the ropes, however, there is no

vestige of any such ratio during the start, as will be seen from an inspection of Fig. 3. After a lapse of 0.05 sec., for example, the ratio between velocities of load and of piston is as much as 1:55; after 0.117 sec. it is 1:1; after 0.3 sec. it is approximately 3:1.

The rope tensions as they vary with time are shown in Figs. 4, 5 and 6. In the state of equilibrium $S_1 = 58,000$ lb., $S_2 = 61,000$ lb., and $S_3 = 64,300$ lb. During the start, however, $S_{1max} = 83,700$ lb., $S_{2max.} = 85,800$ lb., $S_{3max.} = 93,300$ lb., exceeding the former by 44.2 per cent, 40.5 per cent, and 45 per cent, respectively. It will be seen that in the present case the forces S_1, S_2 and S_3 are not very considerably in excess of the values which they have as soon as the machine runs at constant speed. This is primarily due to the nature of the motive force, as already explained.

From the foregoing it follows that the stresses in a machine at starting or stopping depend on a number of factors, namely:

1 The inertia of the individual parts, in particular the inertia of the motor in respect to that of other parts. The heavier the motor mass, the less violent will its equilibrium be disturbed at the start and the smaller the resulting stresses

2 The position of the motor mass within the system. The effect of a locomotive, for example, placed at the head of a string of cars, will be quite different than when placed in the middle

3 The elasticity of the individual machine parts

4 The distribution of the elasticity throughout the system. If, for instance, the equilibrium of the motor is liable to be violently disturbed at the start, the stresses in the machine will be less if the motor is coupled to the remainder of the machine by very elastic members

5 The nature of the motive force. In the hydraulic machine of Fig. 1 the drop in the motive force is approximately proportional to the square of the piston speed. Had the motor characteristics been such that the drop in the motive force was only proportional with the piston speed, far larger stresses would have resulted.

THE ELASTIC INDENTATION OF STEEL BALLS UNDER PRESSURE

By C. A. BRIGGS, WASHINGTON, D. C.

Member of the Society

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Non-Members

In the adjustment and standardization of precision apparatus at the Bureau of Standards incidental to the testing of munition gages, the subject of the effect of pressure on the dimensions of steel balls and length standards having rounded ends came up for consideration. After a preliminary study of the matter it was concluded that the distortion of the steel balls between the contacts, and the elastic compression of the portion of the rounded ends not directly in contact with the measuring surfaces, was very small, a conclusion that appeared inconsistent with some of the results that had been obtained in actual measurements. This directed attention from the main portion of the steel ball or rounded surface to the elastic indentation of the surfaces immediately in contact with each other. In order to settle the questions arising, experiments were undertaken, and the results obtained form the substance of this report.

These experiments, while limited in scope, were so successful in giving consistent results and data of apparently wider application than that originally intended, that it appears desirable to make a brief report summarizing and recording the information obtained. Owing to the fact that the effect of high pressure was of no immediate interest in reference to the problem in hand, and to the fact that to extend the investigation to greater pressures would have required time that was needed for other matters, low pressures only were employed.

The maximum pressure used on steel balls against glass plates was 20 lb., which was used on balls ¾ in. and 1 in. in diameter. On smaller balls the maximum pressure used was 10 lb. The results, therefore, do not represent conditions present when high pressures are used, such as occur in the Brinell hardness test of materials where the stresses are above the elastic limit; or pressures such that the indented area includes a solid angle large enough to invalidate the assumption frequently made when the angle is small that the sine and angle are equal. However, the results obtained do give accurate information of the effect of pressures on the measured diameters of spherical surfaces of steel or other materials which are employed in standardizing gages; and also appear to give information of practical value as to what occurs in ball bearings.

The experiment was performed by observing and measuring with a micrometer microscope the area of contact made by flat and spherical surfaces in contact with each other under varying pressures. This area of contact was viewed as the central spot in the Newton's ring system formed when a glass surface was in contact with a polished surface of steel or with another glass surface. The amount of indentation was obtained from the measured diameters by a very simple computation, easily derived, which it is not necessary to give at this time.

The different combinations of surfaces available for observation and use in the experiments were: a steel sphere pressing against a flat glass surface; a spherical glass surface pressing against a flat steel surface; and a spherical glass surface pressing against a flat glass surface.

From an examination of the results for each pair of surfaces in contact plotted on log paper, and from general reasoning based on the nature of the phenomena, a general equation was worked out for the purpose of correlating all of the results. It is not necessary for present purposes to expand this report by giving all of the various considerations which lead to the particular form assumed for this general equation—suffice it to state that after the constants of the general equation had been determined from the experimental data, the experimental values were reobtained by computations from the general equation, and the agreement between the computed and experimental values was very good. In fact, the agreement was so satisfactory that it was considered unnecessary to take additional data from the same material, as had been contemplated up to that time.

In the case of steel against steel it was of course not possible to observe the area of contact owing to the opaque nature of both contact surfaces, so that the values of steel against

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steel were obtained by the use of the general formula which had been found to fit all the various surfaces and materials used in the experiments.

It will be noted in the equations which follow that a quantity called the "indentation modulus" is used to express the elastic property which determines the indentation. It was originally intended to use Young's modulus as representing in a general way the elastic properties. However, on looking up the elastic constants of glass it was found that a problem of very similar nature had been worked out by Hertz from theoretical considerations which gave practically the same form of equation as was derived in the present experiments.

in contact with cylindrical surfaces—such as are represented by many forms of ball and roller bearings in every-day use. It would be also of interest to extend the experiments already made by employing higher pressures.

The elastic coefficients for the materials used in the experiment of this report were obtained from tabular data. If, in the future, it becomes desirable to obtain information on the indentation of surfaces with great precision, experiments should be performed on materials that have had their properties carefully measured, so as to fix with exactitude the values of Young's modulus and Poisson's ratio for the particular steel and glass used in the experiment.

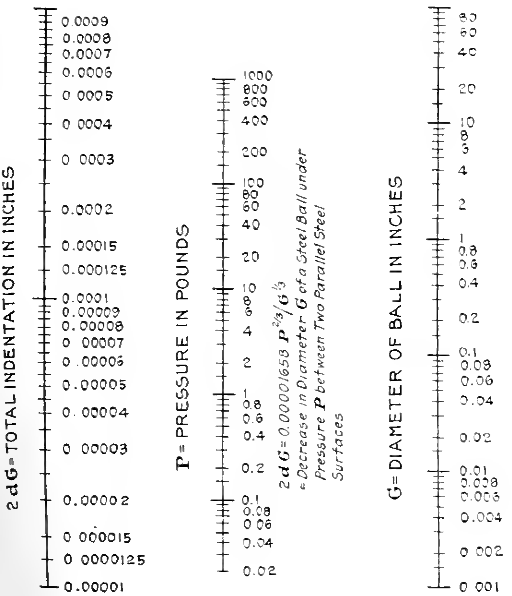

Fig. 1 Chart for Determining the Indentation of Steel Balls

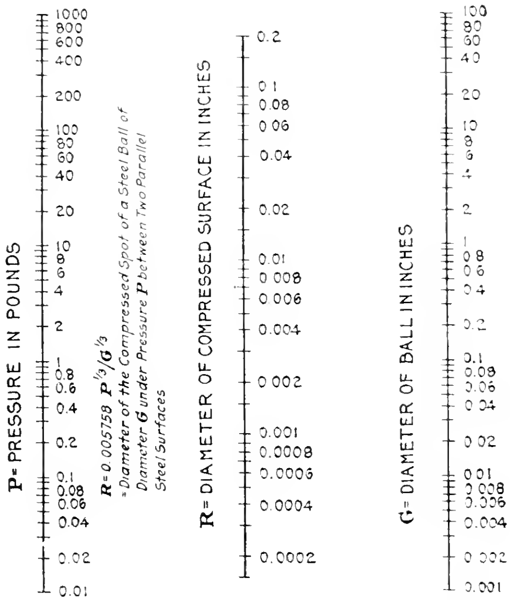

Fig. 2 Chart for Determining the Diameter of the Indented Spot of Steel Balls

and in which the elastic property effective in determining the indentation was found by Hertz to be a function of Young's modulus and Poisson's ratio, and which was called the indentation modulus.

A very interesting feature which can be noted on examining the results is that the indentation is not linear with the pressures but is proportional to the two-thirds power of the pressures. This is a fact of important interest in connection with the design of ball bearings, as it indicates what effects are produced on the distribution of the load by slight variations in the size of the balls in a bearing.

For steel against steel, which is the case of most general and important interest, the results are given in the form of computation charts, Figs. 1 to 3, by means of which numerical values can be obtained quickly for any particular case covered by the equations. (Three other charts, in which metric units are used, are given in the complete paper.)

In reference to future experiments, those which would appear to be of most practical interest are concerned with the determination of the elastic indentation of spherical surfaces

The results of the experiments are summarized in the eight equations which are given below.

General Equation for Indentation:

$$dG = 0.518\sqrt[3]{P^2[(G_1 - G_2)/G_1G_2][(1/E'_1)+(1/E'_2)]^2} \quad [1]$$

where

dG = the mutual indentation between the surfaces in contact

P = the pressure acting between the two surfaces

G_1 and G_2 = the radii of curvature of the two surfaces

E'_1 and E'_2 = the indentation moduli of the surfaces G_1 and G_2.

The indentation modulus is given by the expression

$$E' = E/(1 - u^2) \ldots\ldots\ldots\ldots\ldots\ldots [2]$$

where E = Young's modulus and u = Poisson's ratio. The constant 0.518 is the same for both metric and English units when either are used consistently throughout the formula.

Indentation of Steel Balls Between Flat Steel Surfaces. For metric units the indentation is given by the equation

$$2dG = 0.00210\sqrt[3]{P^2/G} \quad \ldots\ldots\ldots\ldots\ldots [3]$$

where $2dG$ is the indentation in millimeters from both sides of the ball. For English units the equation is

$$2dG = 0.0000166\sqrt[3]{P^2/G} \quad \ldots\ldots\ldots\ldots\ldots [4]$$

where $2dG$ is given in inches.

Diameter of Area of Contact Between the Surfaces, Steel Against Steel. For metric units

$$R = 0.0647\sqrt[3]{PG} \quad \ldots\ldots\ldots\ldots\ldots [5]$$

where R is the diameter of the spot in millimeters. For English units—

$$R = 0.00576\sqrt[3]{PG} \quad \ldots\ldots\ldots\ldots\ldots [6]$$

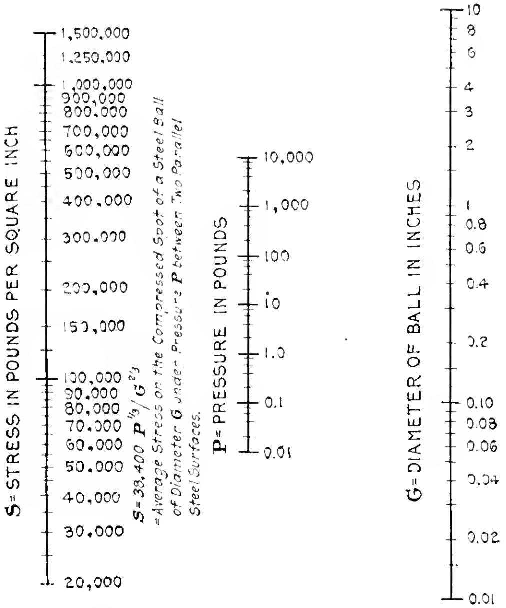

Fig. 3 Chart for Determining the Pressure per Unit Area on the Indented Spot of Steel Balls

where R is given in inches. If the general equation is desired for R it can be derived easily from Equation [1].

Average Pressure Over the Area of Contact, for Steel Against Steel. For metric units—

$$S = 301\sqrt[3]{P/G^2} \quad \ldots\ldots\ldots\ldots\ldots [7]$$

where S is given in kilograms per square millimeter. For English units—

$$S = 38{,}400\sqrt[3]{P/G^2} \quad \ldots\ldots\ldots\ldots\ldots [8]$$

where S is given in pounds per square inch. If the general equation for S is desired it can likewise be developed from Equation [1].

Computation Charts. Means for graphically solving the preceding equations in English units are shown in the charts Figs. 1, 2 and 3. A straight line placed across any of the charts will strike readings on the vertical scales which are a solution of the corresponding equation. With these charts, when any two of the three quantities of the equation are given, these quantities will establish two points which determine a straight line, and the value of the third quantity will be given by the intersection of the straight line on the corresponding vertical scale.

ELECTRIC HEATING OF MOLDS

By HAROLD E. WHITE, AMPERE, N. J.

Member of the Society

SYNTHETIC molding materials are being used on an increasingly extensive scale not only for parts of electrical machinery, but for many other articles of usefulness. It is the purpose of this paper to describe a novel method of applying heat to the molds in which such parts are formed, which the writer believes will be of general interest and of considerable utility under certain conditions.

The earliest example of such a material is perhaps hard rubber or vulcanite. More recent examples are the phenolic condensation products sold under various trade names. All of these materials are alike in that a moderate degree of heat causes them to soften sufficiently to take the form of the mold, while a higher degree of heat causes them to undergo chemical changes that harden them into a highly resistant condition.

Manufacture of parts made of this material on a small scale under the observation of the writer led to the development of the new method of production which is described. While it is not believed that this method can replace the methods used in factories which specialize on these materials, it would appear, nevertheless, that it can be used with success in almost any machine shop equipped with a hydraulic press, or even an arbor press if the articles are small, provided alternating current is available.

At first an attempt was made to use the standard method of production, which was to place the filled molds between two steam-heated plates attached respectively to the upper and lower platens of the hydraulic press. Live steam at about 110 lb. per sq. in. was admitted to these plates until the pieces were fully hardened. Then cold water was circulated through the same plates until the mold was cold, after which the mold was taken out and refilled for another piece.

Under these conditions production was slow and frequently interrupted altogether. The slowness of production was due to the fact that heat was not transmitted rapidly enough from the hot plates to the mold because the steam was often wet and the plates had a lower temperature than the boiler pressure would indicate. These difficulties were accentuated by the fact that most of the molds were long and slender, so that they had but a small part of their surface in contact with the hot plates and a large part of their surface in contact with the air. The heating and cooling of the fittings alternately carrying the steam and the cooling water resulted in frequent leaks, especially in the flexible piping, the use of which was necessitated by the movement of the upper platen of the press.

During one of these periods of interruption recourse was had to a method of electrical heating with such good results that the use of steam was abandoned altogether. In brief, the method consisted in magnetizing the molds with alternating current at 60 cycles. As these molds are always made of steel and generally hardened, they will heat up rapidly under these conditions, due to induced electric currents in the various parts of the molds, and also in some measure to hysteresis losses, especially in the hardened parts.

The method as at first used was simple in the extreme. The coil was made of 100 turns of No. 6 asbestos-covered wire, and when in operation its terminals were connected by a switch

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directly to the 220-volt supply line. With molds weighing 10 to 15 lb. a curing temperature could be reached, starting cold, in from 3 to 5 min. It should be understood that under the conditions of working the magnetizing coil remains quite cool.

The heat is developed in the interior, though mostly near the surface, of the molds. If the current is left on indefinitely a temperature destructive to the molding material results. This necessitates some way by which a definite result may be secured. Generally, it is sufficient to make trial pieces, noting the time of heating of each by a watch or clock. A good method of gaging the temperature of the molds is to observe the color of sulphur when melted in contact with the mold. A better material is a cane-sugar syrup with a little blue litmus, which clings to the hot molds and chars to a tobacco-brown when the temperature limit has been reached.

A study of the heating action in detail is interesting. Referring to Fig. 1, P' and P'' are the cast-iron platens of the press, M the matrix, and K' and K'' the plugs by which the molding material D is pressed in the matrix. C is the current-carrying coil. Since the magnetic field is the means of carrying the energy to the mold, it will be seen by those familiar with electromagnetism that the part of the mold in the plane of the coil heats most rapidly. The ends of the mold in contact with the platens lose heat rapidly, so that it was found well to protect them against such loss by asbestos or pasteboard sheets at Z. Next, several coils of different proportions were made, long ones for the longer molds and flatter ones for the shorter ones.

It was found inconvenient to lift the hot molds from the interior of the coils, so a further improvement was made in which the coils were divided into two halves and mounted as shown in Fig. 2, in which letters designate the same parts as in Fig. 1. This arrangement gives good heating throughout the mold regardless of the shape. In fact, there is a little greater heating at the ends, which compensates for loss by

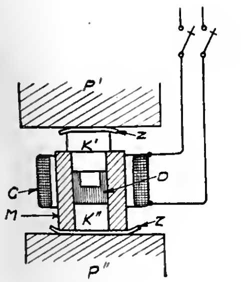

Fig. 1 Elementary Arrangement of Heating Coil

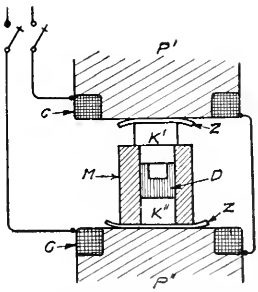

Fig. 2 Improved Arrangement with Coils Above and Below

conduction. The plates P' P'' were fitted with laminated-iron sections so that a path for the magnetic flux in them, which would not develop heat, could be provided. Fig. 3 is a photograph of the press fitted with these coils. It is evident that the molds could be put into or removed from the press thus fitted as readily as from an ordinary press.

In all of these arrangements the magnetic return circuit consists of leakage through the air and through the massive parts of the press, in all of which the magnetism is so diffused that the energy loss is small. This is clear from the fact that such losses are a function of the square of the magnetic density and the electrical conductivity of the material. Cast iron being of low conductivity, losses in the heavy parts of the press are necessarily very small. Cast iron would not be a good material from which to make the molds. It is evident that the thermal efficiency of this method is comparatively high. The writer has good reason to believe that more than half of the heat which is developed makes its appearance in the mold.

By the induction method of heating it is possible to pile several thin molds on top of each other and heat them all at once. This is not possible by any other method. By this

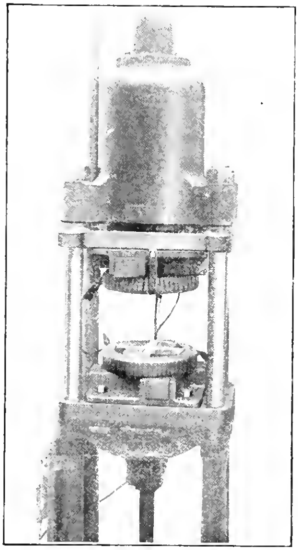

Fig. 3 Hydraulic Press Fitted with Coils as Shown in Fig. 2

means one press can be made to produce several articles simultaneously.

In making molded insulation the cost of molds is frequently very great. By the induction method of heating the cheapest possible mold can be used, since it is never necessary to so shape it as to admit steam to it, or so as to favor the flow of heat into it from any external source.

Many electrical engineers would regard the low power factor at which such devices operate as a serious drawback. However, the writer regards it as an important advantage in that a steadying effect on the circuit is produced, so that whether a large mold or a small mold, or no mold at all, is placed in the coil, no harmful result will follow, the large size of wire used being sufficient for the current at all times. Measured up in terms of value received for the outlay and freedom from trouble and general convenience, the process was entirely satisfactory. A press having a better magnetic circuit which would have operated at a power factor comparable to that of an induction motor could have been made at a greater cost, but the extra cost would have exceeded the saving possible during the time the above apparatus was in use, which was about one year.

It is believed that other uses might be made of this process; for example, die castings of readily fusible metal might be made economically on a small scale; or hardened-steel parts might be tempered, in which case the temper could be drawn without overheating sharp angles and cutting edges.

NEW THEORY OF AIR-PROPELLER ACTION

By MORGAN BROOKS, URBANA, ILL.

Member of the Society

THE term air screw, considered by many writers on aeronautics as descriptive of propeller action, is a misnomer. The theory of the marine propeller, which seems to be adequately presented by the screw principle, has been transferred to air propulsion without sufficient regard for the extreme difference in the two fluids as to elasticity.

In view of the current theory that air is driven by a propeller with a velocity which should not exceed the product of the pitch of the propeller by its revolutions, it was a surprise to find that air may be driven backward at a velocity nearly twice as great as this product indicates. The fact was so revolutionary that it caused the greatest care in measurement before its acceptance. Recognition of this superspeed action of propellers explains many anomalies of air propulsion and will undoubtedly lead to more exact formulæ for thrust and power calculations.

The purpose of this paper is to give proofs of the above possibility and to point out some of the applications of superspeed theory as it relates to propellers and blowers.

Superspeed is not readily observant with the standard type of two-blade propeller owing to the masking of this effect by the mingling of high-speed air with a much larger quantity of inert air lying between the propeller blades. Therefore the measurements were made upon a special type of propeller having extremely short blades of great width, sweeping the entire circumference of the disk area.

A propeller of the wide-blade type described having an experimental mean pitch of 2.53 ft. gives a wind on static test that flows 3.33 ft. per revolution, regardless of the speed of the propeller. These values were determined for the writer by Prof. E. P. Lesley at the Leland Stanford Jr. University wind tunnel, confirming the writer's own measurements. The superspeed ratio, 3.33/2.53, is 1.32, and these figures bear so direct a trigonometrical relation to the blade angle as to suggest that air instead of being swept backward by screw pressure is driven back by precise reflection or batting action.

The reflection theory is supported by data obtained with a blade of 28 deg. angle and by other confirmatory tests. In this connection an investigation was also made of the more complex condition of a propeller operating in a wind tunnel with wind conditions corresponding to those on a flying plane.

Among other things it was found that for low blade angles, where the superspeed ratio is more pronounced, the air leaves the propeller at higher velocity near the blade tips than part way in, a condition inconsistent with the screw theory for standard-type constant-pitch propellers.

Eiffel in his "Recherches" presents an elaborate collection of data showing that this condition exists, but the reflection theory for the first time explains it.

Light ribbons placed in the air flow from a static propeller show that the air moves in a direction strictly perpendicular to the blade angle, a condition determined by the reflection theory but not by screw action. Moreover, these ribbons indicate that the stream contracts slightly in diameter as it leaves the propeller, whereas with the squeezing action of a screw the air would be expected rather to expand.

The most convincing demonstration of the fact that the air leaves a propeller at a greater velocity than the propeller screw advance is found in a test made with two propellers connected in tandem. Calling the forward propeller a blower for the sake of distinction, assume that it provides a wind at 30 miles per hour, or 44 ft. per sec., and that the propeller is driven by this wind at a speed just above idling speed, such that its revolutions times pitch is, say, 48 ft. per sec. An anemometer shows a velocity of about 50 ft. per sec., but if the blower be shut down while the speed of the propeller is maintained constant, the wind velocity rises to 75 ft. per sec. instead of remaining constant as demanded by the screw theory.

The acceptance of superspeed action gives a basis for the evolution of dynamic thrust equations without the questionable assumption of blade activity over a larger portion of the propeller disk than that covered by the blades alone. The proper interpretation of superspeed may reconcile thrust and power values as derived from static tests with those of wind tunnels or of flight. Today it seems to be the common opinion that flying performance may not be predicted from static tests. With the precise air-dynamics formulæ sure to be developed, a single static test of a propeller should furnish all necessary data for the production of complete flying-performance curves.

The writer shows analytically that apparently the wind-tunnel blower relieves the propeller of a portion of the static thrust at a given propeller speed represented by idling speed, even though the propeller giving superspeed sends air backward when tested statically at the speed V/p, where V is plane velocity and p the propeller pitch. The writer shows that under his formula the flying thrust at 30 per cent slip is found to be 51 per cent of the static thrust at the given propeller speed.

The writer does not believe that correct air-dynamics formulæ will produce essential changes in propeller design, but hopes that the paper may lead to a clearer conception of the underlying physical principles of air propulsion.

For presentation at the Spring Meeting, Worcester, Mass., June 4 to 7, 1918, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. The paper is here printed in abstract form, and advance copies of the complete paper may be obtained by members gratis upon application. All papers are subject to revision.

A HIGH-SPEED AIR AND GAS WASHER

By JOHN L. ALDEN,[1] WASHINGTON, D. C.

Member of the Society

THIS paper describes a new type of air and gas washer which has been developed within the past eighteen months, and which offers the following advantages over the existing types:

1 The washing can be continued to any desired degree of cleanliness.

2 The washer will handle unusually large quantities of dust or long fiber without clogging, owing to its large passages and entire absence of eliminators.

3 Due to the high washing efficiency, the water consumption is very low, from 1 to 2 gal. per 1000 cu. ft. of air.

4 The washer is extremely small and compact, and of light weight. A 10,000-cu. ft. washer is about 5 ft. long, 5 ft. in diameter, and weighs less than 400 lb.

In this paper the term "air" will be used to include any

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gaseous fluid or vapor for which cleaning apparatus may be suitable.

The writer has believed for some time that air washing and gas cleaning have been approached from the wrong angle, and that most builders of apparatus for this purpose have not taken advantage of all of the natural laws governing the depositing of air- or gas-borne particles. The result has been the general adoption of crude and unmechanical designs, and has made necessary the use of low velocities of gas through the machine. Gas scrubbers normally operate at a velocity of about 90 ft. per min. and air washers at from 400 to 500 ft. per min., while with these devices the limiting velocity for good washing and a reasonable frictional resistance is about 1000 ft. per min. The washer about to be described operates habitually at from 2000 to 5000 ft. per min. As the efficiency of air cleaning in this type increases rapidly with the velocity, the only limit to the latter is the resistance imposed.

Fig. 1 represents a longitudinal section of the air washer referred to above. A helical passage is constructed within a horizontal drum, provided at one end with a tangential inlet for the dirty air and at the opposite end with an outlet for the purified air. That portion of the helical passage nearest the inlet constitutes the washing chamber, while the remainder comprises the eliminating element. On the inner wall of the helical duct are suitable spray nozzles which spray across the column of air. Depending upon the amount of dust to be removed and the completeness of washing desired, the air makes from 1¼ to 5 screwlike revolutions in passing through the helix from inlet to outlet. For fairly dusty air or for the ordinary dust-collecting system, two turns are sufficient. The whole or a portion of the first turn is used for washing while the last turn is employed for the elimination of the free moisture.

The common commercial air washer with which we are all familiar depends upon its spray nozzles to throw down the dust particles and upon the eliminator plates to catch and retain the particles which have not actually been met by the sprays. The immediate result is low washing efficiency, if we consider water consumption as a measure of washing efficiency. In the first place, it takes an enormous quantity of water divided into a large number of small drops well distributed over the entire washing area to insure the wetting of any considerable portion of the dust. It is necessary that each particle of dust deposited be brought into intimate mechanical contact with a drop of water. The deflection of the air currents through the zig-zag eliminator plates introduces a very limited amount of centrifugal washing when the eliminators are kept flooded. On the other hand, a washer depending upon centrifugal force alone to throw the dust particles out of the air column is limited to the handling of the coarser dusts and will not remove the minute particles which make up the bulk of the dust content of the atmosphere. The washer described in this paper makes use of both spray and centrifugal washing, with the greater dependence placed upon the latter. As the dust-laden air enters through the tangential inlet pipe it is thoroughly wetted by the mist of the spray chamber. Much of the coarser dirt is removed by the direct action of the spray. As the air is whirled through the helical conduit a large proportion of the remaining dust is thrown against the wet curved side of the washer, flowing off to the drain with the spent wash water. The extremely fine dust still remaining cannot be caught by ordinary means, for it is too light to be separated by centrifugal force. However, a considerable amount has been exposed to the mist to such an extent that, although not actually wet, its specific gravity has been increased by the moisture to a degree which will permit its removal centrifugally. Thus, an unusually high proportion of the dust content is removed.

After the washing operation the air passes through the eliminating portion of the washer, where it is freed of the suspended moisture. The elimination of water drops is effectually accomplished by centrifugal action, exactly as the dust itself was removed. It is unnecessary to introduce into this washer any form of eliminator plates such as are found in most commercial washers.

The high washing efficiency thus gained presents two possibilities, either of which is decidedly advantageous. Extreme dust conditions may be met with comparative ease; or, street air may be washed for ventilating purposes with an unusually small amount of water. One of the smaller sizes of these washers handles 4000 cu. ft. per min. of dusty air from a dust-collecting system, and from 50 to 100 lb. of mud is removed daily from the strainer basket. From 4 to 6 gal. of water per minute wash this dirty air to a sufficient degree of cleanliness to permit it to be returned to the room. While no measurements have been made of the dust content, this air has absolutely no dusty odor and has a decidedly pleasant, fresh "feel." These results, obtained from a practical commercial washer, not a laboratory product, show that air sufficiently dirty to show a decidedly smoky dust cloud can be washed with from 1 to 1½ gal. of water per 1000 cu. ft. That this air washer is clearly a step forward is shown by these figures, for the standard washer requires from 4 to 5 gal. per 1000 cu. ft. to successfully wash air which is initially much cleaner than that on which the centrifugal washer was tested. Where it is impossible to recirculate the wash water, the economy in water alone is an appreciable item. For a machine to handle 10,000 cu. ft. of air per min. this amounts to 20,000 gal. per day of 10 hours. In addition to the actual cost of the water, the cost of pumping and the initial cost of pumps, motors, piping, etc., is considerably reduced.

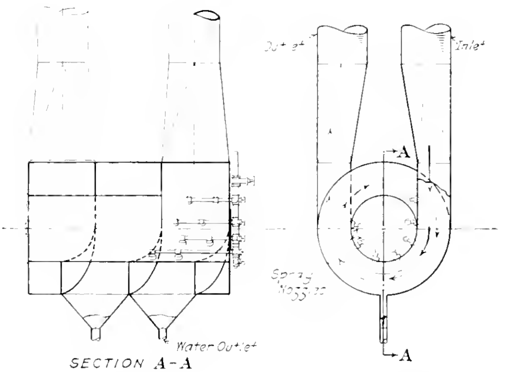

Fig. 1 Centrifugal Air Washer Shown in Section

Any material which may be separated from air by means of washing may be removed in this type of washer in any practical degree of thoroughness desired. This is accomplished by increasing the number of turns of the helical washing space. Thus, for ordinary ventilating purposes, 1 to 2 turns are sufficient; for dust collecting, 1½ to 3 turns; while for extremely fine dust, from 3 to 5 or more turns must be used. The economical limit is probably about 5 or 6 turns, or convolutions. The overall length, as determined by the number of turns of the

screw-shaped conduit, depends, therefore, upon the degree of purity of air desired, and to a very much less extent upon the relative arrangement of inlet and outlet. The outside diameter, on the other hand, depends upon the air volume. Since centrifugal force plays such an important part, the size of the washer is greatly reduced because the efficiency increases as the diameter decreases. In addition, the efficiency increases very rapidly with the higher air velocities. Both factors tend toward the production of a small, compact washer. The reason is very evident from the expression for centrifugal force:

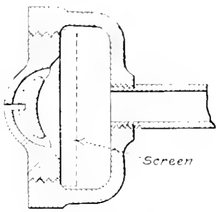

FIG. 2 SPRAY NOZZLE FOR USE IN AIR WASHERS

$F = mv^2/r$, where v = air velocity, ft. per sec., r = radius, ft., and m = mass. Thus, if satisfactory cleaning is done with a washer of 2 ft. mean radius of the washing chamber at 3000 ft. per min. velocity, an 8-ft. washer would require a velocity of 6000 ft. per min. to give equally good cleaning. It is therefore desirable to make the diameter of the washing drum as small as possible and at the same time use as high a velocity as is consistent with a reasonable friction loss. Owing to the fact that with increased diameters higher air speeds must be used to give the same cleanliness, it is probable that the practical limit of size for ordinary air washing is between 15,000 and 25,000 cu. ft. per min. High-speed air washers may be built in sizes as small as 100 cu. ft. per min., but both the upper and lower limits of size may be extended to meet unusual requirements. Table 1 gives the approximate dimensions of centrifugal air washers to be used for ordinary ventilating purposes. For other and special cases the dimensions will, of course, be different. It will be seen that in every case the washers are very small for the capacity; those already built and installed have been so small and light that they have been hung from the ceiling with band-iron straps, leaving ample headroom beneath.

TABLE 1 APPROXIMATE DIMENSIONS OF CENTRIFUGAL AIR WASHERS FOR VENTILATING PURPOSES[1]

Capacity, cu. ft. per min	Diameter, inches	Length, inches
2,000	30	36
4,000	40	42
6,000	48	52
9,000	56	60
12,000	64	72
16,000	72	80
22,000	80	90
30,000	96	108

[1] The exact dimensions vary with the air volume, the character of the dust, the relative positions of the inlet and outlet, etc.

The new washer described in this paper will supply a field hitherto untouched by the standard air washer. The latter is utterly unsuited to the handling of large quantities of fibrous materials, cotton, jute, hemp, wool, and miscellaneous waste. Large amounts of fine dust, shavings, or any other materials ordinarily handled by exhaust systems are beyond the capability of the common air washer. These substances will either clog the eliminators or will pass completely through the ordinary commercial machine. On the other hand, it is extremely difficult to clog the centrifugal air washer with dirt and refuse, owing to the large passages and to the entire absence of eliminator plates or other obstructions. It is unnecessary to interpose between the washer and the source of dust any form of dust collector or rough washer. Since the dirt and water are removed at each convolution of the helix, there is no accumulation of water and material to be reëntrained by the air current. This is an essential feature where the centrifugal removal of free moisture from a high velocity current is attempted.

With the air flowing through a rectangular passage, it is desirable to throw a flat spray of water across the channel. After considerable experiment with a variety of forms, the nozzle shown in Fig. 2 was designed to fulfill these requirements. The spraying tip is part of a removable plug containing two holes designed to throw opposing streams. The impact of the jets forms a flat sheet of spray at right angles to the plane of the holes. Although this spray is quite fine, much of it is further broken into mist upon striking upon the opposite wall of the washer. Locating the spray nozzles upon the inner wall of the chamber makes it necessary for all of the dirty air to pass through this fog-filled passage. This arrangement is much superior to that whereby water is allowed to flow from perforated pipes or nozzles over the outer cylinder alone, as it insures a thorough wetting of the dust taking place.

The pressure loss through the washer is from ⅛ in. to 1 in. of water, depending upon the conditions governing the design. The variables to be considered are the diameter, the cross-sectional area and proportions of the washing space, the velocity, the number of turns of the helix, and the volume of water per square inch of the sectional area of the washing chamber. Ordinarily, this washer can be designed for ventilating work with a resistance of about ¼ in. of water. Where the dust requirements are more severe, demanding higher velocities, more wash water and a greater number of convolutions of the helix, the loss will be somewhat greater.

Unfortunately, the writer is unable to give additional details of the performance of this washer, as his investigation of the first commercial installation was interrupted in May 1917 by the war. However, it may be said that two others were built from his design, and although he has not seen these either during construction or operation, they are reported by the owner to be in successful operation. Each of the later washers has a capacity of 15,000 cu. ft. per min., and was designed to hang from the ceiling with 7 ft. of headroom beneath. This type of washer was designed and developed for a specific job, that of washing the clouds of dust from the fan blast of dust-collecting system, leaving the air fit for breathing. The first experimental installation and the subsequent machines showed that for this purpose the washer was eminently satisfactory. The severe test of dust-collecting work, removing great quantities of dust from the air and returning the purified air to the room, justifies the belief that the centrifugal washer will easily satisfy ventilating requirements. Owing to the similarity of refined dust washing and blast-furnace-gas scrubbing, an investigation of the adaptability of this washer to gas cleaning would seem well worth while.

A SELF-ADJUSTING SPRING THRUST BEARING

By H. G. REIST, SCHENECTADY, N. Y.

Member of the Society

THRUST bearings for supporting the heavy loads of water wheels and the electric generators driven by them, are now very widely used. The difficulties in the fitting and use of plate bearings are much aggravated as the weight is increased, on account of the large overall dimensions of the supporting plate. It is true that the surfaces can be fitted quite accurately by machining, but the writer has known cases where the surfaces were turned slightly conical so that they touched hard on the inner or the outer edge. The deflection of the supporting collar on the shaft may allow the runner to be slightly dished, or there may be a deflection of the supporting surface, thereby dishing the babbitted seat or causing one side to be lower than the other. The self-adjusting spherical seat provided to correct some of these difficulties is of doubtful value on large bearings on account of the great frictional resistance which must be overcome to make it shift.

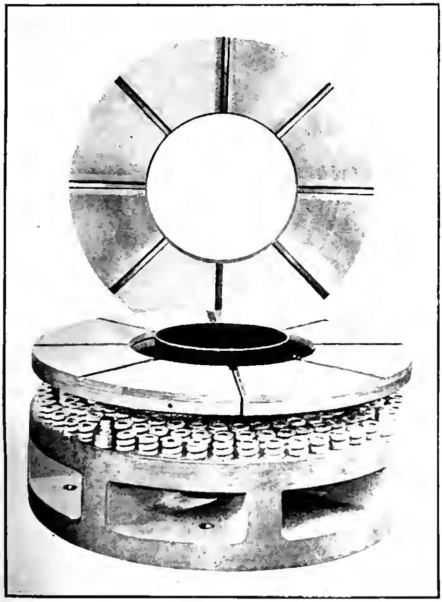

FIG. 1 SPRING THRUST BEARING, FOR VERTICAL WATERWHEEL-DRIVEN GENERATOR, TO CARRY A LOAD OF 300,000 LB. AT 100 R. P. M.

(View shows rubbing surfaces of both rotating and stationary rings, the latter being raised to show the arrangement of springs)

Thrust-bearing surfaces are usually scraped to each other, or to a surface plate, to avoid dangerously high spots; but, since the oil film is of the order of 0.0002 in. to 0.0003 in. in thickness, the difference in level must be smaller than these values. This work must usually be done without load, and no matter how carefully done, when the bearing is loaded the parts will probably not fit each other, due to deflection.

A careful study of the above difficulties led the writer to the design of a flexible bearing surface pressed against the runner by springs. It seemed that this would prevent the possibility of undue pressure at any point, and compel each element of the surface to carry its share of the load. On trial, this solution proved satisfactory.

A typical design of a spring thrust bearing for vertical-shaft machines is shown in Fig. 1. The bearing consists of a runner of a special grade of cast iron resting on a thin steel ring with a babbitted surface. The babbitted stationary ring, in turn, rests on short helical springs and is held against rotation by dowel pins. A saw cut through one side eliminates any tendency of the ring to dish with a change in temperature.

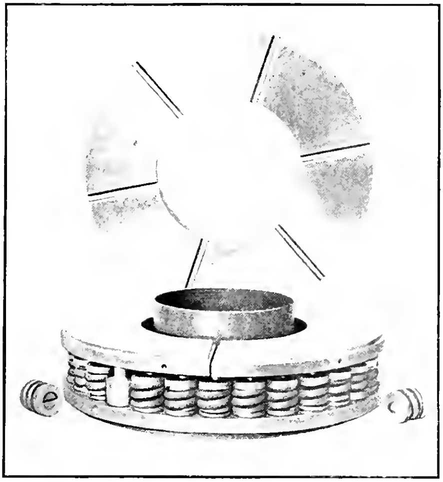

FIG. 2 SPRING THRUST BEARING WITH "COMPRESSED SPRINGS" FOR MACHINES HAVING SMALL CLEARANCES

(The stationary babbitted ring is raised to show springs and dowel pin)

The high base ring shown, on which the springs stand, is often used in connection with a deep housing to increase the amount of oil in the surrounding bath. The tube in the center forms a retaining wall around the shaft, for the oil. The springs ordinarily used are wound of $\frac{1}{2}$-in. round wire and have an outside diameter of 2 in. and a free length of $1\frac{1}{2}$ in. Under load the springs close about $\frac{1}{16}$ in. and the total pressure is well distributed. By this means it is possible to avoid excessive pressures at any point. Thus, it is safe to run with a much higher average pressure than when there is no definite limit to the pressure which may occur over a small area.

It will be seen that this type of bearing differs from the solid-ring thrust bearing in that one of the bearing surfaces is made to yield at any point by using a comparatively thin plate supported by a large number of springs. While solid bearings may be used successfully for small loads, a bearing which thus automatically adjusts itself to faults in finish and in alignment is preferable for carrying very heavy weights.

Oil grooves are provided in one of the members and sometimes in both. In order to insure proper circulation of the oil

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for cooling purposes, in the case of bearings operating at low speed it is necessary to have grooves in the rotor. On high speeds these grooves may sometimes be omitted, relying for circulation only on the friction of the rotor on the oil while passing the grooves in the stator. In many cases we have had very satisfactory results by placing radial grooves in both the rotating and the stationary surface. It is our practice to have different numbers of grooves in the two plates, for instance, six and eight. With grooves in each of the surfaces we have a continuous flooding of oil on all the bearing surfaces and a very effective means of cooling. Much of the heat would otherwise have to be transmitted through the metal of the stationary part of the bearing.

The pressure usually allowed on these bearings is from 300 to 400 lb. per sq. in., the design permitting a very thin oil film without metallic contact. It is necessary to have the runner very smooth and free from scratches, especially any at an angle to the direction of rotation, as these might cause injury to the babbitt. The babbitted surface does not need to be scraped but is turned with a tool as smooth as is convenient. Wearing sometimes occurs in minute spots all over the plates. When this happens, there is no risk of dragging the metal. The bright spots that show themselves are produced while starting and slowing down, before a pressure film is formed. When in operation the weight is apparently entirely supported on the oil film.

It is desirable to run bearings at a high pressure if they can be designed to do this safely, as the parts then are smaller, the rubbing speed is less, and the friction very much reduced. With this design of bearing the tendency to excessive pressure at one point is automatically relieved by the springs yielding, and while there will be some uneven distribution, a variation in pressure of two or three times the average is comparatively unimportant and does not cause bearing failures,—it is pressures of twenty or more times the average that cause injury. These excessive pressures are prevented by the construction just described. For this reason it is safer to operate this bearing with high pressures than a more rigid bearing at lower pressures.

The loss of alignment due to settling of foundations or other causes does not affect the bearing adversely. In one water-wheel-driven alternator installation the striking of the field against the armature led to the discovery that the coupling between the two units had loosened, which allowed the shaft to "run out." The bearing operated without injury with over 0.03 in. vertical movement of the outer edge of the rubbing surface. This caused an uneven distribution of load on the bearing, to the extent of reducing the load on one side of the bearing about 16 per cent, and increasing the pressure a similar percentage on the extreme opposite side.

An advantage of increased pressure in the reduction of friction is shown by the following table of comparison:

Bearing number	1	2
Rev. per min.	200	200
Total load, lb.	300,000	300,000
Outside diameter of bearing, in.	35	46
Inside diameter of bearing, in.	17.5	17.5
Net area, sq. in.	600	1200
Pressure, lb. per sq. in.	500	250
Average rubbing speed, ft. per min.	1370	1670
Coefficient of friction	0.0018	0.0033
Kilowatt loss	16.7	38
Horsepower loss	22.5	51

In some designs the vertical clearance between the water wheel and the casing is very small, so that the displacement caused by a free spring under the variation of hydraulic suction is objectionable. In such cases an initial compression equal to full load, or to an overload, is put on the springs. The load will still distribute, since an overload at any point will cause the spring to close beyond the initial compression. Such a bearing is shown in Fig. 2. However, this bearing was designed to replace a roller bearing, and was so made that the parts of the water wheel would occupy the same relative positions as before. The principles used in the construction of these thrust bearings are applicable also to journal bearings and to bearing surfaces having a reciprocating motion, like the crosshead of a steam or gas engine.

CORRESPONDENCE

CONTRIBUTIONS to the Correspondence Departments of The Journal by members of The American Society of Mechanical Engineers are solicited by the Publication Committee. Contributions particularly welcomed are suggestions on Society Affairs, discussions of papers published in The Journal, or brief articles of current interest to mechanical engineers.

The High-Speed Motor and the Fuel Question

To the Editor:

In the past three or four years automobile engineers have developed a modified type of gasoline motor with piston speeds greatly in excess of what was considered proper and safe before.

Several causes are back of this development: first, the ability of the forging plants of the country to produce crankshafts with integral counterweights, which reduce the pressure on the bearings to a safe limit; second, the demand for smoother-running engines; third, the work done to develop lighter and more efficient power plants.

For some time it has been a question in the mind of the writer whether, in that search for higher speed, a cardinal point has not been overlooked—to the detriment of motor efficiency—in failing to take into account the vaporizing qualities of the fuel at our disposal during the past years.

In discussing this question of high-speed motors and fuel it must be remembered that the high-speed motor originated in Europe with the racing motors brought out by European designers in 1912, 1913 and 1914; and as the gasoline which they used was of a very high grade, they were successful in developing that type of motor; but our fuel being of a much lower grade, principles of design that can be used in Europe do not apply to conditions on this continent.

It is a fact that the quality of fuel sold as gasoline to the automobile owner has been gradually declining year by year. The enormous demand made upon the oil industry for a volatile fuel has resulted in the marketing of a fuel containing less and less of the main volatile elements of gasoline. The gasoline of the early days consisted mainly of pentane, hexane and heptane—elements which are very volatile and, conse-

quently, easily vaporized. Until 1914 the gasoline used in Europe was of that composition, while ours had already started on the decline. Since that period gasoline has passed from a by-product of petroleum to a main product, and therefore the heavier elements of petroleum have had to be incorporated in increasing volume to keep up with the demand. These elements comprise octane, nonane and decane, which are hard to ignite when mixed with air. However, if heat is applied to them before admitting them into the cylinder their inflammability is very much improved. These points being kept in mind, let us see what happens when we try to run a high-speed engine with these grades of fuel.

Not so very long ago 1000 ft. per min. was considered an average and efficient piston speed, but automobile designers, for the reasons stated above, tried to increase piston speeds to a point near 3000 ft. per min. Without entering into details of the improved lubrication necessary to take care of the increased friction, we find that the time given to the explosive mixture to reach the cylinder, to be compressed, exploded, and evacuated, has been reduced to one-third of what it was formerly. If the fuel used was very volatile, as the gasoline of older days, we might still consider it possible to burn the full charge of gas in the cylinder and evacuate it. But the fuel being much poorer, we think it is a physical impossibility to mix properly an explosive gas and burn it entirely in the limited time left for the explosion to take place. This is proved practically by the reports received from users of cars, principally of the higher-speed types. It is found that a portion of the mixture does not burn: it passes by the piston rings and goes down into the crankcase, where it dilutes the oil to the danger point, resulting in burned-out bearings and seizing of parts subject to friction. It is therefore evident that a speed of 3000 ft. per min. for pistons is not practical. Let us see what piston speeds we find in the best-developed engines at the present time.

It is a recognized fact that the highest form of gasoline motor today is the engine used in aeroplanes at the front. A comparison of the piston speeds used in the most modern battleplane motors of France, Germany, the United States and England discloses the fact that the highest piston speed maintained does not exceed 2000 ft. per min., and is closer to 1600 ft. per min. than to 2000—nearly half the piston speed used in the so-called high-speed motors. There is room for thought in this. It is our own opinion that these speeds are even a maximum which the commercial automobile motor used in either passenger cars or trucks should not exceed, and engineers who will study these motors in the future with this idea in mind will be more successful with their product than those who cling to the high-speed principle.

This fuel question is so complex that some other points have also to be considered. We shall mention the most important one—the starting of a motor in cold weather. Every one who is familiar with the driving of an automobile knows that in the cold morning temperatures which we experience on this continent great difficulties are encountered in starting the motor with some types of cars. Some of them will start easier than others, but from the writer's experience the starting qualities can be improved greatly by reducing the section of the inlet passages into the cylinders to permit of higher gas velocities. Also, if the carburetor is set very close to the cylinder, permitting the heat of the exhaust to warm up the inlet pipe, still better results can be obtained. The reducing of the inlet passages by tapering them gradually into the cylinder produces a better mixture which is exploded more readily with less residue and less carbon deposits in the explosion chamber and on the spark plugs. The writer has applied these principles to several engines designed in the past four years with marked success, and he has at the same time tried to limit the piston speed in these motors to a maximum of 1600 ft. per min., this design being in line with the ideas set forth above.

We are of the opinion that the qualities which attracted designers to the high-speed idea in gasoline motors can be taken care of as well with the slower types of engines and permit at the same time a better solution of the lubrication problem.

E. Planche.

Flint, Mich.

Report on Pulverized Fuel

To the Editor:

I am enclosing an abstract of a report recently made to the President of the U. S. Shipping Board, on the use of powdered fuel for marine purposes. This report was prepared by the Fuel and Fuel Handling Committee of the Naval Consulting Board, of which the writer is chairman, in response to the following resolution by the Naval Consulting Board, November 17, 1917:

Resolved, That in view of the efficiency, economy and smokeless conditions which would accompany the use of powdered coal on ships, the Naval Consulting Board recommends to the United States Shipping Board that a thorough investigation be made of this subject and a trial plant be installed.

Spencer Miller.

New York, N. Y.

Abstract of Report

Pulverizing coal as a fuel is extensively employed in the arts for smelting, for burning portland cement and to a limited extent for generating steam. It is estimated that 50,000,000 tons of coal has been pulverized and consumed within recent years in the United States. In stationary practice definite economies have been claimed over the use of solid coal. From the above it appears that the art of pulverizing and burning coal as a powder has passed the experimental stage in certain arts.

From evidence placed before us pulverized coal is a smokeless fuel, a fact of considerable military importance.

By a simple and immediate adjustment of the burners, powdered coal as a fuel may be made to emit dense clouds of smoke to serve as a screen, another fact of military importance.

In an emergency the ship's boilers may be rapidly forced, thereby increasing the steam supply and the speed of the vessel. This is a fact of military importance.

A great reduction in the fire-room force is effected over using solid coal. This saving in man power has military value.

The supply of fuel oil in the United States is limited, and as a means of conserving fuel oil for naval vessels equipped to burn oil exclusively the Consulting Board feels justified in encouraging the use of powdered coal as a fuel for merchant ships.

The Fuel and Fuel Handling Committee was canvassed to vote upon the two following questions:

a Is it feasible to carry powdered coal on merchant or naval vessels such as would be used in transatlantic service?

One replied in the affirmative and three in the negative.

6. Is it feasible to install on any such ships apparatus to powder coal?

Four replied in the affirmative and one in the negative.

From the above it will be noted that, in the opinion of the Committee, which has been approved by the vote of the Board, it appears feasible to equip merchantmen with requisite machinery for pulverizing and burning coal, and we therefore earnestly recommend that the Emergency Fleet Corporation authorize the preparation of the necessary plans and drawings for such an installation upon such ships, and that a shore installation be made of such equipment to determine as well as may be the value of such an installation on board ship. Such shore installation can be set up and tested at the Annapolis Experiment Station, Annapolis.

A ship equipped with pulverizing equipment should, in the opinion of the Naval Consulting Board, be expected to take on coal in any port of any kind available and by the ordinary methods. In Atlantic ports this will be run-of-mine bituminous of high volatile and of high grade, sometimes dry and dusty and at other times quite wet.

Such coal on board ship, following shore practice, would then pass through the following processes:

Crushing in power rolls, and delivering to a storage bin.

Drying if found essential to remove the moisture prior to pulverizing, delivering to a second storage bin.

Extraction of iron particles. This being advised to save damage to the pulverizing mill. A magnetic separator is commonly used for this purpose.

Pulverizing, either in Fuller or Raymond mills or their equivalent, then storing in a third storage bin.

Mixing with air, feeding to furnace and burning.

After delivery of the raw coal to crushers the fuel will be handled by conveyors or spouts. All storage bins, conveyors and spouts must be constructed and maintained dust-tight as a means of preventing explosions, and possibly such may have to be made of non-corrosive material.

The Naval Consulting Board is at your service, and if it be your pleasure to proceed in the preparation of designs, estimates and specifications, we shall be honored by your seeking our aid in the solution of this important problem.

A Suggested Extension of the Scope of A. S. M. E. Transactions

TO THE EDITOR:

The Publication Committees of recent years are to be congratulated upon the character of our publications. There was a feeling of dismay among some members a few years ago when the discontinuance of the TRANSACTIONS was proposed. Happily, this situation has been adjusted, so that there are now only expressions of satisfaction.

It has occurred to me that we could with benefit include in our TRANSACTIONS more papers of general scientific value than has been customary. Such papers would not be of sufficient current interest to be discussed at either local or general meetings, but would be of such character as to be of future value to specialists in particular branches of our field. To use a slang expression, which, as is often the case, conveys a great deal of meaning in a terse way, I plead for the publication of more "high-brow" papers in our TRANSACTIONS. Of course, an innovation is not to be expected during these war times. However, the matter can be discussed and planned for, so as to be in operation by the time the war is over.

Our country is already taking an advanced position in the affairs of the world in many directions. We have, however, been somewhat backward in the matter of learnedness. There are French, English and even German publications extending back a century or so which contain epoch-making papers. Many of these papers had little or no current interest, and yet they are the foundation stones of our present scientific structures. We, in this country, must also lay such foundation stones for the benefit of our posterity if we expect to take the place in the world's affairs which we seem to be seeking. There are in this country at the present time but few places where abstruse mechanical-engineering papers can be published, as compared with England, France and Germany. Hence it seems necessary that our own TRANSACTIONS should be arranged so as to include such papers in greater number. The money put into their publication would, of course, not yield us immediate dividends, but would be a contribution to our successors. The net result of publication of such papers would be references to them by specialists of the future. Our own TRANSACTIONS would then stand alongside those of foreign societies as valuable works of reference. The value of an abstruse paper is measured by the number of times it is referred to in footnotes of later papers.

The lack of a vehicle for the publication of papers of the character described has, of course, discouraged abstruse mechanical-engineering research. The provision of a vehicle would, doubtless, stimulate research.

In order that this plan can be executed, two things are necessary:

(1) To secure an increased number of meritorious papers of the character described;

(2) To arrange for their publication.

Progress in either one of these directions will, of course, assist progress in the other. Our Secretary, Editor and Publication Committee are already in touch with various research laboratories engaged in mechanical-engineering work connected both with colleges and commercial establishments, and are endeavoring to secure papers from them. This effort should be assisted in every way by the membership. Many commercial establishments have been very broadminded in recent years in allowing the work of their research laboratories to be published. I have no doubt that papers from such sources will increase, particularly as there seems to be an increase in the amount of commercial research work being done.

After such papers have been secured they might be passed upon for publication by our Research Committee. The Meetings and the Publication Committees would then pass on to the Research Committee a paper which they decided was not of sufficient current interest to be read and discussed at a meeting. The Meetings Committee, of course, read a paper from an entirely different point of view from that of the Research Committee. If the Research Committee decided that the paper was meritorious, from their point of view, they would direct the Publication Committee to publish it. Such an arrangement would also give the Research Committee more direct responsibility in regard to securing such papers.

I understand that it has already been proposed that papers of the character referred to be printed in advance form, circulated previous to a meeting, read by title only at a meeting with request for written discussion, and published in the TRANSACTIONS if it finally seems advisable. If the Research Committee were made responsible in such matters they would direct the Publication Committee regarding both advance and final publication.

I have no doubt that a very satisfactory arrangement of such details can easily be managed if we can secure a sufficient number of good papers of the character described.

SANFORD A. MOSS.

Lynn, Mass.

Urgent Need for the Inventive Ability of Mechanical Engineers

TO THE EDITOR:

In connection with the statement in regard to the work of the War Committee of the Engineering Council, printed elsewhere in this number,[1] I desire to urge that the mechanical engineers of the United States should give their thought and consideration, and above all should put their imagination to work, in order to invent new types of apparatus for waging war. It is the quality of imagination which will count in the fight. It is especially the imagination of the man who is technically trained which is of the greatest value. As a direct method the mechanical engineers of the country should give consideration to and make a study of the various types of weapons now in use, with the object of determining whether these types as they now stand are in fact the ultimate types. This sort of study will unquestionably stir the minds of technically trained men into the invention of many new types of weapons.

The theory on which the War Committee of Technical Societies, of which Mr. David W. Brunton is chairman, is based, is—that if the vast body of technically trained men in the United States could be stirred into consideration of weapons and apparatus of war, then there would be brought forth without question valuable types of weapons and apparatus which are at the present moment unheard of. Most of the present weapons have been brought forth in the manner of slow evolution, as has also been the case in the development of most machines. However, it is believed that by stimulating such an enormous number of minds the period of time of evolution will be shortened. It is further believed that valuable weapons may be produced by the combination of old and thoroughly evolved machines and ideas into new and effective machines.

It must be remembered that past experience has shown that the invention of valuable war apparatus and weapons has by no means been confined to the members of the Army and the Navy. It is a well-known fact that some of the most important war inventions have been those of civilians. This of course is also true in every industry; that is, valuable inventions in any given industry are very often made by men who are in nowise connected with that industry. This is due undoubtedly to the opportunity of the outsider to consider and judge without prejudice.

It is thoroughly well known that previous to the war inventions of civilians in connection with war apparatus were not cordially received by the Army and the Navy, and the situation in this country at that time was such that very few civilians were willing to lend assistance to the Army and the Navy. The day of these conditions is now past, however, and the day of great urgency has arrived. The ideas and inventions of the civilian trained engineer are of the utmost value to the Government and are cordially received. The mechanical engineer must enter into the fight, and he will be welcomed, as will also his ideas if they are good. Furthermore, the old handicap of cost and the handicap of the expense of investigation do not now exist, for the money and the credit have been provided and will be provided to meet the situation.

It is indeed the day of magnificent opportunity for the mechanical engineer!

R. N. INGLIS.

New York, N. Y.

WORK OF THE BOILER CODE COMMITTEE

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York City.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval, after which it is issued to the inquirer and simultaneously published in THE JOURNAL, in order that any one interested may readily secure the latest information concerning the interpretation.

Below are given the interpretations of the Committee in Cases Nos. 187-189, inclusive, as formulated at the meeting of March 28-29, and approved by the Council. In this report, as previously, the names of inquirers have been omitted.

CASE No. 187

Inquiry: Will not a method of suspension for h.r.t. boilers over 78 in. in diameter involving suspension in battery, using channel or I-beam girders resting on brick work with strap hangers and U-rods, meet the requirements of Par. 323, where the weight of the boiler is distributed uniformly and evenly over the setting walls, and very little, if any, of the weight comes on the firebrick lining? It is not believed advisable to place supporting columns of either cast iron or steel in a battery wall.

Reply: It is the opinion of the Boiler Code Committee that, as specified in Par. 323 of the Code, all h.r.t. boilers over 78 in. in diameter must be supported entirely independent of the side walls of the setting, in order that the side walls may be kept entirely free from troubles from settlement and cracking due to the weight of the boiler structure. This practice is known to be extensively followed by engineers, and is believed to be a necessary requirement for safety.

CASE No. 188

Inquiry: Is it allowable under the rules of the Boiler Code to flange the head of a round boiler of $13\frac{3}{4}$ in. radius, $\frac{5}{16}$ in. thick, on a 1 in. radius without heating?

Reply: The Committee considers the practice of flanging heads of boilers cold to be unsafe.

CASE No. 189

Inquiry: Is there a rule in the Boiler Code with regard to the use of single reinforcing straps where this type of construction is used to secure additional efficiency in tube elements? It is believed that by this construction, eccentricity of loading is worked beyond a reasonable limit, and that double straps, internal and external, should be used where reinforcement for tube elements is necessary.

Reply: The Committee agrees that for the particular purpose referred to, a double strap construction is better practice,

[1] Page 402, Society Affairs Section.

but it is deemed inadvisable to make a ruling that would prohibit generally the single strap reinforcement.

REVISION OF BOILER CODE

THE Council of the Society directed that a hearing be conducted in accordance with the recommendation in the Boiler Code that a meeting at which all interested parties may be heard be held at least once in two years to make such revisions as may be found desirable in the Code, and to modify the Code as the state of the art advances. The first of these meetings was held at the Society's headquarters in New York, December 8 and 9, 1916.

The Council also directed that the proposed revisions in the Boiler Code be published in THE JOURNAL, with the request that they be fully and freely discussed, so as to make it possible for any one to suggest changes before the Rules are brought to the final form and presented to the Council for approval. This has been done, and the revisions were presented in the March issue of THE JOURNAL, pp. 234-247, and in the April issue, p. 316, in the form proposed for submission to the Council, except as they may be modified by editing without change of sense. Discussions should be mailed to Mr. C. W. Obert, Secretary of the Boiler Code Committee, 29 West 39th Street, New York, N. Y., and they will be presented and acted on by the Boiler Code Committee. Since the publication of the March issue of THE JOURNAL certain typographical errors have been discovered in the revisions there presented, and corrections of these were published in the April issue of THE JOURNAL; these are supplemented by additional corrections appearing below.

Any further discussions or criticisms, in order to receive consideration by the Boiler Code Committee before the new edition of the Code is published, must reach the office of the Secretary on or before the 15th of May.

PAGE 2

LETTER TO THE COUNCIL.

In the Letter to the Council, after the third paragraph of the matter published in the March JOURNAL, add two new paragraphs to read as follows:

> Your Committee have met monthly for the purpose of considering inquiries relative to the Boiler Code. The procedure in handling each Case is as follows:
>
> All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all members of the Committee. The interpretation in the form of a reply is prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is then submitted in typewritten form to each member of the Council of the Society, and to each member of the Committee. Where a single adverse criticism is received respecting any one of the interpretations, the inquiry is referred back to the Committee. Where there is no adverse criticism, the Council of the Society approves the interpretations which are then issued to the inquirer and simultaneously published in THE JOURNAL. In publishing the replies in THE JOURNAL, the names of firms and parties making the inquiries are withheld. Where there has been urgent need for haste, the Executive Committee of the Council of the Society has acted for the Council.
>
> In accordance with your instructions, each State and Municipality that has adopted the Boiler Code has been invited to appoint a representative to act on a Conference Committee to the Boiler Code Committee, such Conference Committee to consist solely of representatives of the States and Municipalities that adopt the Code. The States and Municipalities have responded by appointing representatives, who have attended the meetings and coöperated in the work of the Boiler Code Committee.

After the seventh paragraph of the matter published in the March JOURNAL, add four new paragraphs to read as follows:

> In the specifications for boiler plate steel, the range in tensile strength in pounds per square inch for firebox steel has been changed from 8000 to 10,000 lb., the tensile strength now specified being from 55,000 to 65,000 lb. per sq. in., which is the same as for flange steel. Your Committee believes that although there are certain features of the specifications for firebox steel which differentiate between the physical properties as compared with flange steel, that there should be a further differentiation. This feature has been taken up with the Sub-Committees of the American Society for Testing Materials, and of The Association of American Steel Manufacturers; but an agreement has not yet been reached. It was considered desirable not to delay the issuance of the revised Code until there could be an agreement; but to transmit the Code to you with the specifications in their present form, with the understanding that as soon as an agreement is reached a supplementary report will be submitted to you for your consideration.
>
> Additional tests for firebox steel, which in the opinion of the Committee would entail the least hardship with a maximum benefit, would be homogeneity tests on the bend test specimens, which are taken transversely from the middle of the top of the plate; the homogeneity tests to be made on the bend test samples after the bend tests are completed, thus requiring no additional specimens to be taken from the plate. Homogeneity tests are now specified for firebox steel on the tension test specimens taken from the lower part of the plate; and in the opinion of your Committee, it would be desirable to make additional homogeneity tests on the samples from the top of the plate where the metal is more apt to be segregated than near the bottom of the plate.
>
> The requirements for the homogeneity tests, at the top of the plate, may necessarily be different from those at the bottom of the plate; and until the requirements for the homogeneity tests at the top of the plate are determined by tests, the specifications cannot be changed to include the requirements.
>
> The rule for determining the strength of diagonal ligaments between tube holes in a drum, which is given in the preceding edition of the Code, has been found to be defective. Experiments have been made with a view of establishing a more exact rule. The experiments so far made indicate that certain theoretical curves which are published herein, in connection with Par. 193, are safe and accurate, and these curves are therefore offered for determining the efficiency of such ligaments. The experiments projected by your Committee are still proceeding, and it is possible that these may finally lead to minor modifications in the curves, in which case your Committee will present a new set of curves to take the place of those now offered.

PAGE 8

PAR. 12. IN THE SECOND LINE OF PAR. 12, CHANGE THE WORD "AT" TO "FOR."

PAGE 10

PAR. 22. CHANGE FIRST LINE OF TABULATED MATTER IN ORIGINAL PAR. 22 TO READ AS FOLLOWS:

> Diameters 1 in. or over but less than $2\frac{1}{2}$ in. . . . No. 13 B. W. G.

CHANGE THE TWO LINES FOLLOWING THE TABULATED MATTER TO READ:

> For each increase of one gage in thickness the maximum allowable working pressure will be increased by 200 lb. divided by the diameter of the tube in inches.

PAGE 12

PAR. 28. DIRECTLY AFTER SECTION *a* IN ORIGINAL PAR. 28, ADD:

b Should the above rule for minimum allowable elongation give a value of less than 24 per cent for firebox steel, the minimum allowable elongation shall be taken as 24 per cent, subject to the modification given in Par. 29.

CHANGE SECTION *b* TO SECTION *c* AND SECTION *c* TO SECTION *d*.

PAR. 31. ALLOW THIS PARAGRAPH TO STAND AS IT APPEARS IN THE PRESENT EDITION OF THE CODE (EDITION OF 1914), CANCELING ALL REVISIONS PROPOSED.

PAGE 44

PAR. 182. CHANGE PAR. 182 TO READ AS FOLLOWS:

182 The distance between the center lines of any two adjacent rows of rivets, or the "back-pitch" measured at right angles to the direction of the joint, shall have the following minimum values:

a If $\frac{P}{D}$ is 4 or less, the minimum value shall be $2\,D$;

b If $\frac{P}{D}$ is over 4, the minimum value shall be

$$\left[2 + 0.1\left(\frac{P}{D} - 4\right)\right] D$$

where P = pitch of rivets in longitudinal rows where a rivet in the inner row comes midway between two rivets in the outer row,

D = pitch of rivets in the outer row less pitch of rivets in the inner row where two rivets in the inner row come between two rivets in the outer row. (It is here assumed that the joints are of the usual construction where the rivets in any single row are evenly spaced.)

PAR. 184. IN SECTION *c* OF PAR. 184 INSERT AFTER THE FIRST WORD "IN" IN THE FIRST LINE THE FOLLOWING WORDS:

"the portion of"

IN THE SECOND LINE AFTER THE WORD "BOILERS" INSERT THE FOLLOWING:

"exposed to the products of combustion,"

PAGE 47

PAR. 193. CHANGE PAR. 193 TO READ AS FOLLOWS:

193 When a shell or drum is drilled for tube holes in the line diagonal with the axis of the shell or drum, as shown in Fig. 12, the efficiency of the ligament between the tube holes shall be that given by the diagram, Fig. 12*a*.

In this diagram the abscissae are $\frac{p}{d}$ and the ordinates $\frac{p'}{p}$, where

p = longitudinal pitch of tube holes, or distance between centers of tubes in a longitudinal row, in.
p' = diagonal pitch of tube holes, in.
d = diameter of tube holes, in.

To use the diagram, Fig. 12*a*, the values of $\frac{p}{d}$ and $\frac{p'}{p}$ are computed and the efficiency for the corresponding point is read off from the diagram. Should the point fall above the curve of equal efficiency for the diagonal and longitudinal ligaments, the longitudinal ligament will be the weaker, in which case the efficiency is computed from the following formula:

a $$\frac{p - d}{p}$$

Examples: 1st, diagonal pitch of tube holes in drum as shown in Fig. 12 = 6.42 in.
Diameters of holes = 4 1/32 in.
Longitudinal pitch of tube holes = 11½ in.

$$\frac{p}{d} = \frac{11.5}{4.031} = 2.853$$

$$\frac{p'}{p} = \frac{6.42}{11.5} = 0.558$$

The point corresponding to these values is shown at *A* on the diagram, Fig. 12*a*, and the corresponding efficiency is 36.3 per cent. As the point falls below the curve of equal efficiency for the diagonal and longitudinal ligaments, the longitudinal ligament is the weaker.

2d, diagonal pitch of tube holes in drum = 6 35/64 in.
Diameter of tube holes = 4 1/64 in.
Longitudinal pitch of tube holes = 7 in.

$$\frac{p}{d} = \frac{7}{4.0156} = 1.743$$

$$\frac{p'}{p} = \frac{6.547}{7} = 0.935$$

The point corresponding to these values is shown at *B*, and it will be seen that it falls above the line of equal

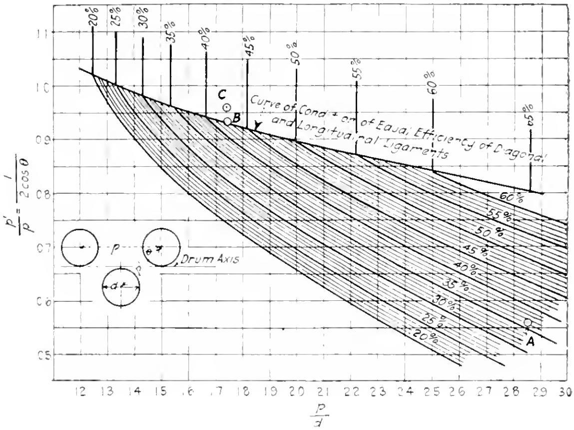


FIG. 12*a*

efficiency for the diagonal and longitudinal ligaments, in which case the efficiency is computed from formula *a*. Applying formula *a*, we have

$$\frac{7 - 4.0156}{7} = 0.426, \text{ efficiency of ligament, or 42.6 per cent.}$$

PAGE 48

PAR. 194. IN ADDITION TO THE REVISION PROPOSED IN THE MARCH SCHEDULE, ADD AT THE END OF PAR. 194 A NEW PARAGRAPH TO READ AS FOLLOWS:

Flanges of domes shall be formed with a corner radius measured on the inside, of at least twice the thickness of the plate for plates 1 in. thick or less, and at least three times the thickness of the plate for plates over 1 in. in thickness.

PAGE 50

PAR. 200. IN THE EIGHTH LINE CHANGE THE WORD "OR" AFTER "DRILLING" TO "OF."

PAGE 51

Par. 203. In Section *a* of Par. 203 in the fourth line, replace the words "by the formula" by the word "as."

PAGE 52

Par. 212. In Section *c* of Par. 212, in the first line, omit the word "internal."

In the last line of Section *c*, which is the last line of Par. 212, omit the letter "R."

PAGE 53

Par. 214. In the fifth line of Par. 214 change the word "shall" to "may," and in the sixth line omit the words, "but not less than 3 in."

PAGE 54

Table 4. In the second line under item *c* change "*c*" to "*b*."

Par. 220. In Section *c* of Par. 220 in the third line insert the word "as" before "given."

PAGE 61

Par. 239. In the new paragraph which is proposed in the March schedule to precede the example, change the words "butt and strap construction" to "butt and single or double strap construction."

PAGE 69

Par. 274. In the fifteenth line after the word "number" insert "and size."

PAGE 75

Par. 296. In the first line of the proposed addition to Par. 296, which appears in the March Journal, insert the following after the word "necessary":

> an exception may be made to the rule that the gage must be arranged so that it cannot be shut off except by a cock placed near the gage and

PAGE 76

Par. 299. In the seventh line, change the sentence following the word "face" to read as follows:

> See Par. 12 for exceptions. For pressures above 160 lb. per sq. in., cast iron shall not be used for boiler pressure parts except for fittings under 2 in. pipe size or equivalent cross sectional area. See Pars. 9 and 245

Fig. 18*a*. Omit the captions, "Bronze or Steel" and "Wrought Iron."

PAGE 79

Par. 332. Insert a sentence at the beginning of Par. 332 to read as follows:

> 332 Each boiler shall conform in every detail to these Rules, and shall be distinctly stamped with the symbol shown in Fig. 19, denoting that the boiler was constructed in accordance therewith.

In the eighth line of the revision of Par. 332 appearing in the March Journal, after the word "and" insert the word "he."

Replace the first two sentences of the second paragraph of Par. 332 by the following:

> Each boiler shall be stamped below the symbol as follows, with intervals of about one-half inch between the lines:
>
> 1. Name of state in which the boiler is built
> 2. State serial number of the boiler
> 3. Name of the manufacturer (and manufacturer's serial number if desired)
> 4. Installation number and name of the state in which the boiler is installed
> 5. Year put into service.
>
> Items 1, 2 and 3 are to be stamped at the shop where built.
>
> Items 4 and 5 are to be stamped by the proper authority at point of installation.

PAGE 80

Fig. 20. Revise Fig. 20 to read as follows:

To be stamped at shop where built	(State in which boiler is built)
	....................................STD
	(State serial number of boiler)
	....
	(Name of mfr.) (Mfr.'s serial No.)
	....
To be stamped in field	(Installation No.) (Name of state)
	....
	(Year put into service)
	....

PAGE 83

Par. 354. Omit Section *b* of Par. 354.

PAGE 85

Par. 361. In the ninth line insert the word "pipe" before "Connections."

PAGE 101

Par. 416. Omit Par. 416, and Figs. 26 and 27.

In accordance with its plan in eliminating as far as possible preventable diseases among workers in various industries, the United States Public Health Service of the Treasury Department has begun an investigation of the effect on the health of workers of pneumatic hammers as used in cutting limestone. Workers in this industry who use air hammers experience a temporary numbness of the fingers whenever the hand becomes chilled. The causes appear to be the higher vibration rate of the hammers when used in soft stone, and the tight and strained grasp which the workers have to use. Cold weather brings out the symptoms, but is not of itself a cause of the condition. By using a shank of larger diameter, which permits a more comfortable grasp by the worker, it is believed that a good deal of the strain on the muscles will be relieved. If the shank were enlarged by using a tight-fitting covering of asbestos, or some similar substance, the cold would not be intensified by the metal as at present and the handle would act as a shock absorber. (*Official Bulletin*, March 28, 1918, p. 11)

SOCIETY AFFAIRS

A Record of the Current Activities of the Society, Its Members, Council, Committees, Sections and Student Branches; and an Account of Professional Affairs of Interest to the Membership

THE Secretary's letter this month might well be entitled, The Usefulness of a Technical Society in War. Notwithstanding that what follows is a routine activity, nevertheless, the Secretary doubts if many know of it. Our great ambition is to have the Society used.

Below is given a digest of only a few of the inquiries which were received in one week last month, accompanied by abstracts of the replies made and some typical letters of appreciation for our attention. Sometimes the information is secured by telephone, sometimes the inquiries are referred to the faithful members of the Society closest to hand, but when the urgency is not too great they are sent to committees to insure the replies' being of the most authoritative nature possible.

Your Secretary believes that the sum total of this prompt individual service is the best means of making the Society useful, and he is accordingly devoting special attention to such service, giving priority obviously to requests which are of a war nature.

One of the inquiries in this period was from a Government department for the names of manufacturers to make carpenters' stoppers, which was a somewhat unusual request, but regarding which we were able to secure considerable information through the courtesy of a member of the Society outside of New York and which we forwarded within five days.

Another, from a Government arsenal, was for information regarding a special type of gas mask for industrial use. This, like the foregoing inquiry, was a matter of urgency, so that the arsenal "might get immediate relief." We were able to supply this information within four days.

Still another inquiry from a Government department requested "at the earliest possible time" information regarding remedying a certain trouble with the machinery on a transport. This again was a matter which required us to get in touch with a member who had had special experience. We fortunately were able to and furnished the information the same day.

Another request was from a member for comprehensive information to assist him to prepare an important paper, as follows:

"If there are any permanent changes brought about by the war which necessitate greater activities in engineering research, what are these changes?

"How can the difficulties after the war be lessened by activities in research?

"What important engineering-research problems were brought about by the war and which can be published without injuring our interests?

"What phases of engineering research should be taken up at the present time?

"What engineering problems will be of utmost value to us during the reconstruction period?"

By referring this inquiry to our Research Committee, the member was able to secure valuable replies.

Also in this same week inquiries were received on such varied subjects as catalogues for aviation repair depots, to be used in the preparation of requisitions on purchase orders; sizes of gaskets for standard and extra heavy anges running from 20-in. to 60-in. pipe: all the recent articles relating to concrete-ship construction, soot cleaners, pulverized coal, small high-power water motors for experimental purposes, hardening of forgings of 0.40 to 0.50 carbon steel, baling presses, replacing a worn-out laboratory steam engine, motor-driven turbine blowers for a forced-draft proposition, etc. Some of these were answered direct by the Secretary or Editor assisted by our own extensive files and indexes, and some were referred to the Library Service Bureau, which every member should remember has special facilities for making bibliographical searches on all technical subjects.

Another set of numerous inquiries demanding urgent and special attention the same week were requests from Government departments and industries engaged in war work for men possessing special qualifications, to be commissioned or to serve in civilian capacities.

In this class came a request for nominations of specially qualified professional engineers for submarine duty, a request from an important Government board for men of the highest attainment in projectile fuses; a request for a whole staff of both technically trained and experienced engineers for officers or civilians in the construction and later the operation of nitrate and powder plants, a request for 75 men qualified for steel inspectors, and so on. We have furnished the names of several hundred specialists in one day and since our bureau was started have supplied over 3000 names. The members have responded splendidly to the request to fill out classification blanks, with the result that we are told that we have the most complete bureau in the United States.

On the other hand, we have on the average of three offers a day from members who desire to give their personal services or who have manufacturing facilities which they can devote to the service of the Government, and we make it our business to give prompt attention to these requests and refer them to the most likely departments requiring such services. The Engineering Council hopes soon to act as a clearing house for all the societies in the matter of providing men with special experience to fill particular positions in or out of the Government service.

In acknowledgment of our services we receive some very nice letters. In one recent acknowledgment they wrote: "Once more we are very grateful to you for your splendid work in submitting names of men for——"

We recently had a comprehensive request from the American Library Association to send our JOURNAL to the forty or more U. S. cantonment camps for the duration of the war. Upon the approval of the Library Committee this was promptly complied with, and the letters of acknowledgment we received afford wholesome reading. One camp librarian writes: "It is the heartiest sort of thanks that we extend to the Society for its complimentary subscription to its JOURNAL. Our table of technical periodicals is a mighty well patronized institution, and most welcome to it is your JOURNAL."

The Gage Committee has secured a signal triumph. Under its initiative the Society arranged a conference in Washington of the heads of all technical Government bureaus and made

the proposition developed at the Cincinnati meeting to have all gages certified in one place. The Bureau of Standards was designated by common consent as the place. Included in the Gage Committee's recommendation was the establishment of branch certification. We have the satisfaction of reporting the success of the certification and the establishment of a branch in New York and in the Engineering Societies Building.

The object of these reports is not, however, to produce a sense of satisfaction over performance however well accomplished. Rather we should be inspired to greater undertakings commensurate with our special abilities.

The Lord tells of some who had ten talents, some had five talents and of the man with one talent who did nothing even with his one talent!

In which group shall engineers place themselves?

There is only one way we can double our talents, namely, by using them. This nation has thrown itself unselfishly into the war. Write in to the Secretary what you can do more than you are doing, and what manufacturing facilities you have to offer. Also suggest more things that the Society can do. Come to the Spring Meeting in Worcester, June 4 to 7, and inspire all to greater endeavor.

Calvin W. Rice,
Secretary.

Council Notes[1]

At the meeting of the Council on March 15 the following members were present: C. H. Benjamin, *Vice-President,* in the chair, John H. Barr, W. F. M. Goss, R. H. Fernald, F. N. Bushnell, F. R. Hutton, A. M. Greene, Jr., D. S. Jacobus, Wm. H. Wiley, *Treasurer,* and Calvin W. Rice, *Secretary.*

Boiler Code Committee. Interpretations of the Boiler Code in cases Nos. 175, 185 and 186 were approved with slight modification and ordered printed.

War Activities Committees. The Secretary reported the following committees of the Society and joint committees on which the Society is represented, as being engaged in war activities:

- Committee on Engineering Resources
- Engineering Service Committee of the Engineering Council
- Committee on Vocational Training
- Committee on Machine Shop Practice
- National Defense Committee
- Gage Committee
- Naval Consulting Board of the United States
- National Research Council
- New York Military Engineering Committee.

Communications. A letter was read from Sir J. A. F. Aspinall, Honorary Member of the Society, announcing his election to the presidency of the Institution of Civil Engineers, and it was voted to extend congratulations and greetings to Sir John. The letter also mentioned the visit of Messrs. Hartness and Durand from our Society to the London Aircraft Standards Conference.

Adjournment was taken to meet in Philadelphia on April 23 on the invitation of the Philadelphia Local Committee, and to join with the Philadelphia Section at their regular meeting on this date. Following is the program arranged for the Council on this occasion:

[illegible] a. m. Council leave by motor car for Hog Island, guests of Resident Engineer, H. H. Esselstyn, member of the Publication Committee.

11.30 a. m. Council leave Hog Island by boat, as guests of Director of Bureau of Wharves and Docks, George S. Webster, for a trip up the river to Cramp's Shipyard.

12.15 p. m. Luncheon at Cramp's Shipyard, guests of L. F. Moody, Secretary of the Philadelphia Section.

1.15 p. m. Leave Cramp's Shipyard by automobile.

2.00 p. m. Council Meeting at Adelphia Hotel.

7.00 p. m. Dinner with the Philadelphia Section at Adelphia Hotel.

Calvin W. Rice,
Secretary.

[1] The April Journal went to press before the Council Meeting.

The Engineering Council's War Committee of Technical Societies

The War Committee of Technical Societies, of which Mr. David W. Brunton is chairman, was founded by the Engineering Council in July, 1917, and represented at the time of its formation the four founder societies. The Committee was formed for the purpose of stimulating members of the various technical societies into giving consideration to the matter of the invention of war apparatus, with the object of assisting the Army and Navy. As a definite means of effecting this object, the Committee was given the work of procuring problems—especially difficult problems—from the Army and Navy for presentation to the membership of the societies for solution.

For several months the Committee has been coöperating actively with the Naval Consulting Board, and now has offices and a meeting room in the New York office of the Naval Consulting Board, 15 Park Row. The Committee now has the following membership:

American Society of Civil Engineers:
Nelson P. Lewis, Major James M. Boyle
American Institute of Electrical Engineers:
Harold W. Buck, A. S. McAllister
American Society of Mechanical Engineers:
A. M. Greene, Jr., R. N. Inglis
American Institute of Mining Engineers:
David W. Brunton, Edmund B. Kirby
American Gas Institute:
Dana D. Barnum, E. C. Uhlig
American Electrochemical Society:
Joseph Bijur, Dr. Chas. A. Doremus
Illuminating Engineering Society:
Louis B. Marks, Preston S. Millar
Mining and Metallurgical Society of America:
Christopher R. Corning, George C. Stone
American Society of Refrigerating Engineers:
Henry Torrance, F. E. Matthews
American Institute of Chemical Engineers:
Charles F. McKenna, Frank E. Dodge
American Chemical Society: (Coöperating)
Dr. Chas. Baskerville, W. D. Richardson

For the past several months the Committee has been working energetically along these lines and has received from governmental departments problems of importance which have been passed on to various trained specialists, and in many cases information of great value has been received and turned over to the Government. Also through this Committee many of the largest and most important experimental and research laboratories of the country have offered their services to the Government and are now carrying on experimental work for the Government, which work has been apportioned to them by the Committee.

In connection with the above the Committee is now super-

intending tests and experiments for various departments of the Army.

One of the most pleasing features of the work in this connection has been the exhibition of intense interest and energy on the part of the various specialists in making tests and experiments for the Government. These men and these laboratories have given freely of their services for this purpose without any cost whatever, and have rendered services which would have cost the Government under ordinary circumstances large sums of money.

The value of the work of this Committee is now so well recognized that a prominent Ordnance officer has been assigned to the War Committee, so that complete and continuous contact may be effected with the Ordnance Department.

Another and most important function of the Committee is to assist members of the technical societies to develop their inventions, and to bring these inventions to the attention of the proper governmental authorities so that valuable inventions may be made effective in the shortest possible time. On account of the connection of this Committee with the Naval Consulting Board, abundant funds are available for testing out any idea or invention which appears to be promising.

On account of the fact that additional technical societies are now represented on the Committee over and above the four founder societies, the Committee now represents technical societies having a total membership of approximately 45,000 technically trained men, distributed as follows:

American Society of Civil Engineers	8600
American Institute of Electrical Engineers	7525
American Society of Mechanical Engineers	8800
American Institute of Mining Engineers	5500
American Gas Institute	1600
American Electrochemical Society	1600
Illuminating Engineering Society	1250
Mining and Metallurgical Society of America	310
American Society of Refrigerating Engineers	410
American Institute of Chemical Engineers	300
American Chemical Society (Coöperating)	9000

R. N. Inglis.

Special Service by the Journal

Arrangements have been made whereby The Journal of our Society is to render a special engineering-data service to the recently organized Research Information Committee of the National Research Council.

The purpose of this committee, as announced in the April number, is to gather and distribute to the various departments of the Government technical and scientific information, the results of investigation and research, and confidential advice from all available sources. The committee has headquarters in the rooms of the National Research Council, 1023 Sixteenth Street, Washington, and branch offices at the American Embassies in London and Paris. The technical adviser of the committee at the central office in Washington is Dr. Graham Edgar, formerly professor of chemistry at the University of Virginia.

The service which The Journal is rendering has developed as a result of the review of engineering periodicals which it has published for several years, and for the conduct of which a department has been built up at Society headquarters for scanning and reviewing the periodicals which come to the library from all parts of the globe. Abstracts are made of important articles appearing in journals of all languages, for publication in The Journal of the A.S.M.E., and copies of these are transmitted to Washington, together with more extended abstracts when required, translations of special articles, photostatic prints of articles and engravings, lists of titles appearing in the technical press, etc., as may be necessary to meet the demands of the Research Information Committee and the Government departments which it serves.

Power-Plant Inspection

The United States Fuel Administration have advised us that they are about to take a census of the power plants of the country with a view to listing principally information regarding their equipment and methods of operation. They state that the census will be similar to that taken by the Committee on Industrial Preparedness of the Industrial Plants of the Nation, and similarly will cover all the states of the Union. It is planned that the inspections shall be repeated at approximately regular intervals of several months each. The work will be done under the supervision of each state. As the Society coöperated in this previous work, it has been requested to offer similar service to the Fuel Administration for the new census. The census taking will consist in filling in on special forms, which will be provided, certain data called for.

If all will coöperate, such work can be done at the expense of only a fraction of the time of each member. *Volunteers* for such service are requested to communicate with the Society immediately for further information.

John Fritz Medal for J. Waldo Smith

On Wednesday, April 17, the John Fritz Medal was awarded to J. Waldo Smith, Mem.Am.Soc.M.E., chief engineer of the Board of Water Supply, New York, for "achievement as engineer in providing the City of New York with a supply of water" as a result of the construction of the Catskill Aqueduct. The meeting for the award was held in the Engineering Societies Building. The presentation was made by Ambrose Swasey, Past-President Am.Soc.M.E., who told Mr. Smith that he had accomplished one of the most remarkable engineering feats in history. In accepting, Mr. Smith praised his associates and subordinates, and said they had enabled this work to be accomplished by aiding in every problem which arose.

Encouraging Report from Major Gilbreth

Many inquiries have been received at Society headquarters regarding the health of Frank B. Gilbreth, who was taken critically ill while in the service at Fort Sill, Oklahoma. It is a pleasure to report that Major Gilbreth has so far recovered that he has been able to make the journey to Washington, D. C., where he will remain for several weeks in the Walter Reed hospital to receive treatment for rheumatism. Mrs. Gilbreth advises that as soon as his health has improved to the point where he can have "sick leave" he will return to his home at Providence, R. I., for final convalescence.

Opportunity for A.S.M.E. Women

The Woman's Auxiliary of the American Institute of Mining Engineers now has headquarters in the ladies' reception room on the ground floor of the Engineering Societies Building, New York. This will be used as a war-relief work room for the preparation of comforts for the engineer regiments. The members of the Woman's Auxiliary will be glad to have any of the ladies of the families interested in The American Society of Mechanical Engineers call at the headquarters and join with them in the very helpful work which they are undertaking.

SPRING MEETING PROGRAM

Tuesday, June 4

10:00 a.m. Opening of headquarters and registration at Hotel Bancroft
12:30 p.m. Luncheon for Sections Delegates and Council
2:00 p.m. Council Meeting
2:00 p.m. Meeting of Research Committee and Flow Meters Sub-Committee
8:00 p.m. Addresses of Welcome by Mayor Pehr G. Holmes, Past-President Ira N. Hollis, and R. Sanford Riley, President, Worcester Chamber of Commerce. (*Hotel Bancroft*)
Address by Charles G. Washburn on The Growth of an Industrial City
Reception and Dance

Wednesday, June 5, New England Day

10:00 a.m. Business Meeting (*Worcester Polytechnic Institute*)

FIRST NEW ENGLAND SESSION

The Small Industry in a Democracy, George H. Haynes
The Textile Industry in Relation to the War, J. E. Rousmaniere

10:30 a.m. Visit to Crompton and Knowles Loom Works. Special invitation to ladies
12:30 p.m. Buffet Luncheon (*Polytechnic Institute*)
1:00 p.m. Visit to plant of Royal Worcester Corset Company. Luncheon served. Special invitation to ladies
2:00 p.m. Sections Conference
2:00 p.m. Simultaneous Sessions (*Polytechnic Institute*)

Second New England Session

Papers will be presented upon subjects relating to New England's industries under war conditions, including: Converting a Factory for Munitions Manufacture; Fire Protection; Training Labor for Shipbuilding; Oil Fuel in New England Power Plants

General Session

Foundry Cost and Accounting System, W. W. Bird
The Public Interest as the Bed Rock of Professional Practice, Morris L. Cooke
Moisture Reabsorption of Air Dried Douglas Fir and Hard Pine, and the Effect on the Compressive Strengths, Irving H. Cowdrey
A High-Speed Air and Gas Washer, Lieut. J. L. Alden
Investigation of the Uses of Steam in the Canning Industry, J. C. Smallwood

Industrial Safety and Workmen's Compensation Session

This session will be in charge of the Sub-Committee on Protection of Industrial Workers

4:00 p.m. Tea and Reception at Tatnuck Country Club
8:15 p.m. General War Session. (*Hotel Bancroft*)

The general theme of this session will be: How the Engineering Societies Can Assist in the Procurement Program of the Government. Some major topics to be discussed are: Ordnance and Ships for the Navy Department; Munitions for the Army; Aircraft Material

Thursday, June 6

10:00 a.m. Simultaneous Sessions (*Worcester Polytechnic Institute*)

General Session

Efficiency of Gear Drives, C. M. Allen and F. W. Roys
Self-Adjusting Spring Thrust Bearing, H. G. Reist
Air Propulsion, Morgan Brooks
The Elastic Indentation of Steel Balls under Pressure, C. A. Briggs, W. C. Chapin, H. G. Heil
Electric Heating of Molds, Harold E. White
Stresses in Machines When Starting or Stopping, F. Hymans (*To be read by title only*)

Fuel Session

An Investigation of the Fuel Problem in the Middle West, A. A. Potter
Topical Discussion on Fuel Economy. (Arranged for by the Fuel Conservation Committee of the Engineering Council)

Vocational Training Session

A discussion of The Boston System for Vocational Training

1:00 p.m. Luncheon (*Norton Company's Plant*)
2:30 p.m. Paper upon the results of a questionnaire upon housing, issued to leading industrial firms
4:00 p.m. Inspection of the Norton Company's community housing and garden projects
7:00 p.m. Dinner (*Worcester Country Club*)
8:30 p.m. Illustrated Lecture. Harvard's Contribution to Astronomy, Dr. S. I. Bailey. Dancing

Friday, June 7

9:00 a.m. Automobile Trip to Camp Devens, via Clinton Dam; Lunch at Camp Devens; Continuation of Trip to Concord and Lexington and return via the Wayside Inn

FEATURES OF THE SPRING MEETING

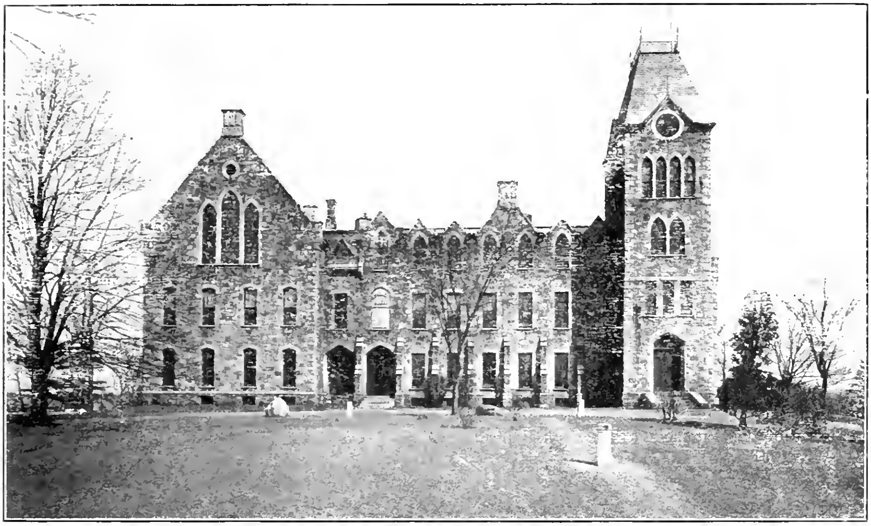
Worcester, Mass., June 4 to 7, 1918

THE coming Spring Meeting, like the two previous meetings, will be primarily a convention for conference on war problems, to which the engineers of the country, almost as a unit, are now giving their thought and attention.

It has been the usual custom at these Spring Meetings to have one or more sessions under the direction of the engineers in the city where the meeting is held, but in this instance the scope of the local representation has been broadened, and one whole day will be given over to the several Local Sections of the Society in New England, and the Providence Engineering Society, with papers on the work of the industries of New England in connection with the war.

On the evening of the same day, Wednesday, June 5, there will be a session, with addresses by representatives of the United States Government, on How the Engineering Societies Can Assist the Procurement Program of the Government in respect to ordnance, aircraft, ships, mobilization of labor, quartermasters' supplies, etc. On Thursday there will be a topical discussion on Economy in the Use of Fuel, arranged by the Fuel Conservation Committee of the Engineering Council, which will present the consensus of the experience of many of the fuel engineers of the country to whom questionnaires have been sent asking for definite data. Another session pertinent to the times will relate to vocational training, based on the Boston system, at the four principal technical schools of that city, under the direction of the War Department. Five hundred men are to be trained at Wentworth Institute and large numbers at the other schools.

On the afternoon of Thursday there will be an inspection of the model community for workmen of the Norton Company, at Worcester, with a discussion of housing problems based on a questionnaire issued to a large number of firms throughout the country. Besides these special features, there will be two general sessions for the presentation of technical papers.



Boynton Hall, Worcester Polytechnic Institute, Containing the Offices of the President. Several Sessions will be Held at the Institute, where all Members will be Welcomed

Entertainment Features

This is to be an outdoor convention with every opportunity for enjoyment of the natural beauty of the New England country, by means of automobile trips and entertainment at two country clubs at Worcester. Tea will be served on Wednesday afternoon at the Tatnuck Country Club, and on Thursday evening there will be a dinner at the Worcester Country Club, followed by a lecture by Dr. S. I. Bailey on Harvard's Contribution to Astronomy.

Two excursions have been planned for Wednesday, with special thought for the ladies' entertainment, though members and guests are cordially invited. The first of these trips is a visit in the morning to the Crompton and Knowles Loom Works, where their weave room and factory will be inspected and their many interesting and fancy looms shown in operation. The plant of the Royal Worcester Corset Company will be the scene of the afternoon's activities. After luncheon, at the plant, an inspection trip will be made to see how the Royal Worcester corsets are manufactured.

The various professional sessions will be so disposed that all day Friday will be free for automobiling, when a trip is planned to the cantonment at Camp Devens where lunch will be served; after which the trip will be continued to Concord, Lexington, and return by Wayside Inn.

Delegations from Nearby Cities

It is already arranged for delegations to attend from Boston, Providence and New York, and in the latter city a special

...ittee has been appointed which expects the attendance of ...any as 400 from New York and nearby points, representative of the New York membership. It is suggested that ... who can do so should go to Worcester by automobile, and ... the benefit of such the following instructions have been issued:

Automobile Routes to Worcester

From New York to Worcester take the main-traveled road to New Haven, 75 miles from Columbus Circle, New York. The route from New Haven leads to Hartford, Conn., by two roads: One through Middletown, 40.9 miles, which gives better views than the alternative route through Meriden, which is 37.1 miles. From Hartford the route goes to Springfield by Suffield, 26.9 miles; and from Springfield to Worcester the route is by Palmer, 51 miles, a total distance of 155.9 miles. Lunch can be secured at the Hotel Taft in New Haven, or at the Highland Court Hotel in Hartford, Conn.

From Albany to Worcester the route is from Albany to Troy, 8 miles, then to Williamstown, 36 miles, and from Williamstown over the Mohawk Trail to Greenfield, 42 miles; from there to Gardner, 39.4 miles, and then to Worcester, 28.2 miles, a total distance of 153.6 miles. A shorter route is from Albany to Pittsfield, 36 miles, then to Springfield, 56 miles, and from Springfield to Worcester, 51 miles, a total distance of 143 miles. However, the beauty of the shorter route is not to be compared with that of the other.

For Points West of Albany to Worcester the route will be shortened somewhat by turning off at Schenectady, going direct to Troy rather than to Albany.

Fred S. Sly, member of the Attendance Committee of New York, care of the *American Architect*, 243 West 39th Street, New York, will be glad to secure any special information for tourists that may be desired, or inquiries can be addressed to the Touring Bureau of the Automobile Blue Book Publishing Company, 243 West 39th Street, New York.

Hotels at Worcester

The headquarters for the convention will be at the Hotel Bancroft, and any who go by automobile are asked to call at the headquarters before putting up their cars so that they may be informed as to the garage which can best serve them at the time they call.

The leading modern hotels of Worcester are the Bancroft and the Warren. The minimum rates for these are as follows:

	Without Bath		With Bath	
	Single	Double	Single	Double
Bancroft	...	...	$2.75	$5.00
				6.00
				7.00
Warren	$1.50	$2.50	2.00	3.50

Other hotels, all of which have moderate rates, are the Bay State House, Franklin, New City, New Park and Pleasant. *Every person expecting to attend should secure his rooms well in advance, since hotels in Worcester, as in other cities affected by the business of the war, are having a large patronage and usually are crowded.*

While the Registration and Information Bureaus will be located at the Bancroft, several of the professional sessions will be held at the Worcester Polytechnic Institute, which will, in a measure, serve as a second headquarters where all will be welcome and where everyone in attendance is requested to make himself at home.

Fuel Session at Spring Meeting

As announced in the April Journal, on Thursday morning, June 6, there will be a session of the Spring Meeting at the Worcester Polytechnic Institute for five-minute presentations of data relating to fuel economy. This session has been planned by the Fuel Conservation Committee of the Engineering Council to assist the United States Fuel Administrator in his nation-wide campaign for fuel economy. Discussion is solicited upon the topics listed below, and all those who have studied the problems incident to the adverse fuel conditions of the past winter are invited to give the results of their experience in the form of brief written communications of from 100 to 1000 words each.

1 What Are the Economic Effects of Impurities in Coal?

Incombustible in fuel has a detrimental effect upon furnace operation out of all proportion to the percentage of refuse contained. It has been claimed that when coal contains 40 per cent of refuse it becomes valueless as fuel. Recent conditions have afforded opportunities for interesting observations in this connection. What has been your experience?

2 To What Extent Is Fuel Oil Likely to be Used as a Substitute for Coal?

Information is desired as to present use, advantage found, probable available supply, etc.

3 How Can Soft Coal Be Burned Without Smoke in Marine Boilers?

The avoidance of smoke would decrease the radius of visibility of our ocean carriers by many miles and greatly reduce their liability to attack by submarines. If efficiency is improved incidentally it means much more than the mere coal saving.

4 What Are the Possibilities in the Direction of the Utilization of Anthracite Wastes?

What success have you had in burning anthracite slack or culm? Do you mix it with soft coal, and in what proportions? What sort of grate do you use and what is your practice with regard to thickness of fire, draft, rate of combustion? Can the mixture be burned in a stoker?

5. What Instruments Are Useful and Desirable in the Boiler Room as Aids in Saving Coal?

What class of equipment has been of the most value to you and how?

6 What Is Essential to the Economical Operation of Hand-Fired Boiler Furnaces When Using Soft Coal?

Helpful hints as to firing methods, front or side; frequency of firing; management of dampers; cleaning; etc.

7 To What Kinds of Plants and Coals are the Different Types of Mechanical Stokers Respectively Adapted, and What Is the Limiting Factor to Their Use in the Small Plant?

Can we agree upon the type of fuel to the combustion of which each type of stoker is best adapted? How large must a plant be to warrant the use of a mechanical stoker?

8 What Experience Have You Had in the Use of Wood as Fuel? To What Extent Is Wood Available as a Fuel?

The coal shortage has occasioned the use of wood fuel in many unwonted places. Accounts of experience that will be helpful are solicited.

9 What Coal Economies Can Be Effected in Residence Heating?

He who could make one ton of coal do the work of two during the past winter, not only conserved the coal for his neighbor and saved his own money but was comfortable when he might have otherwise been cold. How can it be done?

10 What Coal Economies Can Be Effected in the Small Steam Plants?

Plants which are not sufficiently important departments of their industries to warrant expert supervision and are too small to support real engineers waste a lot of coal and steam in the aggregate. What are the principal sources and methods of waste and how can they be avoided and corrected?

11 What Experiences Have You Had With the Storage of Coal?

AMONG THE LOCAL SECTIONS

THE semi-annual conference of Sections' representatives will take place during the Spring Meeting at Worcester. The members of the Council will meet at luncheon with the Sections' delegates, and addresses will be made by President Main and Dr. Hollis.

The Council made its second visit to a Section on April 23, when it held its April meeting at Philadelphia, and in the evening attended the meeting of the Philadelphia Section. During the forenoon the members of the Council had an opportunity to make a special inspection of Hog Island.

Secretary Rice is to go on a somewhat extended trip which will take him to a large number of the Sections. Coming during this crisis in the history of our country, it is felt that this visit by the Secretary will do an inestimable amount of good in correlating the war activities of the Society through the medium of its Sections.

A noteworthy example of the effectiveness of coöperation between Sections and Student Branches was had at New York on April 9. The New York Section turned its April meeting over to the Metropolitan Student Branches located at Columbia University, New York University, Polytechnic Institute of Brooklyn, and Stevens Institute of Technology. Two sessions were held and a buffet supper served between them. About 300 persons attended the afternoon session, over 400 partook of the supper and over 650 were present in the evening. The program included eight speakers, the supper, entertainment features, souvenirs and light refreshments after the evening session.

The Committee in charge of the arrangements consisted of Messrs. J. Gorso, Columbia University, H. Lowenstein, New York University, N. N. Wolpert, W. Sumner and M. Bernner, Brooklyn Polytechnic Institute, and L. V. Aquadro and H. E. Beaven, Stevens Institute of Technology.

Section Meetings

ATLANTA

April 9. Mr. W. G. Eager, Assoc.Mem.A.S.M.E., gave an interesting address on The Effect Upon Fuel Economy of Different Arrangements of Baffles in Boiler Tubes.

CECIL P. POOLE,
Section Secretary.

BALTIMORE

The Section has been recognized by the Fuel Administration and one of its committees, composed of Messrs. Henry Adams, A. E. Walden, W. W. Varney, and A. G. Christie, has been coöperating with the Fuel Administration and the Liberty Loan Committee, in regard to the third Liberty Loan. At the present time the A.S.M.E. Section in coöperation with the Engineers' Club is taking prominent part in engineering matters of public interest in Baltimore.

A. G. CHRISTIE,
Section Secretary.

BIRMINGHAM

February 22. At a joint meeting of the Alabama Technical Association with the A.S.M.E. Section, C. B. Davis, Mem.Am.Soc. M.E., presented a paper on the subject of Fuel Conservation and Increased Production. A résumé of the paper showed:

1 That the possible conservation of coal will be a saving of approximately 126,370 tons annually if the necessary methods are adopted at the various plants as suggested:

2 That the possible saving by making all coke in by-product ovens will be approximately 689,750 tons of coal annually:

3 That an output of approximately 2,000,000 tons annually can be obtained at a cost of approximately $2,000,000 for the initial investment and requiring in the way of new labor 3500 men

4 That the present output will be increased by 5,340,000 tons at an initial cost of $3,840,000 and showing an annual saving of $1,770,000; and

5 That a further increased production could be made by more efficient transportation and utilization of the Warrior and Alabama Rivers for transportation.

Mr. F. G. Cutler, Mem.Am.Soc.M.E., called attention to conditions in Alabama for the saving of fuel and showed that the tendency is to use water power and surplus gas from blast furnaces and by-product ovens. The use of low-pressure-turbine-driven generators in the Birmingham district alone would affect a saving in excess of that quoted by Mr. Davis. He ventured the prediction that within a few years the consumption of coal under boilers for the production of power would be practically eliminated.

Mr. H. M. Gassman, Mem.Am.Soc.M.E., pointed out the difficulty of opening up new mines and modernizing existing mines on account of the large amount of capital invested; and also the difficulty of obtaining equipment and securing labor necessary to operate them. He suggested that a conservation campaign be waged and industrial plants consuming more than five tons per day be urged to conserve coal.

Mr. H. S. Geismer claimed that the opening of new mines would not be feasible at the present time, due to the shortage of labor in the district, which is not sufficient to work the present mines to their full output per man employed. He pointed out that electrification would not be an immediate remedy, due to the difficulty of obtaining deliveries of mining machinery and other equipment. Also that the mines best adapted for that type of equipment have already been electrified. He sugested a campaign to make the miners themselves realize that they alone could increase the output and said that almost without exception the miners are not working full time nor do they seem to realize their duty to the Government in the present crisis.

Mr. M. J. Lide, Mem.Am.Soc.M.E., pointed out the losses due to inefficient steam engines, where more waste could be accounted for than at the boilers. Special stress was laid on the question of instructing labor.

The subject was also discussed in its various phases by Samuel Stewart, R. A. Lee, W. F. Wilcox, G. N. Mitcham, J. T. McKenzie and B. B. Ross.

The following resolution was adopted unanimously:

> RESOLVED. That it is the sense of the Alabama Technical Association to urge operators to run their plants with the greatest possible regard for the conservation of fuel and also that employees and operators coöperate to run mines and industrial plants continuously and at the best possible output, making such sacrifices as are necessary with a view of furnishing a maximum production, and thereby very materially assisting our Government in bringing the war to a prompt and successful conclusion.

April 25. Mr. J. W. Moore, Assoc.Mem.Am.Soc.M.E., delivered an interesting paper on The Gas Producing Plant of the American Cast Iron Pipe Company.

W. L. ROUECHE,
Section Secretary.

BOSTON

April 30. At a joint dinner of the Engineering Societies of Boston Mr. Alfred D. Flinn, Secretary of the Engineering Council, delivered an address on the work of the Engineering Council. Further details regarding the meeting will be published in a succeeding issue of THE JOURNAL.

W. G. STARKWEATHER,
Section Secretary.

BUFFALO

March 27. Prof. D. S. Kimball, Mem.Am.Soc.M.E., delivered a lecture on Water Powers of the Pacific Coast, which was not only of unusual technical interest, but was illustrated with many lan-

tern slides of great beauty, since practically all of the power plants described were situated at places of unusual scenic grandeur.

April 3. At a special meeting of the Buffalo Engineering Society, Mr. N. Boland, of the Beyers Manufacturing Company, delivered an illustrated lecture on The Manufacture of Wrought Iron Pipe, showing the manufacture of wrought iron pipe from pig iron to the finished product.

April 10. At the seventh general meeting of the Buffalo Engineering Society, Eskil Berg, of the General Electric Company at Schenectady, gave a talk on The Recent Development of Propelling Machinery for War and Merchant Ships. The speaker brought out the recent advances in the use of the steam turbine with electric drive for propulsion of war and merchant vessels, showing that high efficiency, at various speeds can be obtained with the electric drive, and pointing out its advantages over the gear drive for large power installations. The water rate per b.hp. of turbine installations with electric and gear drive was compared with that for the same type of ship equipped with reciprocating engines and it was shown that the large turbine installations are more economical than the best types of reciprocating engine installations, particularly when two or three speeds must be maintained for long periods as mentioned above. Mr. Berg's close connection with the war vessels now being built made it possible for him to bring out the latest and the expected future developments of the turbine equipment upon which much work and study has been put.

April 17. Under the auspices of the Electro-Chemical Section, Mr. Oliver C. Ralston, Metallurgist for the Hooker Electro-Chemical Company, Niagara Falls, gave a talk on Recent Advances in Western Non-Ferrous Metallurgy.

E. B. NEIL,
Section Secretary.

CHICAGO

April 22. At a joint meeting of the Chicago Sections of the A.S.M.E., A.I.E.E. and the Mechanical and Electrical Sections of the Western Society of Pennsylvania, C. F. Kettering, Mem. Am.Soc.M.E., delivered an interesting paper on The Automobile Power Plant.

A. L. RICE,
Section Secretary.

CINCINNATI

March 21. A joint meeting of the Engineers' Club of Cincinnati and the A.S.M.E. Section which included two sessions, was held at the Literary Club rooms. The afternoon session was opened by Henry Ritter, Mem.Am.Soc.M.E., with a paper on Shop Kinks, in which he dealt with the subject of shop management in general.

Prof. John T. Faig, Mem.Am.Soc.M.E., delivered a paper on The Economic Use of Coal by Communities which was illustrated by lantern slides. The waste inherent in the present methods of utilizing coal in cities of the Middle West was pointed out. A by-product coke-oven plant handling 7000 tons of coal per day and producing coke, gas, tar, ammonia and benzol was discussed from a business and economic standpoint and the economic advantage of the process and the addition to the raw materials of the country were shown.

Mr. C. U. Carpenter, Mem.Am.Soc.M.E., opened the evening session with a lecture on The Training of Women for Industry. He told of the training of thousands of women of no experience in mechanical lines for the manufacture of time fuses for Russian shrapnel. These women were recruited from all walks of life, and were absolutely ignorant of production work on machines, but by organizing a school apart from the shops, and selecting instructors very carefully, it was found possible to train the women so that they were not only capable of making the parts of these time fuses within the necessary degree of accuracy, usually within one thousandth of an inch, but it was also found possible to train them to give production superior to that secured from men. One of the interesting features of this experiment in the use of women on machine work was the fact that it was found possible to produce time fuses in enormous quantities that met every requirement of rigid inspection without any particular difficulty. In the course of the discussion which followed, Mr. Carpenter brought out the point that his method of organization and teaching was as directly applicable to men as to women, and in his opinion operatives should always be taught in a school separate from the shop. He believed this to be productive of much better results. Operatives whose skill does not appear to increase are withdrawn from the works and put in the school again, under careful instructors who study their defects and attempt to correct them.

The meeting proved to be a great success and there were over 150 persons in attendance.

JOHN T. FAIG,
Section Secretary.

CONNECTICUT SECTION

Bridgeport Branch

April 24. The afternoon session was a general get-together meeting in order that those attending the dinner and evening session might be better acquainted. After the dinner, which took place in the Stratfield Hotel, the evening session opened with a patriotic address by Judge Pullman, of Bridgeport. The following gentlemen also addressed the meeting: Clinton E. Woods, of the Woods-Keller Company, on Factory Accounting as a Bill for Controlling Production; Harry E. Harris, Chairman of the Joint Gage Committee, A.S.M.E. and S.A.E., on Facilitation of War Production by Practicable Manufacturing Allowances; and Wm. R. Webster, Mem.Am.Soc.M.E., on Intelligent Specifications and Inspection as a Factor in Production Increase.

R. W. ELLINGHAM,
Branch Treasurer.

Meriden Branch

The Meriden Branch of the Connecticut Section met April 19th at the Chamber of Commerce Hall. Mr. F. C. Bolton, Tool Engineer at the Meriden Plant of the Colt Patent Fire Arms Manufacturing Co., gave a very interesting description and demonstration of the Browning Machine Rifle. The rifle upon which America is placing great dependence in the great struggle against autocracy, weighs 15 lb. and contains 110 parts. Its bullets travel through the barrel at a rate of 2700 ft. per second and it can fire twenty shots in from two to two-and-a-half seconds. In test, 20,000 shots were fired at high speed without a miss-fire. A feature of the gun is the magazine which holds 20 cartridges and which the operator drops to the ground by releasing a spring. Eight hundred rounds of ammunition can be carried by one man. Another feature of the gun is the ability to fire a single shot or a number of shots according to the will of the operator. Admission was restricted to invited guests, the attendance being slightly over 180.

C. N. FLAGG, JR.,
Branch Secretary.

New Haven Branch

April 16. Mr. George A. Orrok, Mem.Am.Soc.M.E., delivered an interesting paper on Internal-Combustion Engines. He described the development of the aeroplane engine and told of some very interesting recent experiences in connection with the new Liberty motor. This motor is entirely different from the one designed last summer. Comparisons of a number of makes of aeroplanes were made and the speaker stated that in his opinion it is not desirable to manufacture motors under 2.7 lbs. per h.p. Motors which have been developed in the last few months have been strengthened so that they have a working capacity of from 140 to 200 hours. Mr. Orrok said the Germans are now making motors for aeroplanes using the Diesel engine type.

The internal combustion engines made for other purposes were described and it was pointed out that the farmer of the present day depends exclusively upon these to do all of his chores, from tilling the soil to milking the cows, lighting his home, and delivering his produce to the markets.

Among those who joined in the discussion were Messrs. F. R. Low, Editor of Power, Professor L. P. Breckenridge, Professor E. H. Lockwood, S. F. Jeter, Secretary of the Hartford Branch, C. K. Decherd, Chairman of the Meriden Branch. Mr. H. B. Sargent presided.

Mr. Orrok addressed the Student Branch at Yale University in the morning on the same subject.

E. H. LOCKWOOD,
Branch Secretary.

ONTARIO

March 25. At the second annual meeting of the Joint Committee of Technical Organizations, to which the members of all of the engineering societies were invited, special emphasis was made by Col. David Carnegie to the need of training the directors and distributors of production, in order that the whole resources of the country might be devoted to the maximum state of efficiency toward winning the war. He made a strong appeal for greater industrial education in Canada. Preparation of the child for industrial training, he declared, was the immediate need of the day, and urged upon his hearers the importance of strong action, either in the form of direct representations to the Government, or separate action by the organization, or by individuals. He also proposed the establishment of national and district trade boards.

Mr. W. E. Segsworth, Administrator of the Vocational Branch, Military Hospitals Commission, gave a most comprehensive and interesting explanation of the gigantic work undertaken in connection with the Invalided Soldiers' Commission.

Soldiers placed in factories by the commission are situated only after each individual case is thoroughly investigated as to the man's adaptability, and these men are continually looked after by officers, usually engineers having wide experience in all branches of industry, to keep this labor from being exploited.

In closing, Mr. Segsworth impressed upon his audience the need of improved measures for the training and care of blind soldiers.

CHESTER B. HAMILTON, JR.,
Section Secretary.

PHILADELPHIA

March 27. At a joint meeting of the Engineers' Club of Philadelphia and the A.S.M.E. Section, Dr. S. W. Stratton, Director of the U. S. Bureau of Standards, presented a paper on The Relation of the Bureau of Standards to the War, in which he dealt with the scientific work of the Government. Following the lecture a patriotic address was made by Corp. Frank Street, of the British Strathcona Horse.

April 23. After a visit to the A.I.S.C. at Hog Island and the Wm. Cramp Ship and Engine Building Company's yards, the Council of the Society attended a dinner meeting of the Section held at the Adelphia Hotel. The subject of the meeting was Shipbuilding and was discussed from all points of view. A more detailed account of the meeting will appear in a succeeding issue of THE JOURNAL.

JOHN P. MUDD,
Section Secretary.

PROVIDENCE

March 27. Under the auspices of the Municipal Engineering Section, Frederick N. Connet, Mem.Am.Soc.M.E., delivered an illustrated lecture on Recent Developments in the Use of the Venturi Meter.

March 28. A social meeting of the Efficiency Section was held at which W. H. Harriman, of the Universal Winding Company, related his personal experiences in engineering in Mexico.

March 29. At a joint meeting of the Chemical Section of the Providence Engineering Society and the Rhode Island Section of the American Chemical Society, Frederick H. Franklin, connected with Saunders & Franklin, delivered an illustrated lecture on The Metallography of Cast Iron.

April 9. Following a business meeting W. A. Kennedy, Mem. Am.Soc.M.E., presented a paper on Bronze and Its Uses.

April 10. The subject of the meeting held under the auspices of the Power Section was Mill Heating and Lighting.

JAMES A. HALL,
Correspondent.

ST. LOUIS

March 29. After the regular monthly dinner Dr. Isaac Lippincott, associate professor of economics at Washington University, delivered one of the most interesting addresses ever presented before the Section, on Economic Reconstruction After the War.

R. L. RADCLIFFE,
Section Secretary.

SAN FRANCISCO

March 20. An informal dinner was tendered Prof. George F. Swain, Mem.Am.Soc.M.E., and Past-President of the Am.Soc.C.E., by the joint Sections of the A.S.C.E., A.I.M.E., A.I.E.E. American Chemical Society, and the A.S.M.E. Among the many speakers of the evening were the following: P. M. Downing, chief engineer of the Pacific Gas & Electric Company, who delivered a talk on Interconnection of Power Plants; Prof. D. M. Folson, who presented the subject of Fuel Oil Saving; Mr. Max Thelen, President of the State Railroad Commission, who spoke on the subject of War Activities of the Railroad Commission, and Professor Swain, who selected the vitally important subject of National Issues of Today. The meeting was presided over by Prof. C. D. Marx, of Leland Stanford, Jr. University.

C. H. DELANY,
Section Secretary.

Student Branch Meetings

NEW YORK STUDENT BRANCHES

As has been customary for the past few years the Metropolitan Student Branches at Columbia University, New York University, Polytechnic Institute of Brooklyn and Stevens Institute of Technology, again held their Joint Meeting. This year, however, the meeting was held jointly with the New York Section on April 9th, and included an afternoon session, a buffet supper and an evening session. The meeting was a great success and the attendance as large as the well attended sessions of the Annual meetings. The Student Committee in charge of the arrangements are to be congratulated upon their enterprise. The Committee included: Messrs. J. Gorso, Columbia University, H. Lowenstein, New York University, N. N. Wolpert, W. Summer and M. Berner, Polytechnic Institute of Brooklyn, and L. V. Aquadro and H. E. Beaven, Stevens Institute of Technology.

The convention, for such it was in fact, established a new record, which, in these times of depleted student ranks owing to student service in the war, reflected great credit on the enterprise and ability of the committee having the meeting in charge. The entire affair was held on the fifth floor of the Engineering Societies' Building, the capacity of which was taxed to the utmost. Four hundred students and local members attended the "pay-as-you enter" buffet dinner and nearly 700 were present at the evening session.

At the afternoon session talks were given by several engineers as follows:

WANTED: CAPTAINS OF INDUSTRY AFTER THE WAR, M. H. Avram, President Slocum Avram Slocum Company.

WHAT THE ENGINEER HAS DONE FOR THE WAR, F. R. Low, Editor of *Power*.

ENGINEERING PROBLEMS OF THE WAR, Geo. A. Orrok, Consulting Engineer.

CERTAIN PHASES OF ENGINEERING EDUCATION, Prof. Collins P. Bliss, New York University.

ORGANIZATION AND THE RELATION IT BEARS TO ENGINEERS, Charles Whiting Baker, Consulting Engineer and Consulting Editor of *Engineering News-Record*.

At this session an interesting announcement was made by Prof. Bliss of a new educational plan proposed by New York University for greater co-operation between the University and the industries. The plan contemplates 20 scholarships of \$25,000 each, in return for which special opportunities in research work and in the use of the facilities of the University will be available. Classes are to be divided into two sections which will alternate every other term between the University and the co-operating industry.

In the interval following the dinner the audience was highly entertained by "Jack" Armour of *Power*, and during the evening selections were given by the orchestra from Polytechnic Institute of Brooklyn. The evening programme comprised the following addresses:

THE YOUNG ENGINEERS IN THE PRESENT CRISIS, Past-President Ira N. Hollis.

CERTAIN ACCOMPLISHMENTS OF THE NAVY IN THE WAR, Lieut. B. F. Hart of the Brooklyn Navy Yard.

THE WAR IN THE AIR, G. Douglas Wardrop, Editor *Aerial Age;* illustrated by lantern slides and moving pictures.

UNIVERSITY OF CALIFORNIA

February 28. Mr. Domonoske, instructor of machine design at the University, gave an interesting account of student life and work at the University of Illinois.

March 14. At this meeting two papers were presented, one on The Gnome Engine, by E. K. Schulze, and the other on The Spillway of Calavaras Dam, by Prof. J. N. Le Conte.

March 28. Mr. H. L. Reich presented a paper on Power Plants of the San Joaquin Light & Power Co., and Prof. B. F. Raber gave an interesting talk on Dynamometers.

LLEWELLYN BOLTER,
Branch Secretary.

CARNEGIE INSTITUTE OF TECHNOLOGY

April 10. Mr. W. G. Chester, of the Babcock & Wilcox Company, gave an illustrated talk on the various types of boilers manufactured by this company, dealing mainly with the features of the land and marine types. The inability of makers to standardize their product, he said, was a result of the demand for many different types, each especially adapted to peculiar conditions of operation. The difference in design between the ordinary and the marine boiler due to the requirements for compactness and high capacity was clearly shown by many excellent slides.

H. D. KRUMMEL,
Branch Secretary.

UNIVERSITY OF CINCINNATI

March 1. Mr. Fosdick, civil engineer for the W. G. Franz Co., gave a talk on the Dixie Terminal Building to be erected in Cincinnati, which is to serve as an office building for the Kentucky Green Line and the new rapid transit cars. Problems which a contractor has to overcome to fill his contract involving the solving of labor troubles, the advantages and disadvantages of concealing steam piping, considerations in laying out heating systems, problems of sanitation, deciding upon materials of construction, laying out decorating and lighting effects, placing exits properly so as to avoid standing lines during rush hours, and the question of getting supplies such as building materials, were all accurately traced.

March 21. Mr. Hinkle, who has been speaking at the various army cantonments throughout the country, delivered an intensely interesting talk on The Evolution of the U. S. Army Rifle, and exhibited a collection of twenty guns showing those used by our army and navy from the Revolutionary War to the present time. The working principles of the most important types of small arms, the methods of loading the gun and the various forms of ammunition used were discussed in detail.

C. L. KOEHLER,
Branch Secretary.

KANSAS STATE AGRICULTURAL COLLEGE

March 7. Mr. J. B. Marcellus, of the Portland Cement Manufacturing Association, who is at present carrying on research work at the college, gave a talk on Cement, in which he traced the methods of manufacturing cement from the early days.

March 28. Mr. Walter Miller, of the Shop Practice Department, gave a talk on Military Training in Switzerland tracing the various steps and processes as developed by the Swiss Government in training their fighting forces.

I. O. MALL,
Branch Secretary.

UNIVERSITY OF KANSAS

April 4. A plan of reporting on articles published in technical magazines was tried out and the articles appearing in a recent issue of *Power* on the Tamarack Power Plant and on Training Engine Room Crews for American Crews were fully discussed.

H. C. VAN HOUTEN,
Branch Secretary.

LEHIGH UNIVERSITY

April 5. A lecture on Modified Springfield Ammunition as made by the Union Metallic Cartridge Co., was delivered by Mr. B. P. Lander. Specimens tracing the shell from the brass disk to the completely drawn shell were shown and the speaker also told how bullets are cast and jacketed.

Mr. L. J. Jenkins gave a lecture on the Brief History of the Development of the Steam Engine, tracing its progress from the time of its invention by Watt to the present date.

Mr. E. L. Forstall delivered a paper on the Work of the American Army Engineers in France, showing how the corps has been enlarged and how it has been working in France to provide efficient transportation for the American Army.

N. DMYTROW, JR.,
Branch Secretary.

LOUISIANA STATE UNIVERSITY

February 14. The following officers were elected for the ensuing year: E. C. Freeland, chairman; J. Lobo, vice-chairman; C. R. Strattman, secretary; O. A. Wing, treasurer.

A brief address was given by E. C. Freeland, explaining the advantages of joining the A.S.M.E. upon graduation.

March 26. Following the business meeting a very interesting and instructive talk was given by Mr. Piller, Chief Electrician of the Standard Oil Co., on The Operation of Large Gas Engines as used by the Standard Oil Company of Louisiana.

C. R. STRATTMAN,
Branch Secretary.

UNIVERSITY OF MAINE

February 13. Two papers were presented, one by Mr. Chapin on Static and Dynamic Balancing and the other on Motion Study as Applied to War Cripples, by Mr. Russell.

A. MASON RUSSELL,
Branch Secretary.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

April 5. Prof. Charles M. Allen, of the hydraulic engineering department, delivered an illustrated lecture on the Use of Dynamometers and Water Brakes in Tests on Power Plants.

By exhibiting rating curves of circular, Government and other rating stations, which coincided almost identically, he pointed out that in rating current meters a circular station is exactly as accurate as any other. Then by means of capacity-power and gate-opening power curves, it was shown that enough water was wasted in using full gate opening in preference to 0.85 of full-gate to run a separate unit, and that a loss of many dollars resulted.

S. H. CALDWELL,
Branch Secretary.

MICHIGAN AGRICULTURAL COLLEGE

March 7. Mr. Livingston, of the Reo Motor Car Company, presented a paper on Accident Prevention, pointing out the need of definite methods of preventing accidents. Progress has been made in this regard by the installations of mechanical safeguards, the inspection of plants periodically, by placing definite responsibility upon certain employes, and by the organized effort among foremen.

H. M. SASS,
Branch Secretary.

UNIVERSITY OF MISSOURI

March 8. Prof. H. Wade Hibbard, recently engaged in Washington making plans for organizing and making efficient certain departments relative to the war, gave a lecture on Organization Engineering. The underlying principles of efficiency management together with charts used in that work were explained in detail, such as charts representing the organization of an American railway, principle, production, procedure, and production-delays charts.

March 26. Mr. K. K. King presented a paper on The Design of Motor-Truck Engines for Long Life, discussing the factors which go to make up longevity. Methods used in designing rods, wrist-pin bushings, pistons, cylinders, camshafts, valves and other sundry parts were thoroughly described and the methods of

lubrication-splash feed, pressure feed, and splash-pressure feed traced as to their relative merits.

J. W. Baldwin,
Branch Secretary.

OREGON AGRICULTURAL COLLEGE

March 27. Mr. M. L. Granning, instructor in machine-shop practice, gave a lecture on the Construction of a Modern Shrapnel Shell. Incidentally he pointed out the changes which have been made in several large industrial shops which now devote all or a majority of their time to the production of munitions.

Neal K. Ford,
Branch Secretary.

STEVENS INSTITUTE OF TECHNOLOGY

March 4. Arrangements were reported regarding inspection trips. Election of officers for next semester took place on account of the senior class graduating in April, two months prior to regular graduation. This has been possible because of the war schedule which has been in effect since September. The following officers were elected: George H. Spencer, chairman; Harry E. Beaver, vice-chairman; Lincoln V. Aquadro, secretary-treasurer.

L. V. Aquadro,
Branch Secretary-Treasurer.

UNIVERSITY OF WISCONSIN

March 14. Professor Callan gave an account of his recent trip to Europe as a member of a committee sent by the United States Shipping Board. His talk covered briefly his trip over, a new gas engine using exhaust gas to generate steam which is used behind the piston, ship industries of England, gun and submarine building, aeroplanes and air raids.

Wm. Mantonya,
Branch Secretary.

WORCESTER POLYTECHNIC INSTITUTE

Died in France, February 15, 1918, E. W. Jones, United States Aviation Service, Student Member of Worcester Polytechnic Institute Branch.

March 8. At a meeting to which the members of the Civil Engineering Society were invited the subject of The Determiuation of Water Waste in American Cities by Pitometer Methods was presented by Edward S. Cole, Mem.Am.Soc.M.E. Mr. Cole used charts of pumpage against time to demonstrate how large an amount of water had to be furnished a city's mains, even during the night and on Sundays, and by subtracting from this the amount probably used during these periods, a surprisingly large quantity was still left which could only be accounted for as wastage. He then described two types of apparatus for measuring the flow in city mains, one being the Deacon meter and the other the pitometer, with photographic recording attachments. Several experiences in tracing out wastage in metropolitan districts were related. The method of isolating a district by shutting off communicating mains was shown, together with the telltale drops in the pitometer record.

H. P. Fairfield,
Branch Secretary.

YALE UNIVERSITY

March 15. J. Douglas Wardrop, member of the A.I.E.E. and editor of the *Aerial Age*, delivered a most instructive illustrated lecture on The War in the Air, tracing the history and development of the various types of aeroplanes and aircraft in general and pointing out the speeds, cruising radius, carrying capacity and horsepower of the various English, American, French, Italian and German planes.

The importance now and in the future of aeroplanes adapted to both war and peace service, showing their suitability to submarine detection and aerial photography, was also touched upon.

Wm. Rogers Herod,
Branch Secretary.

ROLL OF HONOR

Ashley, Edward E., Jr., Captain, Signal Corps, U. S. Army.

Barlow, Frederic C., Captain, Engineers, 10th Regiment Forestry, U. S. R., American Expeditionary Force, France.

Berg, H. J., Lieutenant, Aviation Section, Signal Officers' Reserve Corps, Ellington Field, Olcott, Texas.

Brock, Clarence A., Field Hospital No. 34, Camp Greenleaf, Medical Officers' Training Camp, Fort Oglethorpe, Ga.

Burrage, Charles W., U. S. Naval Air Service.

Carpenter, Charles I., Approvals Section, Finance Department, Equipment Division, Signal Corps, U. S. Army.

Carter, Clifford R., Equipment Division, Aviation Section, Signal Corps.

Christen, A. B., First Lieutenant, Signal Corps, American Expeditionary Force, France.

Clendon, G. W., Officers' Training School, Artillery Section, Camp McClellan, Ala.

Cooke, Eugene L., Coast Artillery Corps, U. S. Army, Fort Monroe, Va.

Dent, John A., Captain, Ordnance Department, National Army, American Expeditionary Force, France.

Duffy, Frank J., Lieutenant-Colonel, 103rd Regiment Engineers, Camp Hancock, Augusta, Ga.

Ericson, Edward O., First Lieutenant, Ordnance Officers' Reserve Corps.

Flowers, Alan E., Captain, U. S. R., Signal Corps, Land Division, Radio Development.

Fuller, Floid M., Lieutenant, U. S. Naval Reserve Force, Assistant Naval Inspector of Ordnance.

Gilmore, John W., Captain, Coast Artillery Corps, U. S. Army.

Gremmel, Henry F., Second Lieutenant, Ordnance Officers' Reserve Corps.

Hartzell, Earl F., Co. A, 319th Engineers, Camp Fremont, Cal.

Heilmann, Carl A., 303rd Engineers, American Expeditionary Force, France.

Hoskins, Stephen P., Candidate, Third Officers' Training Camp, Camp Lee, Va.

Hubbard, Guy, Ordnance Department, N. A., Ordnance Training School, Dartmouth College, Hanover, N. H.

Hunter, Charles F., Major, Ordnance Department, N. A., Frankford Arsenal, Philadelphia.

Johnston, A. Langstaff, Jr., Lieutenant, Inspector of Machinery, U. S. Navy.

Keet, Clarence T., Second Lieutenant, Engineers, N. A., 5th Co., Engineer Reserve Officers' Training Camp, Camp Lee, Va.

Kulling, O. W., Headquarters Co., 315th Infantry, Camp Meade, Md.

La Fon, Alphonse, First Lieutenant, U. S. R., 18th Co., Coast Artillery Corps, Fort Hancock, Sandy Hook, N. J.

Lindblom, Herbert R., Corporal, Co. E., 301st Engineers, Camp Devens, Mass.

Logan, Lloyd, Private, Co. D, 1st Quebec Regiment, Canadian Expeditionary Force.

Lohmann, Alfred P., Lieutenant Commander, Naval Reserve Flying Corps.

McJilton, John P., First Lieutenant, 65th Engineers, Camp Meade, Md.

Mabbott, H. C., First Lieutenant, Coast Artillery Corps, Fort Totten, New York.

Maury, Dabney H., Lieutenant-Colonel, Construction Division, Quartermaster Corps, N. A.

Miller, Fred J., Major, Ordnance Officers' Reserve Corps, Rock Island Arsenal, Rock Island, Ill.

Montgomery, H. M., Major, Quartermaster Corps, N. A.

Morrill, Guy L., Sergeant, Quartermaster Department, U. S. Army.

Morse, E. R., First Lieutenant, Ordnance Officers' Reserve Corps, 6th Ammunition Train, 6th Division, Headquarters, Camp McClellan, Ala.

Newman, W. C., Warrant Gunner, U. S. Naval Reserve Force, Boston Navy Yard, Charleston, Mass.

Parks, Burritt A., Captain, Engineer Officers' Reserve Corps.

Reckford, John King, Lieutenant, Junior Grade, Naval Reserve Flying Corps.

Robertson, Elroy C., Equipment Division, Signal Corps, U. S. Army.

Rosenfield, Harold, Aviation Section, Signal Corps, Reserve Officers Training Camp.

Royal, James M., Second Lieutenant, Aviation Section, Signal Officers Reserve Corps, School of Military Aeronautics, M. I. T.

Ruth, R. W., Chief Storekeeper, U. S. Naval Reserve Force, assigned to Washington, D. C.

Sauerwein, George K., Captain, Ordnance Officers' Reserve Corps.

Schaller, Alwin L., Captain, Ordnance Department, N. A., Aberdeen Proving Ground, Aberdeen, Md.

Summers, Daniel, Captain, 28th Engineers (Quarry), N. A., Camp Meade, Md.

Taylor, John E., 31st Engineers (Railway Operation Regiment), U. S. Army.

Wadsworth, J. Frederic, Co. A, Machine Gun Battery, No. 313, Camp Lee, Va.

Walbridge, Arthur H., Ensign, U. S. S. *Arkansas*.

Widdicombe, R. A., Major, Quartermaster Corps, U. S. Army.

PERSONALS

In these columns are inserted items concerning members of the Society and their professional activities. Members are always interested in the doings of their fellow-members, and the Society welcomes notes from members and concerning members for insertion in this section. All communications of personal notes should be addressed to the Secretary, and items should be received by May 16 in order to appear in the June issue.

CHANGES OF POSITION

Charles F. Merrill, formerly assistant chief draftsman of the Draper Corporation, Hopedale, Mass., has entered the engineering department of the James Hunter Machine Company, of North Adams, Mass.

Dwight K. Bartlett, until recently assistant treasurer of the Builders Iron Foundry, Providence, R. I., has become associated with the Electro Bleaching Gas Company, and the Niagara Alkali Company, with headquarters at New York City.

Harry K. Fox has assumed the duties of engineer of tests of the Chicago, Milwaukee and St. Paul Railway, Milwaukee, Wis. He was formerly connected with the Western Maryland Railway Company, Hagerstown, Md., in the capacity of chief draftsman of the motive-power department.

Erford J. Peebles has resigned his position of production engineer for the New Haven Clock Company, New Haven, Conn., to take a position on the staff of C. E. Knoeppel and Company, New York. He has been assigned to industrial engineering duties for the Emergency Fleet Corporation, U. S. Shipping Board, Washington, D. C.

Elroy C. Robertson, formerly with the Frantz Premier Company, Cleveland, Ohio, is now associated with the New York District Equipment Office, Signal Corps, U. S. A.

D. B. Clark, formerly superintendent of the shell department of the American Brake Shoe and Foundry Company at Erie, Pa., is now general superintendent of the Watervliet Arsenal, Watervliet, N. Y. Mr. Clark has charge of the entire production of this plant which is the largest and oldest arsenal in the United States.

William C. Fisher, formerly affiliated with the Griscom Russell Company, New York, has become associated with the American Agricultural Chemical Company, Liebig Works, Carteret, N. J.

R. A. Wentworth, until recently superintendent of the Saco Lowell Shops, Lowell, Mass., has assumed the duties of assistant superintendent of the U. S. Cartridge Company, of the same city.

R. H. Dunbar, formerly mechanical engineer with the American Tube and Stamping Company, Bridgeport, Conn., has accepted a position with the Providence Engineering Corporation, of Providence, R. I.

John E. Lovely, formerly connected with the Vermont Farm Machine Company, Bellows Falls, Vt., has become associated with the Jones and Lamson Machine Company, Springfield, Vt.

V. J. Mohler has assumed the position of factory manager with the Moore Motor Vehicle Company, with offices at Danville, Ill. He was formerly identified with the C. J. Tagliabue Manufacturing Company, of Brooklyn, N. Y., as assistant manager of factories.

Henry S. Isham, until recently affiliated with the New York Railways Company, New York, as draftsman, has entered the employ of Ford, Bacon and Davis, of New York, in the capacity of assistant engineer.

Stanley Munson has left the engineering department of the Proctor and Gamble Manufacturing Company, Kansas City, Kan., to become chief engineer for Kirkman and Son, Brooklyn, N. Y.

E. Burton Smith, formerly affiliated with the Westinghouse Lamp Company, Bloomfield, N. J., has entered the employ of the International Arms and Fuze Company, Inc., of Bloomfield, N. J.

Alfred L. Acuhler, recently with the Southwark Foundry and Machine Company, of Philadelphia, Pa., has accepted a position with the Cresson-Morris Company, of the same city, in the engineering department.

Julius G. Hayman, formerly superintendent of the Chattanooga Gas and Coal Products Company, Alton Park, Tenn., has become affiliated with the Union Carbide Company, Niagara Falls, N. Y.

J. Gordon Sparkes, recently associated with Robert D. Johnston, Jr., patent attorney of Birmingham, Ala., has joined the staff of the Standard Scientific Company, New York.

Alfred D. White has assumed the duties of chief operating engineer of the Standard Oil Company, of Brooklyn, N. Y. He was recently affiliated with the Economy Engineering Company, as manager of the New York office.

Edward J. Blanchard, formerly assistant engineer with R. Martens and Company, Inc., New York, has become associated with Young, Corley and Dolan, Inc., of the same city.

Frank L. Glynn, until recently secretary of the Wisconsin State Board of Industrial Education, Madison, Wis., has become affiliated with the Curtiss Aeroplane and Motor Corporation, Buffalo, N. Y.

Charles Foster has been appointed, by the Board of Water and Light Commissioners, general superintendent of the Public Utilities under their control, and assumed his new duties on April 1. He was formerly manager of the St. Paul office of Charles L. Pillsbury Company.

ANNOUNCEMENTS

Roy W. Gifford, affiliated with the Massey-Harris Company, Ltd., Toronto, Ont., Canada, as superintendent of the munitions department, has assumed the position of superintendent of the Toronto Works of the same company.

E. Edmund Jackson, of the H. W. Johns-Manville Company, is resident engineer in charge of roofing construction at the new Federal Shipbuilding Company's plant at Kearny, N. J.

Harry Himelblau, mechanical engineer with the American Steam Conveyor Corporation, Chicago, Ill., has been transferred from the Chicago office to the New York office of the organization and is now employed in the capacity of sales engineer.

Dwight S. Cole has discontinued his office as a consulting mechanical engineer and patent attorney, in Grand Rapids, Mich., due to failing health and sight. His plans for the near future include outdoor work of such a nature as may be helpful toward regaining normal health. He will continue to reside in Grand Rapids, and keep somewhat in touch with his former lines of activity.

Major H. M. Montgomery, Quartermaster Corps, N. A., has been relieved from his present station and duties and will proceed to Jeffersonville and take his station at that place for duty as construction quartermaster for the quartermaster storehouse to be located at that place.

Malcolm Curry, general engineer of the American Thread Company, Holyoke, Mass., Kenneth B. Millett, assistant general engineer, formerly at Willimantic, and A. C. Richardson, of Holyoke, are now located at the head office of the company in New York, to which has been transferred the office of the general

engineering department of the American Thread Company, which was formerly at the Merrick Mills at Holyoke.

Wilbur M. Bosworth has recently had patented steel center constructions, or underframes, which are being used by the Norfolk Southern Railroad Company in reinforcing old freight cars. Mr. Bosworth, who was formerly mechanical engineer with the Norfolk Southern Railroad Company, has become connected with the engineering department of the Under-Feed Stoker Company, Chicago, Ill.

Francis A. Vaughn, senior member of the firm of Vaughn & Meyer, consulting engineers of Milwaukee and Wausau, and Charles L. Pillsbury Company, consulting engineers of Minneapolis and St. Paul, has been engaged by the School of Engineering of Milwaukee as business manager and director of engineering and industrial relations.

James Brakes, Jr., has assumed the position of electrical tester for the Commonwealth Edison Company, of Chicago, Ill.

Harry A. Goalwin has become associated with Dr. Frederick Lester Stanton, of New York, and the two will act as consulting orthodontists and medico-technical engineers. Besides his work of developing this new field of mechanical engineering, Mr. Goalwin will continue his medical course at the College of Physicians and Surgeons, Columbia University, New York.

Arthur L. Roberts has been transferred from the position of mechanical engineer of the Lehigh Valley Railroad Company at South Bethlehem, Pa., to that of master mechanic of the same company, at Coxton, Pa.

Sidney Diamant, formerly at the De Mant Tool and Machine Co. of New York, is continuing his tool and manufacturing business under the firm name of the Diamant Tool and Manufacturing Co., Newark, N. J.

Louis Illmer has become associated with the American Whaley Engine Company, Boston, Mass., in the capacity of mechanical engineer.

William E. Hamilton has become connected with the Standard Parts Company, of Cleveland, Ohio.

Henry D. Jackson, formerly of Timothy W. Sprague and Henry D. Jackson, consulting engineers of Boston, Mass., has joined the organization of Monks and Johnson, engineers and architects, of Boston, Mass., as power engineers, in charge of their power plant and heating work.

Stevens Institute of Technology, Hoboken, N. J., recently conferred the honorary degree of doctor of engineering upon J. Waldo Smith, who was chief engineer on the new Catskill Aqueduct recently turned over to New York City to increase the water supply.

Sidney G. Walker has been appointed vice-president of the Manufacturers' Mutual Fire Insurance Company, Providence, R. I., with which firm he was formerly connected in the capacity of engineer.

NECROLOGY

EDWIN A. STEVENS

Col. Edwin A. Stevens, member of the famous old American family which in Revolutionary days practically founded what we now know as the city of Hoboken, died on March 8, 1918, in Washington, D. C., where he was serving as a field officer of the Emergency Fleet Corporation.

He was born in Philadelphia on March 14, 1858, and attended St. Paul's School, Concord, N. H., later entering Princeton University, from which he was graduated in 1879 with the degree of A.B. In 1905 he was given the degree of Doctor of Engineering by the Stevens Institute of Technology, founded in 1868 by his father, Edwin A. Stevens.

He served as Park Commissioner and as Tax Commissioner of New Jersey and also served on the commission which settled the long-standing boundary dispute between the states of New York and New Jersey. For some time he was also Commissioner of the New York and New Jersey Palisades Interstate Park. In 1880 he was made adjutant of the old Ninth Regiment of New Jersey, and later served on the staff of Governor Ludlow. His appointment as Colonel of the Second Regiment came still later, and he was commander of the regiment for six years. In 1911 he was appointed Commissioner of Public Roads by President Wilson when the latter was Governor of New Jersey. In 1914 he was reappointed by Governor James F. Fielder and served until 1917, when the laws were changed and the management of the road department was taken out of the hands of a commissioner and invested in a commission of eight members.

Colonel Stevens designed the *Bergen*, the first screw-propeller ferryboat. This vessel is still in commission and operates between Hoboken and New York. That invention marked a signal departure in the construction of such vessels and one which proved so satisfactory that all other ferry lines adopted the patent. He had many other inventions of a mechanical nature to his credit. He was president of the Hoboken Ferry Company until 1896 when it was taken over by other interests, later being acquired by the Lackawanna Railroad.

A little more than a year ago Colonel Stevens was appointed a member of the State Highway Commission by Governor Edge.

He was a member of the Society of Naval Architects and Marine Engineers and of the Institute of Naval Architects in Great Britain. He became a life member of our Society in 1889.

Lucius Lawrence Moses

LUCIUS LAWRENCE MOSES

Lucius L. Moses was born on November 26, 1868, in Marcellus, N. Y. He was educated in St. John's Military School, Manlius, N. Y., and later took a special shop course in Cornell University.

From 1889 to 1893 he served his apprenticeship with the Phenix Foundry & Machine Co., Syracuse, N. Y. He then entered the employ of the Paragon Plaster Co., as construction and operating superintendent, having complete charge of the engineering work and of the manufacturing. His next position was with the Clyde Gas & Electric Co., Clyde, N. Y., as treasurer and general manager. Mr. Moses held chief engineer's papers for ocean-going vessels, and from 1901 to 1909 he was in the service of the United States Government in that capacity. In 1909 he became associated with Henshaw, Bulkley & Co., San Francisco, Cal., as construction engineer, and later became consulting engineer in charge of the engineering work of the Hallidie Machinery Co., Seattle and Spokane, Wash. At the time of his death he was practising as a consulting engineer in Seattle.

Mr. Moses was a member of the Marine Engineers' Association, Seattle and San Francisco. He became a member of the Society in 1912. He died on October 15, 1917.

CANDIDATES FOR MEMBERSHIP

TO BE VOTED ON AFTER JUNE 10

BELOW is the list of candidates who have filed applications since the date of the last issue of THE JOURNAL. These are classified according to the grades for which their ages qualify them, and not with regard to professional qualifications, i.e., the ages of those under the first heading place them under either Member, Associate or Associate-Member, those in the next class under Associate or Associate-Member, those in the third class under Associate-Member or Junior, and those in the fourth under Junior grade only. Applications for change of grading are also posted. Total number of new applications, 90.

The Membership Committee, and in turn the Council, urge the members to scrutinize this list with care and advise the Secretary promptly of any objections to the candidates posted. All correspondence in this regard is strictly confidential. Unless objection is made to any of the candidates by June 10, and providing satisfactory replies have been received from the required number of references, they will be balloted upon by the Council. Those elected will be notified about June 15.

NOTE. The Council desires to impress upon applicants for membership that under the present national conditions the procedure of election of members may be slower than under normal conditions.

NEW APPLICATIONS

FOR CONSIDERATION AS MEMBER, ASSOCIATE OR ASSOCIATE-MEMBER

Alabama

ENES, JAMES T., Designer, Tennessee Coal Iron & R. R. Co., Birmingham

SIRNIT, JOHN A., Designing & Electrical Engineer, Alabama Power Co., Birmingham

California

CHURCHMAN, WILLIAM H., Superintendent of Pumping Stations, East Bay Water Co., Oakland

COOLEY, DICK M., Sales Engineer Howe Scale Co., San Francisco

Connecticut

LANEY, FRANK B., Representative in Field of M. M., International Silver Co., Meriden

POST, JOHN D., Assistant to Chief Engineer, The American Brass Co., Ansonia

SHUBERT, GEORGE E., Supervisor of Barrel Department, Remington Arms U. M. C. Co., Bridgeport

WOLFE, JOHN A., Power Superintendent American Brass Co., Ansonia

District of Columbia

BRANTLEY, PERLE P., Mechanical Draftsman, Gun Division Trench Warfare, Washington

HENSZEY, JOSEPH W., Captain, Ordnance Reserve Corps, Inspection Division, Washington

MESSER, THOMAS H., Captain, Engineer R. C., U. S. A., Washington

Illinois

DOWNING, LLOYD E., Efficiency Engineer, Troy Laundry Machine Co., Chicago

NICHOLLS, ALFRED T., Designer, Ar[illegible] & Co., Motive Power Department, Chicago

Kansas

SCHOOLEY, SYLVESTER S., Instructor in Electrical Engineering, University of Kansas, Lawrence

Maryland

HUSS, HENRY, Second Vice President, New York & Hagerstown Metal Stamping Co., Hagerstown

TALIAFERRA, JOHN C., Member of Executive Committee of Directors, Continental Can Co., Baltimore

Massachusetts

HILDRETH, CHARLES I., President and General Manager of Whitcomb-Blaisdell Machine Tool Co., Worcester

JACKSON, P. ANDREW, Mechanical Engineer, American Writing Paper Co., [illegible]

KNOWLES, LUCIUS J., President, Crompton & Knowles Loom Works, Worcester

MELLOR, ALFRED S., Expert Tool Engineer, Cambridge

MURRAY, JAMES A., Commission Merchant, Fall River

TURNER, FRANK A., Chief Engineer, Becker Milling Machine Co., Hyde Park

Michigan

THOMPSON, WILLIAM G., Mechanical Engineer, The United States Graphite Co., Saginaw

Missouri

MUDD, HERBERT K., Assistant Engineer, Steam Engineering Department, Union Electric Light & Power Co., St. Louis

SHANE, LOUIS, Commander, U. S. N., Acting Inspector of Machinery, Busch Sulzer Diesel Engine Co., St. Louis

New Jersey

CAMPBELL, E. GORDON, Superintendent of Construction, Public Service Electric Co., Engineering Department, Newark

HYDE, THOMAS E., Works Manager & Assistant Secretary Huhn Mfg. Co., Arlington

New York

CHAMPION, CHARLES H., Engineer Manager Electrical Division, H. Boker & Co., Inc., New York

FOSTER, CHARLES L., Engineer, Ossining Chemical Works, Ossining

JOHNSON, GEORGE A., Consulting Hydraulic Engineer and Sanitary Expert, New York

McNULTY, ALLEN C., Designing Mechanical Engineer, Westinghouse, Church, Kerr & Co., New York

MALCOLM, GEORGE H., Assistant Construction Manager, Otis Elevator Co., New York

PARSONS, [illegible] H., Engineer, Construction Department, American Locomotive Co., Schenectady

RUSSELL, JOHN M., Engineering Assistant, New York Telephone Co., New York

WHITE, [illegible] J., Superintendent of Machinery, [illegible] Co., New York

Ohio

AMOLD, [illegible] B., Sales Engineer, Hooven, Owens, Rentschler Co., Cincinnati

CARREL, J. WALLACE, Vice President and General Manager, The Lodge & Shipley Machine Tool Co., Cincinnati

THOMPSON, W. G., Inspector, Youngstown Sheet & Tube Co., Youngstown

Oklahoma

BURRELL, THOMAS L., Manager, Burrell Eng. & Con. Co., Oklahoma City

Pennsylvania

BELL, FRANK B., President, Edgewater Steel Co., Pittsburgh

COLBURN, C. P., Major, Ordnance R. C., Officer in Charge and Superintendent Fuse Shop F. A., Frankford Arsenal, Philadelphia

CUSHING, SAMUEL D., Managing Director, John B. Semple & Co., Sewickley

DAVIS, LUTHER A., Production Superintendent, Standard Screw Co., Corry

JONES, CARL G., Transformer Engineer and Designer, Westinghouse Electric & Mfg. Co., East Pittsburgh

KEBLER, ELIOT A., President, Fawcus Mach. Co.; Special Representative, The Matthew Addy Co., Pittsburgh

PENROSE, CHARLES, Engineer, Executive Staff, Day & Zimmermann, Inc., Philadelphia

Tennessee

FISCHER, FRED W., Chief Engineer, Master Mechanic, Standard Knitting Mills, Knoxville

Washington

BRETHERICK, CLARENCE O., Mechanical Engineer, J. F. Duthie Co., Seattle

COX, ALLEN H., President and Manager, A. H. Cox & Co., Inc., Seattle

Wisconsin

DEVLIN, EDWARD C., President, Universal Machinery Co., Milwaukee

TESCHAN, WALTER F., President and General Manager, Milwaukee Concrete Mixer Co., Milwaukee

Canada

JENCKES, JOHN M., General Manager, Engineering & Machine Works of Canada, Ltd., Sherbrooke, Ontario

China

GAITHER, ROBERT H., Manager Engineering Department and Acting Agent, American Trading Co., Shanghai

Cuba

ANDERSON, ROBERT A., General Sales Manager, American Steel Co. of Cuba, Havana

LOMBARD, J. OSWALD, Senior Partner, Lombard & Co., Havana

FOR CONSIDERATION AS ASSOCIATE OR ASSOCIATE-MEMBER

Massachusetts

GELINEAU, EMRIE E., Draftsman, The Lamson Company, Lowell

WASHBURN, EDWIN F., 1st Lieutenant, O. R. C., Watertown Arsenal, Watertown

Michigan
FASOLDT, Karl N., Heating and Ventilating Designer, Ford Motor Co., Detroit

Pennsylvania
HANDLOSER, Bertram F., Chief Engineer, Dilworth, Porter & Co., Inc., Pittsburgh
WILLIAMS, David G., Chief Engineer, Pennsylvania Trojan Power Co., Allentown

Wisconsin
CLARK, Edward S., Plant Manager and Engineer, De Pere Manufacturing Co., De Pere

FOR CONSIDERATION AS ASSOCIATE-MEMBER OR JUNIOR

District of Columbia
WILSON, Roger J., Computer in the Seacoast and Railway Mount Section, Engineering Bureau, Ordnance Department, Washington

Kansas
BOWMAN, George M., Senior Student in Electrical Engineering at University of Kansas, Lawrence

Maryland
RIDER, Albert L., Contracting Engineer, Albert L. Rider, Baltimore

New York
COLLINS, William, Assistant Engineer, Walter Kidde & Co., Inc., New York
FREAS, H. LeRoy, Mechanical Engineer, New York District for Elliott Co. of Pittsburgh, Pa., New York
GRIFFIN, Cecil M., Testing and Erecting, Alberger Pump & Condenser Co., New York
JAMISON, George S., Engineer, Underwriters' Bureau of the Middle and Southern States, New York
ROBINSON, Ralph L., Engineer, Salesman, Griscom-Russell Co., New York
RYAN, John A., Assistant Engineer, H. Boker & Co., Inc., New York

Ohio
ENGEL, Paul H., Lieutenant, O. R. C., Dayton

Pennsylvania
DUKE, Henry T., Equipment Specification Engineer, Ballinger & Perrot, Philadelphia

Porto Rico
CERECEDO, Javier H., General Manager, J. H. Cerecedo & Co., San Juan

FOR CONSIDERATION AS JUNIOR

District of Columbia
MALEY, Robert C., 2nd Lieutenant, Ordnance R. C., Washington
WALEN, Ernest D., Associate Physicist, Bureau of Standards, Washington

Florida
FRANKS, Norvin H., Material Agent, Ship Installing Yard for Emergency Fleet Corp., California Brick Co., Jacksonville

Illinois
BOLLING, John E., Chief Engineer, Drying Systems, Inc., Chicago
CHOATE, Donald H., 2nd Lieutenant, 332nd Field Artillery, Camp Grant

Maine
MARBLE, Gerald C., Proprietor, Skowhegan Monumental Works, Skowhegan

Michigan
MEISENZAHL, Julius A., Inspector A. and A.E., Detroit District Equipment Office, Engineering Department, Detroit

New Jersey
FEIST, Seymour, Production Engineer, Standard Aircraft Corporation, Elizabeth
FORD, Wendell B., Aeronautical Engineer, Aeromarine Plane & Motor Co., Keyport

New York
CONNOR, William B., President, W. B. Connor, Inc., New York
EVERETT, Russell W., Mechanical Engineering, Alberger Pump & Condenser Co., New York
IGLEHEART, George P., Ensign, U. S. Naval Reserve, Office of Superintending Constructor of Aircraft, Curtiss & Co., Buffalo
TYLER, Howard H., Testing Engineer, Alberger Pump & Condenser Co., Newburgh

Ohio
MADISON, Harry A., Naval Aviator, U. S. Naval Reserve Flying Corps, Cambridge

Pennsylvania
RAMAGE, Raymond W., Assistant to Production Engineer, Bethlehem Steel Co., Reading

Virginia
DEGLER, Howard E., Instructor in Mechanical Drafting and Science, Hampton Institute, Hampton

Wisconsin
HUTCHENS, Ralph W., Mechanical Engineer Gillette Rubber Co., Eau Claire

APPLICATIONS FOR CHANGE OF GRADING

PROMOTION FROM ASSOCIATE

Canada
SMALLWOOD, R. L., General Sales Manager, Dodge Manufacturing Co., Ltd., Toronto

PROMOTION FROM ASSOCIATE MEMBER

Maryland
FELKER, George F., Major of Ordnance, National Army, Engineering Bureau, care Gunpowder Reservation, Baltimore

Tennessee
WILFERT, George, Captain Ordnance R.C., Army Inspector of Ordnance, Columbian Iron Works, Chattanooga

Canada
GIFFORD, Roy W., Superintendent Toronto Works, Massey-Harris Co., Ltd., Toronto

PROMOTION FROM JUNIOR

District of Columbia
BATES, Harry H., 1st Lieutenant, Ordnance Department, U. S. A., Washington

Massachusetts
COOK, Harry H., Chief Engineer, The Chapman Valve Mfg. Co., Indian Orchard
WILSON, Chester W., Assistant Shop Superintendent, Boston Navy Yord, Boston

New Jersey
STONE, Edwin W., Assistant Production Manager, Whitehouse Le Compte Mfg. Co., Newark

New York
WHEELER, Seth, Jr., Vice President & General Superintendent, A. P. W. Paper Co. (Reinstatement), New York

SUMMARY

New applications..........	90
Applications for change of grading	8
Promotion from Associate	1
Promotion from Associate Member	3
Promotion from Junior....	5
Total..	107

EMPLOYMENT BULLETIN

THE SECRETARY considers it a special obligation and pleasant duty to make the office of the Society the medium for assisting members to secure positions, by putting them in touch with special opportunities for which their training and experience qualify them, and for helping any one desiring engineering services. The Society acts only as a clearing house in these matters.

GOVERNMENT POSITIONS

Stamps should be inclosed for transmittal of applications to advertisers; non-members should accompany applications with a letter of reference or introduction from a member; such reference letter will be filed with the Society records.

PROCESS INSPECTOR. Man should be capable of taking initiative in bettering conditions and methods of cartridge manufacture. Should be familiar with punch presses, drawing presses, and production on a large scale. Location, Massachusetts. 2596-A.

DIMENSIONAL INSPECTOR OF FINISHED COMPONENTS. Familiar with design and use of special gauges, verniers, etc. Location, Massachusetts. 2596-B.

BALLISTIC ENGINEERS to work on velocity and accuracy tests and data. Location, Massachusetts. 2596-C.

MAN conversant with shipping, tracing, and traffic management. Location, Massachusetts. 2596-D.

COMPETENT OFFICE MANAGER, capable of taking charge of, and disposing of, all office detail in plant. Location, Massachusetts. 2596-E.

All of the above preferably beyond draft age, or, if of draft age, outside of Class 1.

NUMBER OF MEN needed for duties in connection with the maintenance and operation of utilities, such as electric lighting, water supply, road construction, steam-heating plants, building repairs, etc. These men to be above draft age, and in addition to their technical knowledge, should be men who are capable of team work. 2604.

MEN WITH PRACTICAL PRODUCTION EXPERIENCE wanted as assistant superintendents. Those in late classification of draft considered. Location, New York. 2605.

ENGINEERS able to read and translate French, with some experience in the manufacture of steel and steel forgings. Men

[illegible] Location, New York City 2606.

PLANT ENGINEER, man of wide experience for work of exceedingly varied character. 2607 A.

ASSISTANTS TO OFFICERS IN CHARGE OF SHOPS. Men over draft age familiar with machine shop practices. 2607 B.

LUBRICATION ENGINEERS, qualified both in the theory and practice of the internal-combustion engine, as well as in the handling of lubricants, and the engineering side of lubrication. 2608.

CIVILIAN POSITIONS

SUPERINTENDENTS, ASSISTANTS, FOREMEN AND CHIEF OPERATORS. Chemical, electrical, electrochemical, gas, liquid air, refrigerating and mechanical engineers, all with operating experience. Staff of one hundred big men wanted by large industrial plant in Alabama engaged in important Government work. College men with technical training and familiar with cement, power, refrigerating, chemical, sugar refining and electric plants; operators experienced on mining and milling machinery, crushers, conveyors, compressors, furnaces, kilns, ovens. Competent men will be trained in the processes, paid good salaries during instruction, and given an attractive contract as soon as qualified. State age, nationality and experience. 088-E.

MAN WITH TECHNICAL TRAINING as mechanical engineer wanted in inventory and appraisal department of one of the eastern state commissions; one year or more experience in engineering work preferred. Some knowledge of accounting and of appraisal work desirable but not essential. Present engineering staff is small and good opportunity for advancement. Location, New Jersey. 0168 E.

STEAM PLANT SUPERINTENDENT for large paper mill in Canada. Engine room experience not necessary but technical education desirable. Salary commensurate with ability. 0169 E.

SUPERINTENDENT for boiler and machine shop employing about 100 men, building water-tube marine boilers; some engine work. Technical man about 35 years old with broad acquaintance and ability to handle men and actual experience in similar work. Exclusively Government contracts. Excellent opportunity for advancement. State age, nationality, salary, present employment, reference, and when available. Location, South. 0170 E.

ASSISTANT SUPERINTENDENT for outside erection work. Location, South. 0171 E.

CHECKER AND TWO MECHANICAL DRAFTSMEN on munition work, involving power plant equipment design, and handling machinery. Good opportunity for men willing to work hard on war work. Location, Delaware. 0172 E.

MECHANICAL ENGINEER with about five years' experience in power plant construction to act as assistant in connection with construction nitrate plant. Salary, $2,000. Should have deferred draft classification. Location Alabama. 0174 E.

MECHANICAL DRAFTSMAN experienced in power plant work for position in connection with construction nitrate plant. Should have deferred draft classification. Salary, $1,800. Location, Alabama. 0175 E.

INSTRUCTOR, elementary mathematics and mechanical drawing for apprenticeship school. Candidates should have had some technical training and shop experience and understand the handling of young men. Position offers excellent opportunities for advancement in the works and will pay an initial salary of $1200, or more, according to caliber of man. Location, Connecticut. 0176 E.

TIME-STUDY AND COST-WORK MAN, preferably about 27 years old, with actual experience in routine work for a machine shop doing work of a semi-standardized type, on large engines, not interchangeable; capable of setting times on large machine tools. Must be an American citizen. Salary about $30.00. Location, New York. 0177 E.

EXPERIENCED FACTORY PLANNING DEPARTMENT HEAD required by a New York company employing 2,000 men engaged in the manufacture of a variety of complicated electrical and mechanical apparatus. Applicant must have had at least five years' experience in tool design, routing, and dispatching. Excellent prospect open for the right man. State age, education, experience, salary required, and nationality. 0180-E.

FACTORY MANAGER. A well-known New York company employing about 1,800 men, engaged in the manufacture of a variety of electrical and mechanical apparatus, all covered by its own patents, is in need of an experienced factory manager capable of efficiently organizing and managing the factory department, which includes the following departments: welfare and employment, service and maintenance, planning and production, and a shop operating branch. Excellent opportunity. Write, stating age, education, experience, nationality, and other qualifications. 0181-E.

ASSISTANT CHIEF ENGINEER. A New York company employing about 2,000 men engaged in the development, design, and manufacture of complex electrical and mechanical apparatus for special purposes, requires an experienced assistant chief engineer capable of taking charge of mechanical design, standardization, and drafting, leaving the chief engineer free to devote himself to research, invention, and development. Applicant must be technical graduate with at least five years' mechanical designing experience. Excellent opportunity for an able man, position carries good salary, as well as the prospect of very interesting work and a broad future. State age, education, experience, nationality, and salary required. 0182-E.

DRAFTSMAN, with technical training and sufficient experience to enable him to lay out machinery in new plants, including the making of drawings, covering electric light and power systems. Permanent position. Prefer man with chemical plant experience, or one who has done drafting for consulting engineer. State fully qualifications and past experience. Salary $1,500 to start. Location, Southern Ohio. 0184 E.

MAN capable of taking charge of department employing about 100 men. Must thoroughly understand the bleaching, dyeing, sizing and calendering of cotton goods, a good handler of men. Position would pay about $35.00 per week to start and more after the man was able to demonstrate his ability. Location, near New York. 0185 E.

DRAFTSMEN of general mechanical experience, men of integrity reliability and industry, with experience in general drafting, design and layout work. State age, details of experience, salary expected and references. Location, Delaware. 0186 E.

BOILER MAN fully conversant with every detail of design and construction of steam boilers, particularly water-tube boilers. Must be willing to make an investment in a progressive boiler shop. Location, New Jersey. 0187 E.

FOUR OR FIVE TECHNICAL GRADUATES to take a standard apprenticeship course covering a period of two years in boiler shop. Location, New Jersey 0188-E.

DRAFTSMAN AND FIELD MAN. Young engineer with knowledge of anthracite colliery practice. Location, Pennsylvania. 0189 E.

PUBLIC SERVICE COMMISSION. Opportunity for several young technically trained men, preferably with some practical experience in mechanical or electrical engineering. Salary, $90.00 per month to start. Give particulars as to age, training, and experience. Location, New York. 0192-E.

SALES ENGINEER AND PURCHASING AGENT, preferably a man with experience in building line. Position requires man of caliber capable of doing purchasing for medium-sized factory and of handling the development of sales program. One not subject to draft or a late number in the draft. Preferably acquainted in and about New York. Headquarters, New York. 0194-E.

SALES ENGINEERS to represent a line of carefully selected power-plant specialties; sale involves a knowledge of their use and adaptation to power plants in general. Necessary that men have more than an outline knowledge of power-plant design, construction, and operation, in addition to ability and knowledge as salesmen. Prefer men with several years' experience as sales engineers. Location, Virginia. 0196-E.

YOUNG MEN, technically trained in mechanical engineering course, to enter engineering department of company manufacturing fluid meters and special equipment. Rapid advancement to outside power-plant engineering work. Location, Boston, Mass. 0197-E.

DRAFTSMEN for proposition department, in power-house and boiler-rooms, and in making estimates of costs, as an aid to sales department. Opportunities for young men of ability are exceptional. Important that men be conscientious and reliable. Location, New Jersey. 0207-E.

TRANSPORTATION ENGINEERS AND EXECUTIVES. Prominent truck manufacturer offers unusual opportunities for several mechanical engineers for organization and development work and to train for executive positions with owners of large truck fleets, the demand for which is only just beginning. The privilege of a short preparatory training at nominal pay is available. Write how qualified and salary expected. Location, New York State. 0208-E.

EVAPORATOR EXPERT. Engineer experienced in designing and selling of evaporating apparatus for large concern desirous of extending their business. Letter should contain detailed information as to past experience, qualifications, and salary expected. Location, New York State. 0210 E.

DRAFTSMAN acquainted with smelting work. Location, Texas. 0211-E.

SALES ENGINEERS for hand stoker. Will pay liberal commission on the gross sales price. Man should have a technical foundation and be familiar with combustion problems. Would expect man to spend two weeks

with organization to gather selling data, facts and operation of the stoker, thoroughly equipping him for work. Location, New England. 0212-E.

SALES ENGINEERS. Air-compressor manufacturer has several openings for locations in various district offices. State qualifications, experience if any, and compensation expected. Location, Illinois. 0216-E.

SEVERAL MEN WITH MECHANICAL ENGINEERING TRAINING wanted in connection with the various operating and test problems in operation of large power plant.

(a) TWO JUNIOR ENGINEERS with experience in test work on various types of power apparatus. Start with salary of $100 per month.

(b) For the shift operating jobs three vacancies. Start with a salary of $150 per month. Numerous opportunities for promotion and men who make good always considered for transfers to other various plants. Location, Virginia. 0217-E.

PLANNING-DEPARTMENT AND TIME-STUDY MEN. Well-established firm can offer exceptional opportunities for effective and interesting work to engineering graduates with substantial experience in modern industrial methods, with special reference to time study, the determination of standard tasks, planning and scheduling production. In reply state age, education, experience, present and expected salary. Headquarters Boston. 0218-E.

POWER-PLANT ENGINEERS. Well-known industrial concern engaged on important work for the Government wishes to engage the services of several power-plant engineers for the construction and operation of large power plants used in connection with important munition production for the Government. A technically trained college graduate preferred, although equivalent training elsewhere will be considered. Executive experience in the operation of large power plants is essential, supplemented preferably by experience in the construction of large power plants and familiarity with design. Practical experience should cover all of the usual forms of central station equipment and also power distributing systems, refrigeration, compressed air, hydraulic machinery, water-pump machinery, etc. Executive ability is most essential, to be combined with the necessary tact to give successful coöperation. Give fully particulars concerning qualifications including age. Please type information on a full-size letter sheet. 0219-E.

COMBUSTION ENGINEERS, with wide experience in the theoretical and practical operation of boilers and stokers; also executive experience in the operation of very large boiler rooms. Location, Delaware. 0220-E.

DRAFTSMAN AND ENGINEER, one well posted on mechanics and mathematics; up-to-date, with boiler-designing experience. State past experience, advising the past and present employers and how long employed by them, education, nationality and salary expected. Location, Chicago, Illinois. 0221-E.

DRAFTSMEN familiar with power station, piping, and piping layouts for a plant for the U. S. Government. Give age, training, experience, and lowest salary that will be accepted when writing. 0222-E.

SALES MANAGER who will keep in touch with production and shop operations and having wide experience in modern power piping. Eastern Location. 0231-E.

SHOP SUPERINTENDENT for small plant manufacturing gas engines and oil well supplies. Location, Okla. 0233-E.

PRODUCTION MANAGER to systematizing shop; small plant manufacturing gas engines and oil-well supplies. Location, Okla. 0234-E.

HIGH GRADE EXECUTIVE for position as assistant superintendent in factory employing 250 hands, manufacturing duplicate parts. Experienced in handling both men and women employees. Thorough mechanic, experienced in getting work through the shop, operating on a premium basis. State fully in first letter experience, age, nationality, references, salary expected and when available. Location, Ohio. 0235-E.

DRAFTSMAN OR TECHNICAL GRADUATE, mechanical engineer, with one to three years' experience in general mechanical drafting, in an industrial plant. Advise salary expected. Fine opportunity for energetic and original young man. Location, Minnesota. 0236-E.

TECHNICAL MAN experienced in economy and operation of boiler and power-house machinery. Location, East. 0237-E.

TESTING ENGINEER to take charge of testing in steam-turbine manufacturing plant in Western New York. Technical graduate and one with some knowledge of electricity; experienced in handling men. 0238-E.

SUPERINTENDENT, initial qualifications, several years' standing as a technical school graduate, from civil or mechanical engineering course; with energy, good judgment and ability to handle men. 0239-E.

ENGINEER, preferably with field-construction experience or with knowledge of erection work. Salary to start $1800 and good opportunity for advancement. Location, New York. 0240-E.

MECHANICAL ENGINEER AND EXECUTIVE MANAGER for chemical plant. State age, previous employment, salary and when available. Location, New Jersey. 0241-E.

POWER ENGINEER, mechanical and electrical engineer, capable of superintending complete power-plant proposition of cement-manufacturing plant, and of acting as assistant to superintendent of the plant in special study of improvements, fuel conditions, etc. Man 35 to 45. Location, Pennsylvania. 0242-E.

EXPERIENCED ENGINEERING CHECKER. State kind of experience, education, age, nationality and salary. Location, New York. 0243-E.

TOOL AND INSTRUMENT MAKER. Good organizer. Age 35 to 40 years, American born, good personality. Salary, $250. Location, Brooklyn. 0244-E.

EXPERIENCED TOOL DESIGNERS, salary depends on the man. Location, New York. 0246-E.

FIRE PROTECTION ENGINEER. Large plant in Detroit requires man to guard against fire hazards. Should be fully informed as to modern fire-prevention methods, with sufficient training and education in electricity and chemistry to fully appreciate hazards of this sort. In applying, state age, draft status, nationality, extent of education, detailed experience, present employment.

TEACHING POSITIONS. Assistants in mechanical construction and electrical engineering. Location, Rhode Island. 0249-E.

DRAFTSMEN AND CHECKERS. Government work. Location, New York City. 0250-E.

MECHANICAL SUPERINTENDENT for textile manufacturing plant. Salary, $1,800. Location, Rhode Island. 0252-E

SHOP INSPECTOR, preferably 25 to 35 years of age, familiar with car construction or structural work. Salary about $150. Permanent position for the right man. Location, New Jersey. 0256-E.

MECHANICAL ENGINEER. Excellent opportunity for a technical man with shop and drafting room experience with a growing concern in Connecticut making high grade specialized product. Work would be interesting and carries with it considerable responsibility. Applicant must give full particulars in answering. 0257-E

ASSISTANT TESTING ENGINEER, technical graduate, not subject to draft, with experience in steel heat-treatment and testing work, wanted by a growing concern in Connecticut, making a high-grade specialized product; knowledge of chemistry would be an advantage. Good opportunity and work interesting. Applicant must give full particulars in answering. 0258-E.

CONTROLLING INTEREST in prosperous machine tool and gage-manufacturing concern to be sold for best offer. Present owner to enter service. Well-known firm of wide reputation. Location, Connecticut. 0259-E.

CAPABLE PRACTICAL MAN to take entire business control of machine shop building special machinery, gages and tools. Engineer with business knowledge and experience in this line of work preferred. An interest in the business may be acquired by the right man. Location, Connecticut. 0260-E.

SALESMAN familiar with the sale, design and making of special machinery, tools, gages and fixtures, practical mechanical experience necessary. Good opening for right man. Location, Connecticut. 0261-E.

SALES ENGINEER, (0263-E), technical graduate familiar with automobile starting, lighting and ignition apparatus and electrical devices in general. Experience in plastic molding or die casting would be advantageous.

SERVICE ENGINEER, (0264-E), need not be a technical graduate but should be familiar with die casting and hydraulic press work.

If applicants for the above two positions are between the ages of 21 and 31 they should show cause for exemption or have numbers near the end of the draft call. Prefer a single man since the positions will require considerable traveling over a wide territory. Product is highly specialized and the first two or three months of employment will be spent in the shop and laboratory. Salary commensurate with experience and ability. 0263-E and 0264-E.

COLLEGE GRADUATES, men out at least a year, for general shop-engineering work, leading to industrial-management positions, with growing concern. State full particulars. Location, New Jersey. 0265-E.

SHOP SUPERINTENDENT for company manufacturing high-speed machinery for addressing, folding, wrapping and sealing newspapers for the mail. Man over draft age, must be resourceful; technical education, general rather than too highly specialized experience, with all-round shop experience, in machine tool operation, tooling for production, purchasing, laying out of shop, handling men, shop accounting, rate setting, cost production, estimating. Salary will depend on the individual man, his education, experience and native ability. Location, Chicago. 0266-E.

MEN AVAILABLE

Only members of the Society are listed in the published notices in this section. Copy for notices should be in hand by the 12th of the month, and the form of notice should be such that the initial words indicate the classification. Notices are not repeated in consecutive issues.

MECHANICAL ENGINEER, Member, at present professor of mechanical engineering in southern university, desires work for summer. Available from June 10 to September 10. Has had shop and drafting room experience, familiar with design of steam pumps, locomotives, and heating and ventilating plants, also building construction. E-118.

MECHANICAL ENGINEER, American, 14 years' practical experience in the manufacture of engineering specialties, machine tools and shop equipment; also power, machinery and shop maintenance, oxy-acetylene, welding, drafting, physical and experimental department. Familiar with brasses, iron and steel. An executive with initiative and aggressiveness. At present employed. Will go any place. Salary, $2800 and expenses. E-119.

ASSOCIATE-MEMBER, can furnish the best of references. Consider permanent position with a strong company. Salary, $2500 to start. Age 32, married. E-120.

MECHANICAL ADVISER AND DEVELOPMENT ENGINEER. Special-machine designer, policy investigator, practical and technical education, good organizer and systematizer. Specialist on mechanical efficiency operation. Expert on substituting mechanical devices for hand labor. Past 15 years specializing on designing, developing and manufacturing up-to-date cost cutting appliances, special equipment, tools and labor-saving devices for manufacturing special product efficiently. Age 35. Assoc. Mem. Salary, $4800. Desire new connections with large corporation contemplating improving or redesigning its present manufacturing methods where above experience is essential. Location, vicinity Newark or New York City. E-121.

GRADUATE ENGINEER, with ten years' active and consistent experience in the practice of principles of industrial management, is not an efficiency engineer or cost clerk. Will associate himself with a bank as industrial expert or with a large manufacturing enterprise as confidential assistant to president or manager, or will take charge of an executive department but not below works manager. Available July 1. E-122.

MECHANICAL ENGINEER desires position with concern in Philadelphia or California. Technical knowledge, drafting and shop experience. Age 36. Married. Full particulars on application. E-123.

PLANT MANAGER. Executive of proven ability, having wide experience in large factory management. Broad-minded with all-round mechanical training and practical knowledge of production methods. Investigate. Your time will not be wasted. Salary expected, $7500. E-124.

MECHANICAL ENGINEER AND EXECUTIVE. Technical graduate, 39 years of age. Six years' experience in design, construction and operation of ore concentrating plants. Six years' experience in sale and manufacture of ore-concentrating machinery, including thorough study of shop production and management. Employed, but desires responsible position with large mining corporation or with company handling government work and needing men of above qualifications. E-125.

MECHANICAL ENGINEER, CHILE, S. A. Technical graduate, M. E., 1911, married, age 30, American, with 7 years' experience in design along hydroelectric and mechanical lines. At present chief draftsman on construction work for large American mining concern. Available September 1. E-126.

EXECUTIVE, MANUFACTURING AND MECHANICAL. Desires to locate in Connecticut. Has wide experience in the manufacture of interchangeable parts for munitions and general hardware. E-127.

MECHANICAL ENGINEER. Member, age 40, American, 22 years' experience on automatic machinery, automatic press tools and deep-drawing press work, 12 years' experience in Connecticut brass shops, and ten years with present employers. Can design, supervise, organize or install new work as mentioned above. Present employer best recommendation. E-128.

JUNIOR MEMBER, expert in machine design, and a good all-around draftsman, desires part time work outside of regular position. E-129.

EXECUTIVE AND PURCHASING ENGINEER, Boston graduate, member, age 40, married, American, 20 years' experience covering the construction, operation, and maintenance of the estimation, appraisal and purchase for manufacturing plants. At present employed as assistant chief and purchasing engineer. Location preferred, New York City. E-130.

COMBUSTION ENGINEER. Associate-member, mechanical engineering graduate, age 30, married, in class IV of the draft, with five years' experience in the combustion of a variety of different American fuels, testing, investigating, designing and economy work, familiar with stokers, and different types of hand-fired furnaces both in high- and low-pressure work. Good record. Capable of responsible work. Only permanent positions considered. Minimum salary $2700. E-131.

MECHANICAL AND ELECTRICAL ENGINEER. Member, Cornell graduate. About twenty years' experience in general engineering and at present chief engineer for a company operating four manufacturing plants. Familiar with conveying, elevating, crushing, combustion, heat balances, testing and gas and steam problems. Highly recommended by present employer. Minimum salary $3000 per annum. E-132.

MECHANICAL ENGINEER, member, technical education, age 40. Sixteen years' experience with two large corporations on construction, power plant operation, and maintenance work, desires new connections as mechanical engineer in charge of engineering department, with medium- to large-size industrial plant. E-133.

SALES AGENT, mechanical engineer, technical graduate, thirteen years' experience in selling, designing, and estimating, desires to represent high-class manufacturer in New England territory with headquarters in Boston. Best of references. E-134.

CHIEF ENGINEER OR MASTER MECHANIC, with thorough technical and practical experience, covering construction, operation, and upkeep of steel plant. Specialty, metallurgical work, heating and melting furnace. E-135.

SAFETY ENGINEER, with six years' thorough technical and practical experience in this capacity, with large steel works in Pennsylvania. E-136.

PRODUCTION MANAGER, experienced on aeronautical engines and parts and high production on light-weight machinery, desires position as executive on Government work. Expert tool designer; experienced in shop efficiency and cost recording; understands all classes of automatic-machine work, including sheet-metal stampings. Salary about $300 a month. E-137.

MECHANICAL ENGINEER, Member, technical graduate, age 39, desires position as engineer or chief draftsman. Expert in design of high-power hydraulic turbines, governors, etc., also shop practice, layout of power plants and design of general machinery. One year's experience in a testing laboratory for machinery and material. E-138.

WORKS MANAGER OR GENERAL SUPERINTENDENT. Member. American, age 50, married. Thirteen years as superintendent and works manager of company manufacturing superheaters and other power plant specialties. A thorough understanding of gray-iron foundry, forge, and machine-shop practice. Has originated and developed machines and tools and proved good organizer and executive; previous experience as erecting engineer of hydraulic machinery. Desires position with growing concern. References. E-139.

ENGINEER, experienced in estimating, correspondence and sales, and in responsible charge of important work, for general machinery, pneumatic, pumping and pipe work. Age 33 years. Associate Member. E-140.

ASSISTANT PROFESSOR in mechanical engineering qualified by experience as a teacher and as an engineer. Well recommended. E-141.

WORKS ENGINEER, with twenty years' experience on engineering and scientific production; thoroughly versed in drafting, inspection, routing, rate setting, maintenance, tools and special machinery; age 40. E-142.

EXECUTIVE, Member, age 42. Present position 13 years. Manufacturing, drafting, construction, estimating and sales experience. Minimum salary $5000. Location New York. E-143.

MECHANICAL-ELECTRICAL ENGINEER, technical graduate with fifteen years' experience. Thoroughly familiar with engineering construction and operation of power stations and sub-stations. At present assistant superintendent with large public service corporation. Desires position as superintendent or mechanical engineer with direct responsibility and opportunity to expand. E-144.

EXECUTIVE OFFICER of leading industrial corporation, American born citizen, 48, graduate mechanical engineer, 25 years' manufacturing and business experience in this country and in Europe, as works manager, sales manager (domestic and foreign) and subsequently as general manager and managing director of European subsidiary company employing 3000 men, with headquarters in Paris. Recently returned to this country, on account of war conditions, and at present is employed as manager of corporation's foreign business. Desires position of responsibility in executive or selling capacity, offering opportunity to produce results. Highest New York and Pittsburgh references. E-145.

ENGINEERING SURVEY

A Review of Engineering Progress and Attainment in Mechanical Engineering and Related Fields, Including a Digest of Current Technical Periodicals and Selected Titles of Engineering Articles

Boston Society of Civil Engineers

At the last annual meeting of the society Prof. George C. Whipple, of the Civil Engineering Department of Harvard University and the Massachusetts Institute of Technology, delivered a presidential address entitled The Engineer as a Social Force in the New Democracy.

In recent years our forecasting of the future has been on a mathematical basis largely, but the problem has now changed to a social one. The new problem is political and ethical rather than physical and mathematical, and the engineer must join the other professions in the effort to solve this problem.

As regards the effects of the war, Professor Whipple expressed his belief that a readjustment of political and social conditions throughout the world is inevitable and that peace and tranquility will not come until these great questions are settled. After the war the great problems of the day will be social problems, and the engineer must play his part in them.

One social problem, as a result of the war, will be that of rewards. Labor is going to demand its share, and the engineer, who acts as intermediary between labor and capital, will be needed to solve the problem. Another great opportunity is offered the engineer for being a social force in the world, namely, to bring about harmony between the work and the worker. Just as the engineer is now the inspector of the work performed, he should also be the inspector of the men who perform the work.

The speaker called attention to the present opportunities for engineering work in foreign fields and declared that the engineer must henceforth think in terms of the world.

San Francisco Association of Members of the American Society of Civil Engineers

At a recent meeting of the association the subject of discussion was, "Why Have Not Engineers Achieved Higher Rank Among the Professions?" Seven members had been asked to prepare short talks on the subject and a committee was appointed to study and bring in recommendations on the various suggestions. The *Engineering News-Record* for March 28, 1918, reproduces some parts of the report of this committee.

There was a consensus that engineers should broaden their general knowledge of affairs; that in addition to a mastery of the technical side of engineering they should cultivate the ability to speak and write well, and after graduation endeavor to broaden by contact with other men, by taking part in civic affairs and by striving to develop administrative and executive ability.

Both the public and the engineer would benefit, it was held, if engineers were more active in public affairs and had a higher professional standing in the eyes of the public and the other professions. If a change in the status of the engineer is to be brought about, engineers themselves must take the initiative. The question then becomes, "What action is desirable?"

The first step, the committee believed, is to establish clearly just what kinds of engineers are being considered and what distinguishes one class from another. The term "engineer" or even "civil engineer" is too broad to constitute a classification. As a starting point, therefore, the committee suggested three classes: (1) Those who plan or design, (2) those who assemble or erect, and (3) those who manufacture or sell.

In other professions, it was pointed out, there are sharp lines of demarcation; the architect is not easily confused with the builder or with the manufacturer of building materials; the profession of the physician is distinct, and excludes the druggist and the chemical manufacturer. But civil engineers have not taken pains to establish such distinctions. Commercial activity has become so closely identified with professional activity in civil engineering that even those involved have difficulty in drawing the line. The layman is naturally less able to do so and therefore a "civil engineer" is generally thought of as a man with more or less specialized training, engaged in a technical phase of commercial activity.

The committee pointed out the need for further study along this line so that there could be an agreement on definition and classification. Objectives particularly desirable, it was believed, are (1) an up-to-date definition of what constitutes a civil engineer; (2) an up-to-date definition of a consulting engineer; (3) the classification of civil engineers professionally into the three groups suggested, and (4) a statement of ethics or standards by which these classifications shall be established.

Aeronautical Society of America

An open meeting was held in the auditorium of the Engineering Societies Building, April 4, at which the first report of the investigating committee of the society was presented.

After an investigation of several months the committee found a good many features in the execution of the American aircraft program to which objections were made—such as exaggerated statements of what has been accomplished; and excessively rigorous censorship, which, in the view of the committee, has interfered with production and precluded effective coöperation with the Government on behalf of the American engineering profession.

As regards the Liberty motor, it was stated that there is no doubt as to its being a good design, but that the production of the motor has been unnecessarily delayed by constant changes. From all information available it appears that while the low-compression low-altitude type may be considered as being developed to such an extent that with proper effort it can be turned over to standardized production in a comparatively short time, the development of the high-altitude type is still in its infancy.

Considerable space is devoted to the discussion of the state of research and invention in connection with the development of the aviation program. It is stated that the actual situation is as follows:

The entire matter is partly in the hands of the Signal Corps and partly of the National Advisory Committee for Aeronautics. The Signal Corps has somewhat over $2,000,000 avail-

able for this purpose and is doing work of a very high grade at the McCook Field, Dayton, Ohio, but the facilities available and the number of men employed are entirely inadequate for the tremendous program of the country.

Likewise, a good deal of research is being done at the Bureau of Standards, chiefly in connection with development of the Liberty motor. Here, again, the work is of the highest grade, but the staff is small and the facilities limited to such an extent that only matters of the most vital importance can be carried out.

The National Advisory Committee was organized long before the United States entered into the war, and consists of a few men who have many other and onerous duties to perform. The committee has at its command no laboratory facilities for testing out inventions and no organized technical staff for their consideration. The appropriation asked by the committee for the next year is only $260,000, an amount entirely inadequate for properly handling inventions affecting the program which may easily run into several billions of dollars.

The investigating committee suggested that the National Advisory Committee for Aeronautics be reorganized into a modern and adequate body with ample laboratory facilities and a staff of men who would devote their entire time to the consideration of new inventions. An adequate appropriation of something like $25,000,000 should be granted to the committee.

Representative John Q. Tilson, of Connecticut, in discussing the report, stated that he, as well as the Aeronautical Society of America, had only an attitude of extreme friendliness to the Aircraft Administration. He ascribed at least some of the delays in the execution of the program to two causes: First and foremost, the fact that the production, which is a purely industrial problem, was placed in the hands of the Army, which means men who, however highly fitted for the performance of their direct duties, were not equipped with the knowledge and experience necessary to handle the great and noble problems involved in putting through the construction of machines running into something like a billion dollars. Men have been called from the outside, from the industries, but they were put into uniforms, and in this way made subject to orders from men who, while superior to them in military rank, knew far less of the direct industrial problems involved. Machine construction ought to be in hands of captains of Industry, and not majors and captains of the Army.

The other cause of delay, of considerably lesser importance, was the constant desire to improve things and the delays due to tinkering with designs, which, in many cases, have already proved their worth abroad. Representative Tilson expressed his conviction that the aircraft program in particular, and the munitions program generally, are practically at the end of their past errors and that new and startling results on a really big scale may be expected.

A more complete abstract of the report of the investigating committee will be found in the *Iron Trade Review*, April 11, 1918. A practically complete report of the addresses at the meeting was published in the *Air Service Journal*, April 11, 1918.

German Textile Use of Nettles

Stinging nettle fiber as raw material for the textile industry is in use in a varying degree in Germany, Austria, Denmark and Switzerland as a result of the shortage of cotton caused by the war.

The British Board of Trade, which has been watching the progress in the use of the nettle, has issued a report, calling attention to the danger of ignoring a substitute which may become a serious competitor with staple industries before the full extent of the risk has been appreciated. Believing this to be the case with the stinging nettle, and hoping to make Germany independent of supplies of foreign cotton, the Germans have studied, tested and adopted it as a war necessity.

Large quantities were collected in the summer of 1916 under the provision *Nessel faser Verwertungsgesellschaft,* the new German war company, holding an exclusive right to purchase, if necessary by compulsion, all stems of stinging nettles (*Urtica Diocia*), whether native or imported. This company claimed that a tissue was obtained from the fiber comparing favorably with that manufactured from American cotton. When mixed with wool, a cloth of soft texture, resembling expensive woolen material, but much cheaper and easily dyed, is said to be produced, although this claim is not confirmed. By adding flax, cloth of other characteristics is obtained.

In Denmark, a government committee experimented with nettles, paying for them at the rate of 7 kroner per 100 kilograms. For textiles, only the fibrous part of the plants is necessary, and the committee favored the putrefaction method of separating this from the rest of the nettle. The main points of this method are:

1 The nettles are harvested in September and October, and are stacked like straw through the winter
2 Tops and leaves are removed
3 Stalks are rotted either (*a*) in a "rotting dam," consisting of a wooden cage sunk in a lake or other natural water, or (*b*) in hot water. The former process takes fourteen and the latter four days with the water at a temperature of 30 deg. cent. Experiments are still continuing to define the correct heat and time
4 Stalks are dried in the open air
5 Stalks cracked in a breaker
6 Stalks teased on a teasing board with a wooden knife
7 Fiber combed through a large iron comb or hackle, which finally removes all the remaining wood.

The fiber is then ready for the ropewalk or the spinning.

One of the difficulties of the putrefaction process is the presence of bacteria. Two prevalent sorts have been discovered, a beneficial and a harmful. It is said the harmful species can be removed by steeping the nettles in running water for two or five hours before commencing to treat them. Experiments are being conducted in the pure cultivation of these bacteria with a view to finding a simpler method of putrefaction. (*Journal of Commerce*, March 22, 1918, pp. 2 and 13.)

Course to Train Drafted Men for Technical Employments

A war-emergency course to train conscripted men for machine-shop occupations, blacksmithing, sheet-metal working, and pipe fitting, has been prepared by the Federal Board for Vocational Education and will be distributed to the schools throughout the country as soon as it can be printed. It is known as Bulletin No. 8.

"There is a critical and constantly growing need for many thousands of mechanics and technicians for Army occupations carried on in and behind the lines of the United States Army," declares the Board of Vocational Education. "Many of these workers, already experienced in similar occupations of civil life, will be secured through the draft and possibly through voluntary enlistment. It is recognized by those in a position to know that the quotas thus obtained will not be sufficient, and that it will be necessary to give special train-

ing to many thousands of men for various occupations and in various ways. The War Department has taken definite steps to provide for this training systematically through Army schools and in some instances at cantonments, but largely at the industrial trade, and engineering schools of the country."

The Federal Board for Vocational Education is acting for the War Department in preparing these courses of study and in dealing with the State authorities in charge of the school work. Men who take these courses, it is declared, "should not be led to believe that they are learning a trade. They are serving their country by learning to do a special job well, though to some e tent this training may be beneficial to them in after life." (*Official Bulletin*, March 29, 1918, p. 7)

International Air Traffic Company

According to the *Neue Freie Presse,* January 4, a new company has been formed in Austria-Hungary styled the International Air Traffic Company (Internationale Luftverkehr-Aktiengesellschaft, abbreviated "Ilag"). It is intended that the "Ilag" shall at first undertake the conveyance of letters and parcels on the route Hamburg-Berlin-Dresden-Vienna-Budapest-Belgrade-Sofia-Constantinople. From points in this main line numerous branch lines will run to the most important cities and traffic centers of Germany and Austria-Hungary, so that, according to present intentions, the whole of Central Europe will be covered, at no very distant date, with a close network of air lines. Passengers will be carried as well as postal matter.

Steps are to be taken to form separate companies in Austria and Hungary. The promoters are in touch with interests in Germany, so that there, too, a company will shortly be formed in close connection with the Austrian and Hungarian enterprises. The Austrian and Hungarian post-office administration, even before the war, had begun negotiations for a contract for postal dispatch, which can only be definitely concluded when the "Ilag" is ready to commence its service; negotiations, however, with municipal authorities have already commenced there with a view to providing landing places suitably equipped in all the towns covered by the new air service.

Meanwhile the legal committee of the Hungarian Aero Association has made an agreement with the Austrian Aero Club and the Imperial German Aero Club of Berlin that the contemplated interassociation conference for the purpose of establishing uniform laws for the air, to which those in Bulgaria, Turkey and Poland interested in the matter, are to be invited, shall take place in Budapest in the second half of 1918. (*Christian Science Monitor,* March 20, 1918, p. 9.)

The New U. S. Enfield Rifle

The Chief of Ordnance authorizes the following:

American troops are armed with a faster-firing and more accurate rifle than used by the Germans, according to our expert designers, manufacturers and marksmen.

The superiority claimed for the American weapon is supported on three counts: 1, quicker firing as a result of bolt-handle design; 2, easier and quicker sighting as a result of sight design; 3, greater accuracy of bullet flight as a result of bullet design, and greater mechanical accuracy of chamber and bore. Each of these points is e plained hereafter.

In both the attack and the defense of trench position the rifles are fired without removing them from the shoulder at a rate called "rapid fire," which is the most rapid rate of magazine fire consistent with quick accuracy.

When the Mauser rifle, with which the German troops are now armed, was designed in 1898, no one could foresee the development of "rapid fire" from the shoulder which followed, and the necessity for which is emphasized by present-day trench warfare.

In all modern rifles a "bolt handle" is used to lock the carriage in the chamber for firing. After each shot the right hand must leave the trigger, grasp the bolt handle, eject the empty shell, thrust home another cartridge—all done by movements of the bolt handle—and then push the bolt handle into the position which again locks the cartridge chamber. Thus the position of this bolt handle in reference to the trigger is of great importance to rapidity of fire.

The Mauser rifle has the bolt handle projecting horizontally from the rifle so that, in locking the bolt for firing, the index or trigger finger is left several inches above the trigger.

In the United States rifle (model of 1917, popularly called the modified Enfield) the bolt handle is bent not only down, but also an inch to the rear so that upon locking the bolt for firing the index finger is guided naturally into position for firing. This feature was adopted from the British Enfield rifle, model of 1914, as made in America for Great Britain. The speed of firing thus gained is considerable. (*Official Bulletin,* March 21, 1918, p. 13)

Proposed Screw-Thread Commission

A bill is now before the House of Representatives, introduced by Representative John Q. Tilson, of Connecticut, to establish a national standard of screw threads. In the record of the House was placed, among other arguments, a strong plea for the enactment of the bill forwarded by Calvin W. Rice, Secretary of The American Society of Mechanical Engineers. The early passage of this legislation was urged by all the witnesses, several of them declaring that the entire munition production program of the United States had been seriously delayed through lack of standardization, and especially because of the failure of various Government departments and manufacturers to reach an understanding as to screw-thread tolerances.

The bill, as reported, provides that the commission shall be composed of the Director of the Bureau of Standards, who shall act as chairman, one commissioned officer of the Army and one of the Navy, the remaining two members to be appointed by the Secretary of Commerce, one of whom shall be chosen from nominations made by The American Society of Mechanical Engineers, and the other from nominations made by the Society of Automotive Engineers. It may be the duty of the commission to ascertain and establish standards for screw threads, which shall be submitted to the Secretaries of War, the Navy and Commerce for their acceptance and approval. Such standards as are thus accepted and approved "shall be adopted and used in the several manufacturing plants under control of the War and Navy Departments, and, so far as practicable, in all specifications for screw threads in proposals for manufactured articles, parts and materials to be used under the direction of these departments." The Secretary of Commerce is directed to promulgate all such standards for use by the public and cause the same to be distributed as a public document. The members of the commission are to serve without compensation. The bill imposes no penalty for failure to conform to the standard established, and it is believed that no other consideration is necessary to induce manufacturers to accept the standards that have been adopted by the Government and will be enforced as to Government contracts. (*The Iron Age,* April 4, 1918, pp. 870-871.)

This Month's Abstracts

[illegible]o papers abstracted in this issue deserve especial men[illegible]. First is a paper by Harold Jeffreys in the *Philosophical Magazine* presenting a mathematical treatment of the problem of evaporation. The writer treats it as one of gaseous diffusion and derives an equation for evaporation identical in form with those that determine the transference of heat and momentum. In fact, an equation is derived where, for the case of transference being due to turbulence only, the coefficient k has the same value in evaporation as it has in transference of heat and momentum. This gives a definite physical meaning to the phenomenon of evaporation that may prove to be of great interest for the inverse question of condensation of vapors and drying of air.

Another paper of great interest is one by Albert E. Guy in the *Journal of the American Society of Naval Engineers*. In discussing the lateral flow of water under low heads the writer, among other things, shows that the so-called varying flow-head theory is untenable and also that the usual assumption that the pressure within the jet in the case of flow through a thin-plate orifice is atmospheric, is erroneous, and the common practice in measuring the flow through a horizontal orifice by means of the pitot tube with the pointed end of the tube placed along the horizontal diameter is wrong with such heavy fluids as water, since it results in showing a velocity and consequently a volume greater than the actual. A rather novel theory is offered to explain the generation of the velocity of flow of water issuing from a container through a lateral orifice into the atmosphere.

Fundamental systems for steam turbine alternators are discussed from a practical point of view. Among other things is given a formula for the loss on static head equivalent to the resistance to the passage of air through a round or square sheet-metal air duct.

The use of spruce in aeroplane construction is considered on the basis of tests made by the Forest Products Laboratory of the Forest Service, including the relation of shrinkage to specific gravity. In this connection the tests have proved that spruce tends to show a greater shrinkage in heavier pieces than in light pieces, and as a result of this pieces of low weight are likely to cause less trouble from shrinkage than the heavier and stronger pieces.

Substitutes in the German electrical industry are briefly discussed in an abstract from a British publication.

In the section Evaporation two tests are reported from the *Journal of the American Society of Naval Engineers*, one of a Reilly multicoil evaporator and the other of a "jetflo" regenerative evaporator. The tests on the latter are reported in some detail.

Jean Rey, in the *Proceedings of the French Academy of Sciences*, presents a paper on the entropy diagram of gasoline. The interesting part of this paper, which will be more fully abstracted in an early issue, lies in the fact that the thermal properties of gasoline appear to be directly opposite to those of water. For example, the saturated vapor of ordinary gasoline is superheated through fall of pressure.

The engines of the German "Gotha" biplane are described with their half-compression gear. The water pump and the air pump are also described and illustrated.

Annealing by muffle and pot ovens is discussed in a paper by Joseph B. Deisher. Among other things the writer emphasizes the great importance of maintaining a proper rate of cooling, particularly where it is desired to complete the annealing process in the shortest time possible.

A new pressure table for Elev lead crushers is discussed on the basis of the discovery made by H. W. R. Mason: namely, that lead crushers have the capacity of self-annealing, which is a function of the degree of decrement (or degree of resistance developed) and of time. This discovery, which is of immediate interest of course to manufacturers of munitions, may also prove of a much wider interest in view of the fact that the whole subject of the physical properties of lead is likely to undergo a profound reconsideration in the near future. Thus, it has already been stated that the accepted value of the atomic weight of lead may have to be changed and that possibly lead may have more than one atomic weight.

The influence of winter temperatures on locomotive capacity is discussed by W. L. Bean, Mem.Am.Soc.M.E., who states that a drop in temperature decreases the capacity of the boiler and also greatly increases the train resistance, because of the increase of journal friction with the increase in the viscosity of the lubricant. In this way cold weather appears to cut down the efficiency of train operation at both ends. The writer gives an interesting table showing the number of engines which would have to be added in a normal December and a normal January to make up for the loss of operating efficiencies due to winter temperature as compared with summer conditions.

In the section Research special attention is called to the description of the aerodynamic laboratory of the Leland Stanford Jr. University by Prof. Wm. F. Durand, Mem.Am.Soc. M.E. Some of the instruments in this laboratory have been developed especially for aerodynamic work, and the laboratory promises to become an important auxiliary for the testing of design factors of aeroplanes. The equipment for testing of air propellers appears to be especially complete.

A description of an installation where an air heater is provided for each boiler is abstracted from a British publication.

From *The Iron Age* is abstracted an article describing and illustrating a novel type of boiler baffles made of a refractory composition shipped in plastic condition and having a coefficient of expansion so small that the shape of the baffle practically does not change through variation of temperature. It is claimed that this permits of securing a highly airtight baffle.

An abstract of an article in *Power* gives particulars of a modified method of handling boiler pumps devised to prolong the average life of economizers. In this case the arrangement is such that all economizers get the water from the primary heater at a low operating pressure, the pump being in two stages as shown in the illustration.

"Torcrete" is a reinforced concrete specially prepared for ship construction and is said to bear about the same relation to ordinary concrete as rolled steel does to cast iron. Instead of being poured in forms the materials are shot in place by means of compressed air with the "tector," a new type of concrete blower. The processes are the invention of a Mr. Weber. The preparation is discharged on layers of steel fabric or wire mesh, and there may be as many layers as is necessary to produce the required thickness, the layers themselves massing with one another so as to form a perfect solid. It is claimed the torcrete vessels are lighter than wooden ships, built in shorter time and at lower cost than any other type of concrete ships, and that the method of construction is adapted to any size of craft or any form of metal that may be desired. A vessel of 3200 tons displacement has been contracted for by the Southern Oil and Transportation Company. (Philadelphia *Public Ledger*, April 6, 1918, p. 17)

REVIEW OF ENGINEERING PERIODICALS

SUBJECTS OF THIS MONTH'S ABSTRACTS

For Articles on Subjects Relating to the War, see Aeronautics, Engineering Materials, Machine Tools, Munitions, Varia

Aeronautics (See also Internal-Combustion Engines and Engineering Materials)

. The Theoretical Basis of Model Strength Tests for Aeroplane Structures, W. L. Cowley, and H. Levy. *Engineering*, vol. 105, no. 2722, March 1, 1918, pp. 219-221. (to be continued.)

Points in British Air Policy. *Automotive Industries*, vol. 38, no. 14, April 4, 1918, pp. 676-679. Based partly on a debate in the House of Commons on February 21 and also on articles in British medical periodicals. The most interesting part of it is that referring to medical attention to air pilots and influences affecting them in flight.

The Air Force Estimates. *Aeronautics*, vol. 14, no. 223 (New Series) February 27, 1918, pp. 194-199. Same as the preceding abstract, with the difference that the text of the debate is given more completely.

Aeroplane's Parts at a Glance. *Aerial Age Weekly*, vol. 7, no. 1, March 18, 1-18, pp. 52-53, 3 figs.

The Recent and Future Growth of Aerial Law: Lecture I, National and Imperial Laws, Dr. H. D. Hazeltine. *Aeronautics*, vol. 14, no. 230 (New Series) March 13, 1918, pp. 230-231.

Air Engineering (See also Steam Engineering)

Ventilation Systems for Steam Turbine Alternators, E. Knowlton and E. H. Freiburghouse. In modern turbo-generators as much as six times (or possibly more) the power is secured from a pound of material as was in the first large units. This means that proportionate quantities of heat must be dissipated per pound of material, and to prevent serious rise in temperature special means of cooling are necessary. For turbo-generators some sort of forced ventilation is usual.

The quantity of air required for cooling the generator depends on several factors in design, but in general varies approximately with the total losses of the machine minus those in the bearings.

The usual arrangement is that the air passing through the generator may be admitted and discharged wholly outside the turbine room or wholly inside, or partly inside and partly outside. This allows considerable control of generator and turbine-room temperatures throughout the year, and during the coldest weather the air that is passed through the generator may be admitted from and discharged inside the station. A suggestion is made to use the heated air discharged from the alternator for combustion under the boilers.

The design of air ducts is carefully analyzed and formulæ given. The difference in pressure expressed in inches of water necessary to pass the air through the duct is expressed as the loss in static head, the duct being assumed to be round or square sheet metal. This loss is then

$$H = [a + b + (c \div 39)]H_v$$

where H_v = the velocity head
a = the number of right-angle turns
b = the number of abrupt reductions in area
c = the length of duct ÷ diameter of duct.

Attention is called to the importance of maintaining the alternator and ducts free of dirt. In view of the fact that little data are available on the difference in operating temperature between a clean and a dirty machine, the following results of two tests on machines in commercial service are of interest. The loads were the same under both conditions:

	Dirty	Clean
Machine 1—Rise of armature winding, deg.	54	[illegible]
Machine 2—Rise of armature core, deg.	54	[illegible]

For cleaning the air an air washer is claimed to be preferable to screens. But if an air washer is used, it is quite important that all free or entrained water be removed from the air before it leaves the washer. The operation with air washers is discussed in detail. (*General Electric Review*, vol. 21, no. 4, April 1918, pp. 240-246, 5 figs., 5 tables.)

Testing an Air Compressor, Walter S. Weeks. Data of tests of an air compressor as carried out at the University of California for the purpose of giving an answer to the following two questions: How much does the compressed air cost? and is the compressor doing all that it should? In the course of this investigation a highly interesting chart of nozzle discharge was developed.

The paper suggests that all makers of air compressors should agree on a standard method of testing, and it is further suggested that a compressor be guaranteed with respect to horsepower input per 100 cu. ft. of air delivered, with the way of measuring the air carefully determined. (*Mining and Scientific Press*, vol. 116, no. 14, April 6, 1918, pp. 479-482, 2 figs.

Engineering Materials

The Use of Spruce in Aeroplane Construction, J. A. Newlin. The paper presents data obtained by the Forest Products Laboratory of the Forest Service. It gives some

[illegible] information relative to the species and conditions of growth of spruce, the influence of moisture conditions on aeroplane stock, and the relation of density to moisture content, shrinkage and strength. As density is recommended as the best criterion of strength qualifications, methods of determining density or specific gravity are included.

Spruce follows the general law of timber in regard to strength properties and weight: namely, all the strength values increase in proportion to the specific gravity. Two curves are given showing the variation of modulus of elasticity and maximum crushing strength with changes in specific gravity. It is found, among other things, that clear wood with specific gravities of 0.33 (based on value when green) or over 0.36 (when based on oven dry value) would seldom run below 4500 lb. per sq. in. in modulus of rupture or below 2000 lb. per sq. in. in maximum crushing strength along the grain when green. Drying to the condition of aeroplane stock would increase these minimum strength figures to about 8000 lb. and 4000 lb. per sq. in., respectively.

The conditions of moving material at the aeroplane factories are such that there must be of necessity a wide variation in the moisture content of machined material, the factors affecting this moisture content being: variations in the original moisture content, position of the specimen in the pile or conditioning chamber, and the difference in density of individual pieces which cause them to dry at different rates. It has been generally observed that of two pieces of the same species but different in density, the lighter piece will dry the more rapidly. The laboratory observations lead to the belief that a variation of as much as 10 per cent in the moisture content of the material as it goes through the machine may be expected, although no data on this point are available.

The relation of shrinkage to specific gravity is given in the form of a chart, the law in this case being expressed as a straight line.

Good spruce may be assumed to shrink about 12.5 per cent from the green to the oven dry condition. Were the material allowed to stand for several weeks at approximately the humidity condition of the assembling room before manufacture, it would probably all arrive at about a uniform and suitable moisture content, but under the forced conditions which exist, it is safe to assume that the better pieces of machined timber frequently have at least 5 per cent more moisture than they will ultimately have. This change of 5 per cent moisture, which may occur between the time of machining the part and its final use, might cause a reduction in one dimension of nearly 2 per cent and in the other of nearly 5 per cent, an amount of change sufficient, for example, in a built-up propeller to split and twist it.

An important part brought out by the tests is that spruce tends to show a great shrinkage in heavier pieces than in light pieces. Consequently, pieces of low weight, which would be considered of low quality, would not cause so much trouble from shrinkage as the heavier and stronger pieces. Hence, by throwing out material on account of a very slight undersize, except where the dimensions are taken immediately after machining, higher-quality pieces are likely to be excluded. (*Aerial Age Weekly*, vol. 7, no. 3, April 1, 1918, pp. 162-163, 3 figs., *ep*)

ACID-RESISTING IRON. Brief abstract of a paper read by Sidney L. Tongay before the London Section of the Society of Chemical Industry on March 4.

The paper discussed in detail the troubles encountered in making acid-resisting iron, due to its great shrinkage and the possibility of some of the compounds separating out during process of cooling and forming eutectics. Some tests recently made at the Manchester School of Technology showed that these eutectics consist largely of phosphorus and silica. These difficulties were largely overcome by suitable furnaces and improved manipulation in mixing the metal.

The paper gives the physical constants of acid-resisting iron as compared with cast iron. The heat-transmitting power of acid-resisting iron has been calculated at ten times that of stoneware or quartz, which makes it possible to make the parts much smaller. (*The Practical Engineer*, vol. 57, no. 1620, March 14, 1918, p. 127.)

A BIBLIOGRAPHY OF ALLOYS, Clarence Estes. *Metallurgical and Chemical Engineering*, vol. 18, no. 6, March 15, 1918, p. 312.

RAPID GROWTH OF AMERICAN MAGNESIUM INDUSTRY. *Metallurgical and Chemical Engineering*, vol. 18, no. 6, March 15, 1918, pp. 284-285. Brief data on the growth of the American magnesium industry now concentrated in the hands of two companies, The American Magnesium Company, at Niagara Falls, and the Rumford Chemical Company, at Rumford, Maine. Some data are given on the production of magnesium-aluminum alloys.

SUBSTITUTES IN THE GERMAN ELECTRICAL INDUSTRY. Discusses the question of substitutes in the German electrical industry and the way it was handled. The greatest difficulty which the electrical industry had to face in Germany was the shortage of copper and its alloys. The Germans developed the use first of zinc in the form of drawn wire and succeeded in reducing to some extent its brittleness and sensitiveness to change of temperature. Further new alloys of magnesium appeared, such as electrone (10 per cent aluminum, 90 per cent magnesium). Older alloys such as magnalium and duralumin were also used as well as iron.

In insulating materials, paper in different forms and compositions have to take the place of former materials. Regenerated rubber, that is, refined rubber substitute, took the place of soft rubber, while for hard rubber is used an artificial product of phenol and formaldehyde called faturan (a product of the same origin is called bakelite in America).

As a substitute for oil in electrical apparatus, a material called benzinoform was proposed, a substance developed from carbon tetrachloride (the material used in America in fire extinguishers). So far the experience with it has not been satisfactory because of its excessive volatility. (*Engineering*, vol. 105, no. 2723, March 8, 1918, pp. 246-249.)

THE CONSTITUTION OF THE COPPER RICH ALUMINUM-COPPER ALLOYS, J. Neill Greenwood. *Engineering*, vol. 105, no. 2724, March 15, 1918, pp. 277-281, 6 figs., 16 tables (to be continued). First part of an investigation conducted in the metallurgical department of the Victoria University at Manchester. An abstract will be given in an early issue.

CONDENSER TUBE FAILURE—PHOTOMICROGRAPHY, F. W. Sterling. *Journal of the American Society of Naval Engineers*, vol. 30, no. 1, February 1918, pp. 99-103, 20 figs.

THE USE OF CORK IN AERONAUTICS, Arthur K. Barnes. *Aviation and Aeronautical Engineering*, vol. 4, no. 6, April 15, 1918, pp. 369-370, 4 figs.

THE STEEL BASE AND GALVANIZED SHEETS. *The Iron Age*, vol. 101, no. 15, April 11, 1918, pp. 934-935, 3 figs.

PRINCIPLE OF THE GENERATION AND APPLICATION OF HEAT IN STEEL TREATING, A. F. MacFarland. *American Machinist*, vol. 48, no. 15, April 11, 1918, pp. 627-630, 8 figs.

Evaporation

Some Problems of Evaporation, Harold Jeffreys. A mathematical treatment of the problem of evaporation, which the writer considers as being practically one of gaseous diffusion. With this in view he gives an equation identical in form with those that determine the transference of heat and momentum.

If V denote the fraction of the density of the air at any point that is due to water vapor, V will vary from time to time and place to place according to the equation

$$\frac{dV}{dt} = \frac{\partial}{\partial x}\left(k\,\frac{\partial V}{\partial x}\right) + \frac{\partial}{\partial y}\left(k\,\frac{\partial V}{\partial y}\right) + \frac{\partial}{\partial z}\left(k\,\frac{\partial V}{\partial z}\right) \ldots . [1]$$

where k is the effective coefficient of diffusion, t the time, and d/dt denotes the total differential following a particle of the fluid. In general, V, as above defined, will be referred to as the concentration.

Then if u, v, w be the components of velocity and V be supposed to be expressed as a function of x, y, z, and t,

$$\frac{dV}{dt} = \frac{\partial V}{\partial t} + u\,\frac{\partial V}{\partial x} + v\,\frac{\partial V}{\partial y} + w\,\frac{\partial V}{\partial z} \ldots\ldots\ldots [2]$$

The boundary conditions are that the air in contact with a liquid surface is saturated, so that V is equal to the concentration in saturated air at the temperature of the liquid, and that at the great distance.

When the transference is due entirely to turbulence, the quantity k has the same value in evaporation as it has in the case of transference of heat and momentum.

The rate of transference outwards is given by an equation which determines the rate of evaporation, the latter, other things being equal, being proportional to the linear dimensions, since the electrostatic capacity varies in this way on bodies of the same shape. In this way the present formula agrees with Stefan's solution, which has been experimentally proved to be correct subject to certain conditions.

The case of evaporation due to steady wind blowing over a flat surface of water is next considered, and an equation is given expressing the amount of evaporation taken over the whole area. In particular, it is shown that for areas of the same shape and dimension proportional to a, the rate of evaporation would be proportional to $a^{1.5}$. This again is in accordance with the experimental results for bodies of medium dimensions discovered by Thomas and Ferguson.

The evaporation from a circular cylinder wet at the bottom and open at the top is considered next, as well as the very biologically important case of evaporation from the surface of a leaf. (*The London, Edinburgh, and Dublin Philosophical Magazine and Journal of Science*, vol. 35, no. 207, March 1918, pp. 270-280.)

Test of Reilly Multicoil Evaporator (Submerged Type), H. T. Dyer. A portion of the results of a test on this type of evaporator. It has been found that—

a There is an average reduction in capacity of about 11 per cent for each 1/32 increase of salinity.

b For each number of coils, vapor pressure and temperature difference there is a best water level for maximum capacity and safe operation with low chlorine content and no danger of priming.

c For vapor pressures below the atmosphere, the number of coils must be decreased to insure satisfactory operation.

d In order to obtain a capacity of 5000 lb. per hour for this evaporator, the blowdown must occur at intervals of 20 min. To avoid this too frequent blowdown, either continuous blowdown must be used or the water space of the evaporator must be greatly increased.

e The construction of the coils is such as to provide a very effective means of self-scaling of coils by sudden changes in temperature.

f The vapor produced is of exceptionally low chlorine content when the water level and temperature difference is within safe limits. (*Journal of the American Society of Naval Engineers*, vol. 30, no. 1, February 1918, pp. 78-98, 14 figs.)

Test of Regenerative Evaporating Apparatus, M. C. Stuart, Mem.Am.Soc.M.E. Data of tests recently made at the United States Naval Engineering Experiment Station, Annapolis, upon a patented system for the regenerative operation of evaporators, in which the efficiency of multiple effect evaporation was obtained with a single evaporator shell.

The essential feature of the system consists of a compressor called a "jetflo" compressor, Fig. 1, the function of which is to

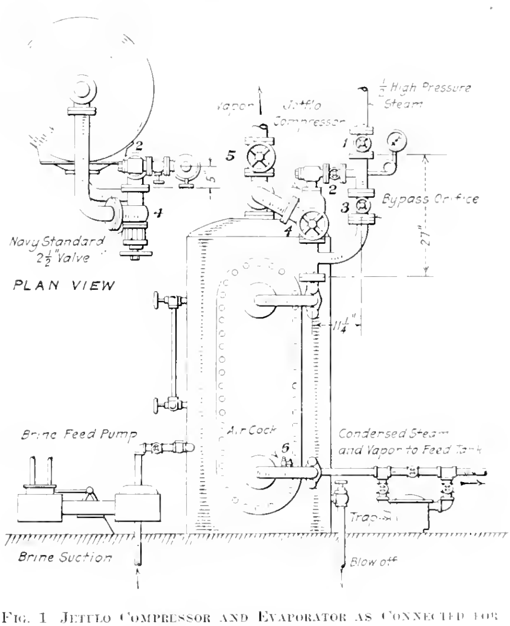


Fig. 1 Jetflo Compressor and Evaporator as Connected for the Tests Described

compress, by the use of live steam, part of the vapor produced by the evaporator and to return to the coils of the evaporator the compressed vapor together with the steam used in compressing it.

The principal objects of the tests were to determine for various conditions of operation the amount of steam used by the compressor, the vapor entrained and compressed, non-entrained vapor produced, total vapor produced, amount of compression produced by the compressor and temperature difference maintained between coils and shell. Besides these data certain facts were established by the tests.

Comparative performances of the jet compressor when equipped with two separate nozzle tips, as well as the typical performance characteristics of the jet compressor, are shown in Fig. 2. In the lower curves the pounds of vapor entrained per pound of steam supplied are plotted against the amount

of compression produced. That there is a definite relation between these two quantities for constant steam and vapor pressures is shown by the fact that for each nozzle tip the test points for all runs fall on a smooth curve which may be

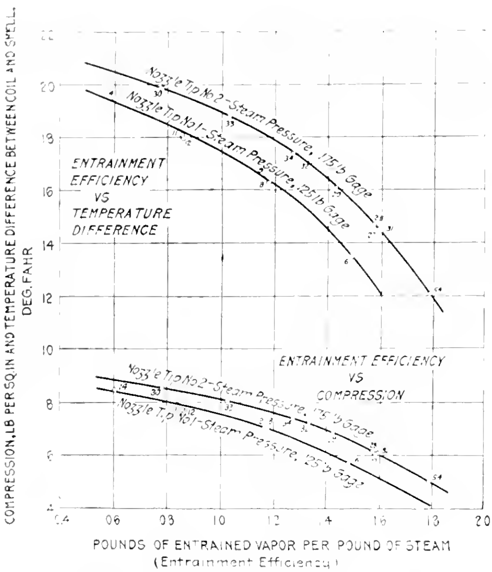


Fig. 2 Comparative Performance of Two Nozzle Tips on Jetflo Compressor

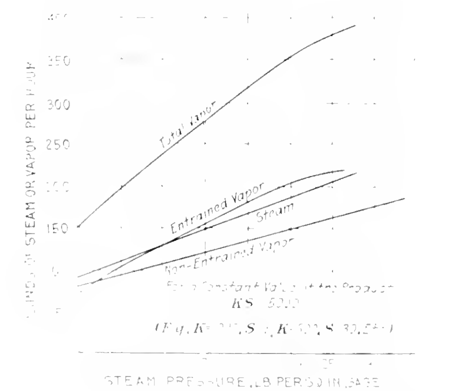


Fig. 3 Curves Showing Effect of Steam Pressure on Capacity of Compressor

termed a characteristic of the compressor. In the upper curves the pounds of vapor entrained per pound of steam are plotted against the temperature differences, and here also the points for each nozzle tip fall on a smooth characteristic curve.

Lines of constant value of the ratio pounds of vapor entrained per pound of steam used, which might be termed the entrainment efficiency, were drawn by the use of the relation: weight of condensate = weight of steam times (1 + entrainment efficiency). Within the range of proper operation of the compressor the entrainment efficiency varied from zero to 1.89 lb. of vapor entrained per pound of steam used.

It developed during the test that the performance of the jet compressor in connection with the evaporators was constant for a constant value of the product of heat-transfer coefficient and surface; that is, if the compressor operated at a certain point in its characteristic with the value of $K = 1000$ and $S = 10$ sq. ft., it would operate at the same point for values of $K = 500$ and $S = 20$ sq. ft.

To show the effect of steam pressure on capacity and efficiency several curves plotted from test data are given in the original article. Thus, the curves in Fig. 3 show that for a value of the product $KS = 15{,}000$, the steam, non-entrained vapor and entrained vapor each increase with increasing steam pressure. From another figure not reproduced here and showing the variation of efficiencies with steam pressure, it is seen that the non-entrained vapor produced per pound of steam is nearly constant at various steam pressures; this is due to the fact that, approximately speaking, the latent heat of the entrained vapor forms a closed cycle within the apparatus, being alternately given to the entrained vapor in the shell, given up therefrom in the cells and reappearing as latent heat of the steam in the non-entrained vapor.

From still another figure it is apparent that both the efficiency and capacity are increased by increasing either the surface or the heat-transfer coefficient in the product KS. For the smaller amounts of surface there is a considerable variation in capacity and efficiency with heat-transfer coefficient, but with the larger amounts of surface installed there may be a considerable variation in the value of the heat-transfer coefficient with little effect upon the capacity and efficiency.

The heat balance of the system is shown diagrammatically in Fig. 4, which gives the distribution of all heat units involved in the production of one pound of vapor. A weight of 1.10 lb. of a mixture of steam and vapor is required in the coils to produce 1 lb. of vapor, in this respect the action being

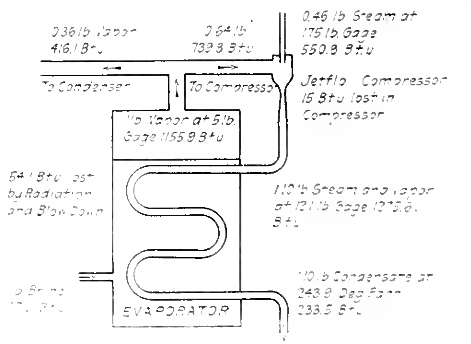


Fig. 4 Heat Balance of the Jetflo Compressor System

similar to the usual single-effect evaporator. The efficiency of the regenerative system lies in the fact that of the 1.10 lb. of mixture required in the coils only 0.46 lb. is required from the steam line and the remainder, 0.64 lb., is obtained from the entrained vapor which is compressed and returned to the coils and condensed in place of going to the distiller condenser to be condensed.

During operation of the evaporator the main steam valve

is opened wide, no throttling being required unless it is desired to operate at reduced capacity. When operating in connection with a distiller condenser in which atmospheric pressure is carried, the vapor valve to the condenser is opened wide. The valve in the vapor line to the compressor is left wide open, and the amount of vapor compressed and the pressure in the coils will adjust themselves. The maintenance of the proper water level, bleeding the air from the coils, attention to the drain from the coils and the maintenance of the proper salinity of the brine must be taken care of as in ordinary evaporator operation.

The system for the regenerative operation of evaporators, whereby part of the vapor is compressed by means of a jet compressor and returned to the coils, produces approximately the efficiency of a triple-effect plant in a single evaporator shell. The system operates with a relatively low temperature difference, and the amount of surface required to produce the desired capacity must be proportioned in accordance with the values tabulated in Fig. 2. An economical point of the design and operation of the system tested is for a steam pressure of 225 lb. gage and 17.48 sq. ft. of surface per 1000 gal. per day, assuming a heat-transfer coefficient of 1000. For these conditions the temperature difference will be 20 deg. fahr., and 2.15 lb. of total vapor is produced per pound of steam used. For lower values of heat-transfer coefficient the surface required must be increased inversely with the value of the heat-transfer coefficient. The use of a larger amount of surface results in increased efficiencies with the same amount of steam used. (*Journal of the American Society of Naval Engineers*, vol. 30, no. 1, February 1918, pp. 41-59, 12 figs., *e*)

Foundry

Die-Casting of Aluminum-Bronze, H. Rix and H. Whitaker. Paper read before the Institute of Metals on March 13, 1918, describing, among other things, the experiences of the authors in the production of die castings, especially 60:40 brass. A program for a scientific investigation into die casting is proposed, with a reservation, however, to the effect that the principal secret of die casting is experience. (*Engineering*, vol. 105, no. 2725, March 22, 1918, pp. 326-328, 1 fig.)

The Manufacture and Use of Die-Castings, Charles Pack. *Proceedings of The Engineers' Society of Western Pennsylvania*, vol. 33, no. 10, January 1918, pp. 668-692, 10 figs.

The Manufacture of Manganese Steel Castings, B. S. Carr. *The Armour Engineer*, vol. 10, no. 3, March 1918, pp. 155-186, 25 figs. Description of the manufacture of die castings, mainly as carried out at the Chicago Heights plant.

Urge Revised Casting Specifications. *The Iron Trade Review*, vol. 62, no. 15, April 11, 1918, pp. 904-905.

Fuels and Firing

Further Notes on Forced Draft, C. H. Willey. *International Marine Engineering*, vol. 23, no. 4, April 1918, pp. 241-243, 2 figs. Description of the Howden system of forced draft, with practical instructions for its application.

Combustion Characteristics of Coal, Joseph G. Worker. Discussion of the characteristics of coal mainly as affecting the selection of the equipment to burn the coal. From the paper it appears that the most important factor in the selection of stoker equipment is not the kind of coal to be burned, but the load condition of the plant. The available coal comes next, then draft conditions, and finally application conditions. A number of tests on the performance of various types of stokers with various coals are given. The coals discussed are anthracite, western bituminous, Pittsburgh, coke breeze, middle-western coals and lignite. (*The Electric Journal*, vol. 15, no. 4, April 1918, pp. 120-123, 5 figs.)

Increased Efficiency Through Proper Furnace Construction, Carl B. Harrop. *Brick and Clay Record*, vol. 52, no. 7, March 26, 1918, pp. 583-587, 8 figs.

Om Uppskattning av Gasformiga Brännmaterials Relativa Värde, Alf Grabe. Bihang till *Jern-Kontorets Annaler*, Arg. 19, no. 1, January 15, 1918, pp. 1-11, 2 figs., 2 tables. Description of methods of determining the relative heat value of gaseous fuels.

Diagramme Entropique du Petrole, M. Jean Rey. The physical laws of vaporization of gasoline are here expressed in the form of an entropy diagram, which will be reproduced in an early issue. The two main conclusions arrived at are that (1), the saturated vapor of ordinary gasoline is superheated through fall of pressure, and that (2), the heat of the liquid is always considerably higher than the heat of vaporization, both of these properties being opposite to those of water vapor. (*Comptes Rendus Hebdomadaires des Séances de L'Academie des Sciences*, Tome 166, no. 9, March 4, 1918, pp. 387-390, 1 fig.)

Unpreventable Losses in Coal Combustion Under Boilers, Haylett O'Neill. Calculations showing the relative magnitude of the various unavoidable losses in the combustion of coal under boilers. Charts are given showing (1) the relation between hydrogen, excess of air and carbon dioxide, (2) ratio of moisture to dry air for various humidities, and (3) relation between ash in the coal and heat value. An interesting chart gives the separate and total necessary losses as calculated in the paper. (*Power*, vol. 47, no. 15, April 9, 1918, pp. 502-504, 5 figs.)

Hydraulics

Lateral Flow of Water Under Low Heads, Albert E. Guy. Discussion of flow through a lateral orifice, with special regard to the question of head causing such a flow.

The case under consideration is that of a container filled with water and provided with the lateral orifice near its lower end. If water be allowed to flow freely out of the orifice into the atmosphere, the velocity of flow through the most constricted section of the issuing jet is generated at any given instant by a head having for its height the distance from the center of the orifice to the level of the water in the container at that instant. This velocity is somewhat diminished by friction against the walls of the orifice, with the further reservation that the head measured should represent only an approximate average between those obtaining at the upper and lower strata of the jet. As the head is made smaller, the condition gradually approaches that of the flow in open conduits or in river beds.

The writer discusses the application in this case of Bossut's equation and its possible limitations, as well as its application to an orifice only partly filled vertically by the outflowing water. (Case investigated by Poncelet and Lesbros.)

In that case it was found (Fig. 5) that there was a very noticeable rise of the vein past the lower edge of the orifice, the angle at the edge being 54 deg. According to the theory

as explained by Bossut, the flow head should be the greatest above the edge. If so, the velocity would be maximum there and the underside of the vein would be expected to remain a horizontal plane for quite a distance from the sill. This rise of the lower part of the vein may be observed with any kind of orifice when the depth of water from the sill to the bottom of the container is larger than the vertical thickness of the vein through the orifice, and the writer believes that the true significance of such rise has not been realized previously.

This, in connection with the fact previously observed, that very definite stream lines exist throughout the mass of water in motion in the container and converge from all sides toward

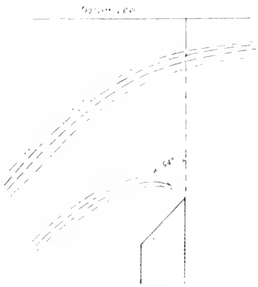


Fig. 5 Poncelet and Lesbros Experiment on the Flow Through a Partially Submerged Orifice

the orifice in the direction from the bottom to the sill, makes the so-called "varying flow-head theory" untenable.

From this the writer passes to the consideration of the general distribution of velocity at different points in the cross-section of a channel, and, referring to Fig. 6 (first shown by Darcy in 1857), he considers as predominant the fact that the velocity is very nearly constant along one even circuit, and in particular that it is practically the same at the lower extremity

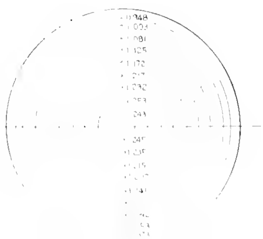


Fig. 6 Darcy Curves of Velocities of Flow Through a Cement Pipe

of a vertical diameter as at the upper end. It seems evident, therefore, first, since at the two ends of a vertical diameter the velocity is the same, that velocity is due to one head only, which in this case corresponds to the slope of the pipe, and second, that were it not for the frictional disturbances the velocity would be uniform throughout the whole section.

The question next discussed is whether there is a difference between a given cross-section of a stream flowing in a circular conduit and of a contracted vein flowing from a thin-plate orifice into the atmosphere, the flow being horizontal in both instances.

The writer shows that the usual assumption that the pressure within a jet is atmospheric is erroneous, and that the common practice in measuring the flow through a horizontal orifice by means of the pitot tube with the point of the tube placed along the horizontal diameter is wrong with such heavy fluids as water, since it results in showing a velocity, and, consequently, a volume, greater than the actual.

The measurement of hydrostatic pressures in the container and the question of various orifices are next discussed in detail. In this connection the writer discusses also the rotation of a jet issuing from an annular orifice, which he ascribes to the fact that the fluid is imperfect, that is, viscous, and is, therefore, subject to friction within itself, and also because the walls of the orifice and of the container are also imperfect and subject to friction. This friction is most intense along the edges of the orifice, and hence the streams in contact with the edge are retarded in their motion. Because of the velocity this retardation is communicated successively to the adjacent streams with diminishing intensity from the edge to the axis of the orifice where the velocity is known to be greatest, the axial portion of the jet flowing more easily and rapidly as the rest requires such active feeding from the upper level that a depression forms, which goes on increasing and assumes a funnel shape finally.

The most interesting part of the discussion is the theory that the velocity of flow of water issuing from a container through a lateral orifice into atmosphere is generated by the head or static height measured from the top of the contracted section of the issuing vein to the upstream level in the container. This assumes, of course, that the pressure upon the upstream level is that of the atmosphere; if it is not, the difference of pressure expressed in terms of head must be added or subtracted from the static height. (*Journal of the American Society of Naval Engineers*, vol. 30, no. 1, February 1918, pp. 60-77, 10 figs., *e*)

Internal-Combustion Engines

The Engines of the German Gotha Biplane. A series of articles is now appearing in *The Engineer* (the first article appeared on February 22, 1918) describing the engines of captured German aircraft. The first articles described the Maybach engine as used in the zeppelins and other airships. The present article describes the Mercedes engine as used in big Gothas.

One of the interesting features of this latter engine is the so-called half-compression gear used in order to reduce the compression when the engine is being started.

For this purpose means are provided (Fig. 7) whereby the camshaft may be moved longitudinally through a short distance so as to bring into action an additional face on each exhaust cam. The small auxiliary cam face is formed on the mid-axis of the exhaust cam towards one side and during the compression stroke opens the exhaust valve 12 deg. above the bottom dead center, and closes to 44 deg. before the top dead center. The edge of the auxiliary cam and of the roller in the rocker arm are beveled to 45 deg. to permit of easy engagement when the camshaft is shifted. The longitudinal movement of the camshaft is effected by partially rotating the handle shown at its end in the illustration. This handle is attached to a gun-metal collar contained within an aluminum housing and threaded internally.

The thread within the collar engages with the thread on the exterior of a steel sleeve, the forward end of which is flanged to engage with the double ball thrust bearing fixed to the end of the camshaft. The beveled gearwheel driving the camshaft

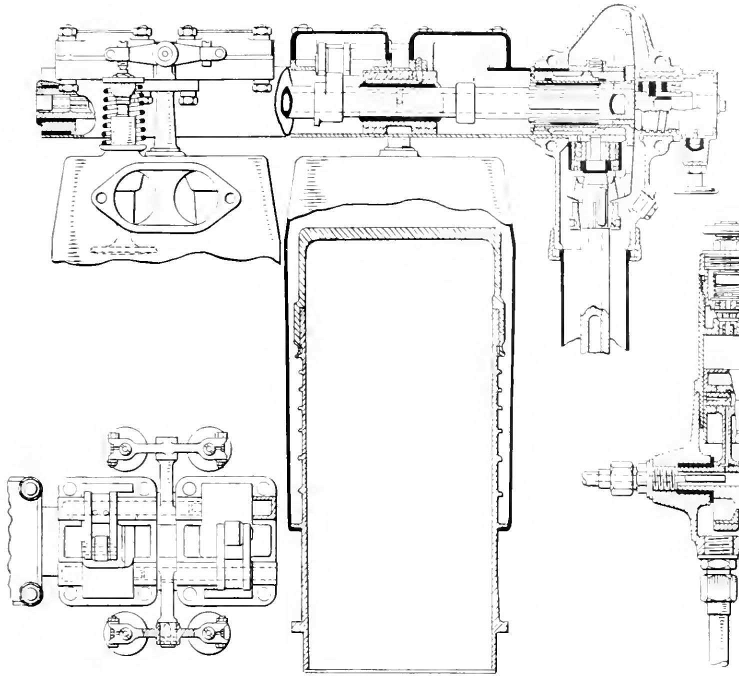


FIG. 7 ARRANGEMENT OF CAMSHAFT AND HALF COMPRESSION GEAR

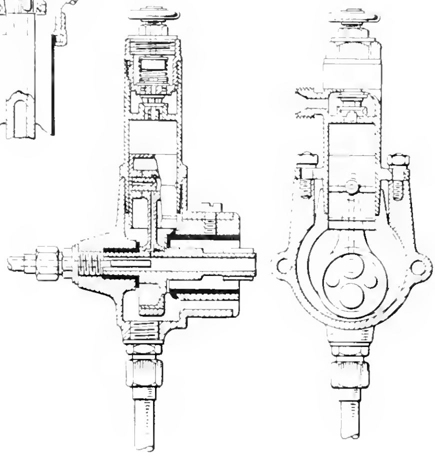


FIG. 8 AIR PUMP

has an extended boss that fits within a split gun-metal bearing driven into the rear end of the camshaft case. The interior of this boss has six serrations which engage with similar serrations on the camshaft so that the movement of the latter does not affect the meshing of the beveled wheel with the beveled pinion.

The drawing reproduced here is taken from an official report but it does not appear to be correctly sectioned.

The cooling water is circulated by means of a centrifugal pump disposed with the axis of its rotor vertical and collinear with the axis of the vertical shaft driving the camshaft—see Fig. 7. It is driven through bevel gearing from the crankshaft. As shown in the section of it given in Fig. 9, the pump draws its supply from below. The vanes formed on top of the rotor serve to throw the water away from the spindle, the object presumably being to assist in the prevention of leakake. The spindle is not provided with a packing gland. Instead of it a hardened steel washer is let into a groove turned in the upper face of the rotor and is pulled up against the lower end of the spindle bush by a spring acting, through a ball thrust bearing, against the under side of the flanged head of the spindle. The flanged head is provided with two claws that engage with the foot of a short vertical driving shaft as illustrated in Fig. 7. The spindle of the pump is lubricated by means of a grease cup operated by a ratchet from the pilot's seat.

The petrol is fed to the carburetor by placing the tanks under air pressure. The air pressure is supplied by a small pump, Fig. 8, mounted at the front end of the camshaft and driven by it through serrations, which preserve the driving connection when the half compression handle is rotated and the camshaft slides. The bore of the pump is 26 mm., camshaft diameter 27 mm. The drawing does not show the inlet port, but the delivery valve is seen on the center line above the piston. The air is delivered into a small chamber from which a connection is taken to the fuel reservoir. In the top wall of this

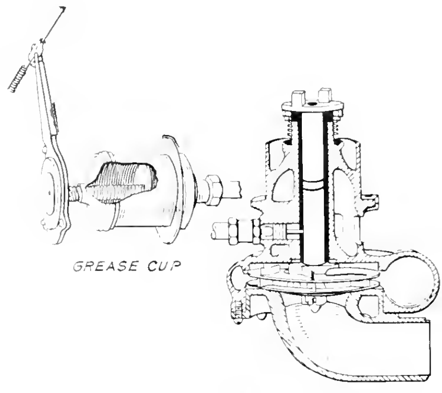


FIG. 9 WATER PUMP

chamber, ports (closed by a flat disk valve) are formed to relieve excess pressure. The strength of the spring behind the disk valve is adjustable by means of a screw handle, the stem of which is hollow and affords a passage for the surplus air.

The oil pressure pump, of a rather complicated design, is described in some detail in the original article. A special oil-supply pulsation damper is also described and illustrated. (*The Engineer*, vol. 125, no. 3244, March 1, 1918, pp. 182-184 illustrated, *d*)

Lubrication (See also Railroad Engineering)

STUDIO SUGLI OLI LUBRIFICANTI PER TRASFORMATORI. *Rivista Tecnica delle Ferrovie Italiane*, Anno 7, vol. 13, no. 2, February 15, 1918, pp. 63-77, 2 figs., 1 chart.

STANDARDIZED SPECIFICATIONS FOR LUBRICATING OILS, C. W. Stratford. Discussion of possible standard specifications for lubricating oil. As regards the stability of oils, the writer considers the oxidation test the only dependable and satisfactory one. The main facts shown by this test are the evaporation loss and the rate at which solid hydrocarbons are formed by polymerization or precipitation when oils are exposed to working conditions of an engine.

Distillation of finished oils under a high vacuum offers an unfailing means of determining their situation, that is, of what groups of hydrocarbons highly volatile or less volatile the finished oils may consist.

The various tests are described in detail, and the properties of representative American lubricating oils for use in internal combustion engines are given in a table.

It is stated that the investigation here discussed was carried out at the suggestion of the chairman of the Automotive Products Section of the War Industries Board. (*Aerial Age Weekly*, vol. 7, no. 1, March 18, 1918, pp. 48-51, 4 figs.)

Machine Parts

SAFETY AND RELIEF VALVES, M. W. Link. *International Marine Engineering*, vol. 23, no. 4, April 1918, pp. 172-174, 6 figs.

JOINTS AND JOINTING MATERIAL. *The Engineer*, vol. 125, no. 3245, March 8, 1918, pp. 212-213. The subject of jointing materials, both plastic and sheet packing, is discussed in detail, as well as such metallic joints as those of lead wool.

VALVE CAMS, Ernest G. Ritchie. Notes on the design of three types of valve cams—(1) a cam giving constant rate of change of acceleration, (2) a cam giving constant acceleration, and (3) a tangential cam.

The investigation here described indicates that a cam designed to give constant rate of change of acceleration has many advantages, and it should result in much "sweeter" motion of the valve gear, giving longer life of the moving parts. Also, it should result in higher volumetric efficiency so far as the engine itself is concerned. (*The Automobile Engineer*, vol. 8, no. 111, February 1918, pp. 34-36, 7 figs.)

FRICTION CLUTCHES, Herbert L. Towns. *The Automobile Engineer*, vol. 8, no. 3, February 1918, pp. 54-59, 12 figs. Paper presented to the Coventry Branch of the Graduate Section of the Institution of Automobile Engineers. The design of the various types of clutches is described in considerable detail.

Machine Shop

ANNEALING BY MUFFLE AND POT OVENS COMPARED, Jos. B. Deisher. Discussion of carbon losses in these two methods of treating malleable iron and data of tests made in this connection.

The writer points out that in the matter of annealing temperatures for malleable cast iron much depends on the chemical composition of the hard iron.

For many reasons it is often desirable to run the temperature considerably higher than 1400 deg., the maximum and minimum temperatures of annealing being in the case of pot ovens 1650 and 1450 deg. fahr., and in the case of muffle ovens 1700 and 1500 deg., respectively. Further, exhaustive tests have shown that prolonged annealing has no detrimental effect on the physical strength of the product unless the temperature is run too high, and it is safe to say that more poor malleable cast iron is produced by underannealing than by overannealing.

For reasons not generally announced it has been found necessary to hold castings at annealing temperature from 60 to 72 hours before the cooling process is commenced. Otherwise, the result will almost invariably show that the iron carbide has not been completely dissolved, this combined carbon causing brittleness.

The writer believes, however, that 60 hours are not actually required to dissolve the iron carbide and that its dissolution is largely a matter of heat penetration, particularly where the muffle-type oven is used, while in the pot oven there is little doubt but that the nature and composition of the packing material affects the dissolution of the iron carbide.

An opinion is expressed that had annealing temperature been made as high as the casting would stand at the beginning of the anneal, then the casting withdrawn before 60 hours of annealing had been completed and cooled very slowly, the result would doubtless have shown that a greater percentage of the carbon had precipitated as graphite. The writer recalls an incident where by accident the arch forming a muffle chamber in a muffle-type oven fell in and the fire had to be shut off about 36 hours before the regular time. The stack chamber and the oven were sealed up practically airtight and allowed to cool down as slowly as possible with the result that when the oven was opened the castings were found to be fairly well annealed. The carbide appeared to be completely broken up, but there was scarcely a trace of decarbonization visible without the aid of a microscope, which the writer ascribes to the fact that the annealing temperature was high when the accident occurred while the cooling was extremely slow, thus allowing plenty of time for the precipitation of graphite.

In the estimation of the writer, aside from the absolute necessity of first completely dissolving the iron carbide, the rate of cooling is of the utmost importance, particularly where it is desired to complete the annealing process in the shortest time possible. The writer recommends the following practice: To reach the highest temperature at the beginning of the anneal and hold it until the iron carbide is dissolved; then gradually dropped to 1400 deg., which, besides favoring the precipitation of graphitic carbon, would also lessen the danger of warping.

TABLE 1 COMPARATIVE RESULTS ON POT-OVEN AND MUFFLE-OVEN ANNEALING

	Pot Oven		Muffle Oven
	Mild packing	Strong packing	Without packing
Total carbon in hard iron, per cent	2.63	2.63	2.63
Combined carbon after anneal, per cent	0.53	0.13	0.05
Graphitic carbon after anneal, per cent	1.75	1.85	2.12
Total carbon after anneal, per cent	2.28	1.98	2.17
Total carbon removed in anneal, per cent	0.35	0.65	0.46
Wedge test, length of butt in inches	2⅞	2¾	2
Tensile strength, lb. per sq. in.	49,448	50,044	49,542
Elastic limit, lb. per sq. in.	38,746	37,122	37,398
Elongation, per cent in 2 in.	6.3	6.7	7.3

As regards the comparative advantages and disadvantages of muffle ovens, the principal advantages in favor of the muffle oven are: elimination of labor required to pack, handle and shake out the pots; cost of packing material; expense of renewing pots, etc. The disadvantages are: longer time required to bring the casting to annealing temperature; the castings are more apt to become warped or distorted. There is more danger of the castings becoming scaled due to the air leakage into the muffle and finally, small and delicately constructed castings cannot be annealed in this type of oven at all, unless they are packed in trays.

Table 1 gives the comparative results of pot-oven and muffle-oven annealing. (Paper presented at the Boston Convention of the American Foundrymen's Association, abstracted through *The Foundry,* vol. 46, no. 308, April 1918, pp. 154-158, *cp*)

The Salvaging of High-Speed Steel. *The Iron Trade Review,* vol. 62, no. 14, April 4, 1918, pp. 845-848, 16 figs. Popular description of some practical methods for conserving high-speed steel, including the discussion of electrically welded tools and the use of formed cutters.

Templets, Jigs and Fixtures, Joseph Horner. *Engineering,* vol. 105, no. 2724, March 15, 1918, pp. 274-277, 24 figs.

The Process of Case-hardening, E. Standiford. *American Machinist,* vol. 48, no. 13, March 28, 1918, pp. 542-544. Discussion of the process of case-hardening, giving a number of practical suggestions as to carrying out of the process. It is said that the best results have been obtained by allowing the pieces to cool after cementation and then reheating them before quenching. Interesting details are given as to the water hardening of the pieces.

Manufacturing the Addressograph, M. E. Hoag. *American Machinist,* vol. 48, no. 12, March 21, 1918, pp. 491-494, 13 figs.

Development of the Pneumatic Sand-Blast, Glenn B. Harris. *American Machinist,* vol. 48, no. 12, March 21, 1918, pp. 497-501, 4 figs. A descriptive article of a practical nature showing the different types of sand-blast and giving general suggestions as to the design and use of such apparatus.

Machine Tools

Manufacture of Machine Tools in Switzerland, C. E. Carpenter. It is said that the machine-tool industry of Switzerland has experienced a phenomenal growth since the beginning of the war. Tools of many types and sizes are being produced in large quantities, but the supply is not equal to the demand. In particular, exportation of machine tools has increased by leaps and bounds.

The types of machines which have figured most prominently in Swiss exports during the last years are engine lathes up to 24-in. swing and 12 to 15 ft. between centers, turret lathes up to 2-in. spindle capacity, bench precision lathe, thread milling machines for fuse work and shells, universal milling machines and grinding machines.

The various types of machines exported are briefly described. (*American Machinist,* vol. 48, no. 12, March 21, 1918, pp. 485-486.)

Making Concrete Metal-Planing Machines, Ethan Viall. *American Machinist,* vol. 48, no. 15, April 11, 1918, pp. 603-608, 15 figs. Description of a strikingly novel type of metal planing machine. A more detailed abstract of this article will be presented in an early issue.

Measurements and Testing

An Electromagnetic Clutch Indicating Device, V. Karapetoff. *Automotive Engineering,* vol. 3, no. 3, March 1918, pp. 101-104, 3 figs. Description of an indicating device designed especially for use on the Entz magnetic transmission in motor cars, such as used on the Owen magnetic car.

Erichsen Tests on Aluminum Sheets, Robert J. Anderson. Data of tests with the Erichsen ductility testing apparatus on annealed No. 18 gage aluminum sheets.

The Erichsen apparatus consists essentially of a die and holder for holding the sample to be tested and the internal tool actuated by a hand wheel which moves gradually forward until the sample is ruptured. The progress of the internal tool and the ultimate factor are observed in the mirror and the depth of indentation is read directly from a micrometer-graduated screw.

One of the distinctive features of this test is the evidence of approximate grain size of the metal tested which the fractured domes of the test pieces indicate. Particularly is this test of value as a guide to drawing operations on annealed metal. Under-annealed metal will rupture by deep draws, owing to its hardness and lack of ductility, while over-annealed metal will also rupture because of the weakened condition of the metal resulting from large grain size. The domes of the Erichsen test pieces indicate at once how a given metal may be expected to behave in the draw press, because, in fact, the apparatus is itself a miniature draw press. (*The Iron Age,* vol. 101, no. 15, April 11, 1918, pp. 950-951, 4 figs., 4 tables.)

Tubo Piezometrico dell'Impianto Idroelettrico sul Corfino, Luigi Mangiagalli. *L'Industria,* vol. 32, no. 2, January 31, 1918, pp. 44-52, 16 figs. Description of the arrangement of the piezometer tube at the hydroelectric installation of Corfino. An abstract of this article may be given in an early issue.

Water Gauges on Marine Boilers, W. M. McRobert. *Mechanical World,* vol. 63, no. 1628, March 15, 1918, pp. 124-125.

Measuring Air and Gases with the Pitot Tube, A. H. Anderson. *Compressed Air Magazine,* vol. 22, no. 3, March 1918, pp. 8692-8695, 3 figs., 3 tables.

Motor-Car Engineering

Fuels for Tractor Engines, Prof. J. L. Mowry. Brief data of an investigation carried out at the Department of Agricultural Engineering, University of Minnesota, with tractor engines showing the comparative efficiencies (or rather inefficiencies) of the various manifold used for burning kerosene. The author has found that in practically all cases there was a considerable dilution of the lubricating oil by kerosene after one hour's run. (*The Journal of the Society of Automotive Engineers,* vol. 2, no. 3, March 1918, pp. 222-225.)

Thermostatic Control Considerations, J. Edward Schipper. *Automotive Industries,* vol. 38, no. 13, March 28, 1918, pp. 637-639, 7 figs. Brief description of the two older systems of temperature control on motor cars, namely, straight thermostat and radiator shutters.

Traction on Bad Roads or Land, L. A. Legros. *The Journal of the Institution of Mechanical Engineers,* no. 3, March 1918, pp. 55-151, 163 figs., 2 tables.

Mechanics

Some Fundamentals of Rolling Support, F. W. Gurney. A general discussion on the subject of bearings and their construction, including a comparison between ball bearings and roller bearings. The matter of increasing the area of contact between the ball and its raceway is discussed in some detail.

There is a limit to the closeness with which the race curvature may approach the curvature of the ball. In large bearings for carrying great loads at slow speeds the race contour is made very much closer than in high-speed bearings. In one case the chief consideration is load capacity; in the other, the consideration of load is practically negligible, but the reduction of friction is of supreme importance. Increasing the curvature of the race is one of two ways of increasing the available area of contact between the ball and its raceway. In ordinary practice the race curvature may be increased to an extent that will multiply the capacity of the ball many times before objectionable friction is incurred, but close race curvature spells safety for the bearing. In fact, the ball bearing made with close race contour is in effect a roller bearing. In it there are realized ample areas of contact which the advocates of the roller bearing particularly emphasize as an advantage. (*Journal of the Society of Automotive Engineers*, vol. 2, no. 3, March 1918, pp. 210-213, 4 figs., *g*)

Whirling and Whip of a Revolving Shaft, G. Greenhill. *Engineering*, vol. 105, no. 2724, March 15, 1918, pp. 273-274, 1 fig. (to be continued).

The Resistance of a Group of Piles, H. M. Westergaard. *Engineering and Cement World*, vol. 12, no. 7, April 1, 1918, pp. 22-26, 7 figs.

On a New Gyroscopic Phenomenon, E. E. Tournay Hinde. *Proceedings of the Royal Society*, Series A, vol. 94, no. A659, Mathematical and Physical Sciences, pp. 218-222, 1 fig.

Dynamic Balancing, Commander F. J. Cleary. *Journal of the American Society of Naval Engineers*, vol. 30, no. 1, February 1918, pp. 1-22, 12 figs., 7 plates.

On Moments of Inertia, T. H. Jones. *Flight*, no. 478 (no. 8, vol. 10), February 21, 1918, pp. 201-202, 3 figs.

Volume of Tanks with Spherical Ends, Harry Gwinner. *The Monthly Journal of The Engineers Club of Baltimore*, vol. 7, no. 5, November 1917, pp. 75-78, 2 figs.

Munitions

New Pressure Table for Eley Lead Crushers, F. W. Jones. In the determination of shotgun pressure the Eley lead-crusher tables play a most important part. In fact, lead crushers are very convenient for testing of pressure in many kinds of rifles. They were not usually employed with military rifles because of the inconsistencies of results obtained with pistons of various sizes, which hitherto could not be properly explained. Some fifteen years ago an attempt was made to replace lead crushers by coppers of a special conical form, the object of this change having been to utilize the material for which exact calibration was possible. These crushers were given several years' trial in all the important testing stations in England, but ultimately they had to return to lead.

In 1913 a series of experiments on a very large scale was initiated for the purpose of building up a new table for Eley lead crushers. The process underlying these experiments was the taking of simultaneous records from pistons of alternative diameters. The pressure curve was worked out step by step in so many pairs of places that the resulting table must be accepted for all time as beyond dispute. It was not proved, and a fact that could not be proved at the time was whether the scale of tons pressure was correct or not. There were good reasons for believing that it was not correct, but as absolute values were not available the conventions of estimate were allowed to remain. Hence, the 1913 table gave all pressures in true proportion, but the real values could only be obtained by applying throughout a multiplier, which, at that time, was unknown.

Recently H. W. R. Mason revealed the data which explain the previous experience with lead crushers and provide figures for their exact calibration. He discovered that lead crushers developed a resistance during compression which varied with the amount of decrement, but was independent of the means by which the decrement was brought about. Whether the lead is squeezed in a press or reduced by the ordinary method of compression in a proof barrel, equal resistances are set up for equal decrements. The excess resistance developed by lead is transient and it disappears inside of 5 min. of decrement greater than 0.050 in. Thus, lead which is hardened by compression no matter to what degree, recovers to what may be termed the dead-soft condition inside a period of a very few minutes. In other words, it possesses the property of spontaneous annealing.

The rate at which this temporary hardness disappears grows with the degree of decrement and hence with the degree of resistance developed. For example, the dead-soft condition of a lead crusher compressed from 0.500 in. to 0.400 in. is reached in a period of 5 min. Whereas, the lead compressed to 0.340 in. recovers in the fraction of a minute. Tests of crushers which were made in ignorance of these facts were necessarily inconsistent, because nobody ever dreamed that time variations between successive treatments introduced so disturbing an influence. Now, however, when these conditions are understood, lead crushers may be tested by the simplest of all methods—that of the dropped weight.

The successive decrements produced by the repeated application of the same blow will not supply a true impact table of resistances, the reason being that the resistance developed by the initial blow has disappeared wholly or in part before the second can be delivered. Thus, three blows delivered in succession produce a greater total effect than the same three blows would do if they could be repeated so quickly that the lead had no time to anneal in the interval. In other words, three blows under practical conditions of experiment are not the equivalent of three times one blow. A true resistance table derived from impacts can be obtained by blows varying in amounts. For example, lead crushers may be submitted to blows of one, two, three, etc., pounds in successive series, and the difference in decrements between any two qualities of blow are those which would exist between successive blows by the same weight, supposing the disturbing effect of the time interval could be eliminated. The fact that it cannot is of no present concern, bearing in mind that alternative methods get around the difficulty. What is important is to realize that a succession of blows gives misleading results and should therefore be avoided.

Common sense supports the decision arrived at, for the ultimate object is to estimate powder pressure, and as powder produces its result in one continuous movement the method of calibration may be accepted which repeats this condition as nearly as may be. In point of fact, the time taken by a 3-lb. weight dropped from heights of 1 in. to 24 in. to compress the

crusher is about the thousandth part of a second. Again, the difference between the times of compression of 1-ft-lb. and 2-ft-lb. blows is less than the ten thousandth part of a second. The loss of hardness, or what is more aptly termed the error due to spontaneous annealing, may be ignored when dealing with such small time intervals—time intervals which are less than the period of duration of pressure in a shotgun proof barrel.

Mr. Mason made measurements of the decrements of Eley lead crushers from the drop of a 3-lb. weight released from nine different heights between the limits 1 in. and 24 in. The details having been published in these columns, it is now only necessary to assemble the results as in Table 2. For convenience, they may be stated with reference to a piston of 0.225 in. diameter. In that form they stand as pressure. Pressure can be converted into dead load by multiplying by 89.06, which is the product of one ton stated in pounds and the area of the piston. The word "resistance" has the same significance as "dead load," but it is more scientific because it better conveys an idea of the properties of a crusher in reference to the load it can support, for it can only support a given load provided it can bring to bear an equivalent value of resistance against the force seeking to compress it.

TABLE 2 RESULTS OF IMPACT EXPERIMENTS WITH ELEY LEAD CRUSHERS

Remaining length, inches	True pressure for 0.225-in. piston	Multiplier which gives agreement with Eley 1913 Table
0 4920	2 15	1 156
0 4779	2.77	1 130
0.4668	3.40	1 196
0.4572	3.66	1 172
0 4375	4.52	1 248
0.4104	5 60	1 302
0 3878	6.45	1 325
0.3678	7.12	1 332
0 3496	7.78	1 345

In the third column of this table there is no evidence of the equal multiplier which converts the Eley 1913 Pressure Table into absolute pressure values. As a matter of fact, there should not be, and this for reasons which must be carefully explained. According to the Eley table a remaining length of 0.3678 corresponds to a pressure 2.18 times greater than that corresponding to a remaining length of 0.478 in. The impact results by contrast show a ratio of 2.57 times for the same basic values. It has previously been stated that the Eley table conforms within itself, that is, one part with another, beyond all question of doubt. A much smaller testimonial has been accorded to the values arising out of Mr. Mason's experiments. No further sets of experiments are likely to be conducted which could compete in range and the exactitude with those upon which the Eley table is based. The appearance of disconformity of the impact results with the values of the Eley table must, therefore, be open to explanation, and the explanation is that the above impact results show the effect of resistance of statical loads, whereas in shotguns the pressure is applied in the manner known as dynamical.

The crusher may be loaded absolutely statically or absolutely dynamically, or any intermediate condition may exist between the two. In copper crushers an effort is made to eliminate dynamic tendencies and generally, if a crusher could be so designed that it would respond instantaneously to the applied pressure, its readings could be translated by a statical scale.

The writer discusses in detail the determination of pressure by means of a piston. In view of the irregular pressure given by shotgun cartridges an empirical rule had to be formulated for extracting real pressure results from the obviously excessive readings which followed when insufficiently compressed coppers were employed in connection with cartridges giving unexpectedly high results. The rule was to regard all pressure registered by decrements of 0.020 in. or under as true, while all decrements beyond this limit were treated as being in excess to the extent of half the surplus over 0.020 in. This rule proved of great assistance in tests with coppers and demonstrated that conical copper crushers under the conditions of use presented in shotguns are loaded partly dynamically, which may involve possible errors in the use of a table based on static behavior. The Eley table is, however, wholly dynamical and hence the figures of pressure do not represent the actual resistance of the crusher, though it is possible to obtain from a dynamical table a series of true dead-load or resistance values. By means of a rather complicated process, described in the

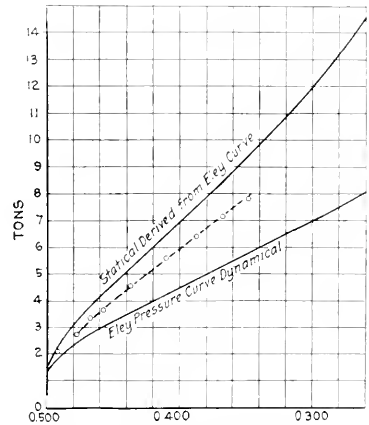


Fig. 10 Eley Lead Crushers, Pressure on a 0.225-in. Piston

original article, two curves were derived as shown in Fig. 10. The lower curve is that of the Eley table, from which the top one was derived. The resistances are shown for convenience as pressure on a 0.225-in. piston. Dynamical and statical curves for the same crusher are thus shown in contrast, and between them is another curve showing the resistances obtained from the drop-weight experiments. This curve shows that when a pressure was called 3 tons, it was, in reality only 85 per cent of 3 tons, or 2.55 tons. It must be decided in the future whether so much fiction can be allowed in a measurement which is otherwise fundamentally sound. The statical equipment of the Eley curve with the above correction becomes a dot curve in the figure, which agrees with the results of the drop-weight experiment to a very considerable extent. (*Arms and Explosives*, vol. 26, no. 305, Feb. 1. 1918, pp. 20-22, 2 figs., *ea*)

Manufacture of the 4.7-Inch Gun, Model 1906-1, E. A. Suverkrop. *American Machinist*, vol. 48, no. 13, March 28, 1918, pp. 519-524, 10 figs.

Resistance des Bouches a Feu, L. Jacob. *La Technique Moderne*, tome 10, no. 1, January 1918, pp. 3-7. A mathe-

making ... in discussing the stresses in the barrel of a gun and showing why composite barrel construction or hooped construction has to be used. An abstract of this article will appear in an early issue.

The Browning Machine Rifle and Gun. *American Machinist*, vol. 48, no. 12, March 21, 1918, pp. 477-479, 2 figs.

The 1917 Calibration of Eley Lead Crushers, F. W. Jones. *Arms and Explosives*, vol. 26, no. 306, March 1, 1918, pp. 34-36, 1 fig., 2 tables. A continuation of the article on dynamical and statical pressures in Eley lead crushers, abstracted in the present issue. An abstract of this part will appear in an early issue of The Journal.

Power Plants

Tamarack Mills Power Plant, Charles H. Bromley. Describes the chief features of the new oil-burning plant furnishing light, heat and power to the Tamarack Mills, Pawtucket, R. I. The plant was designed solely for fuel, has a 2500-kw. extraction turbine, heats the mills with forced-circulation hot water and has the largest atmospheric cooling tower in New England. Unusually interesting performance figures are given. (*Power*, vol. 47, no. 13, March 26, 1918, pp. 426-430, 6 figs.)

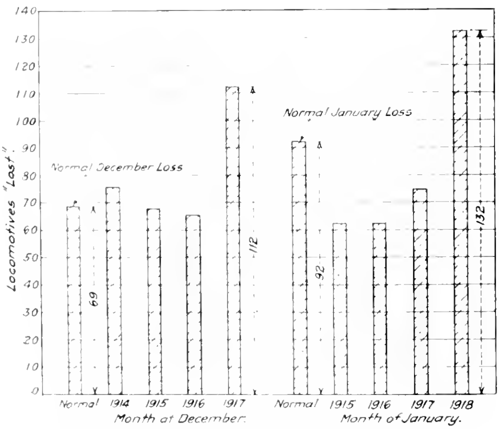


Fig. 11 Estimated Effect of Winter Temperatures on Train Resistance Stated in Terms of Loss of Use of Locomotives. (N. Y., N. H. & H. RR.)

Pumps

Tests of Main Circulating Pumps of the "North Dakota" and "Nevada," Commander S. M. Robinson, U. S. N. Data of tests of the main circulating pump of the *Nevada*, carried out on board ship, and of the *North Dakota*, made by the Fore River Shipbuilding Company, and carried out partly ashore and partly on ship.

The paper presents a complete description of the method of carrying out the tests, and gives the data in the form of curves and tables.

Several points of design were brought out in these tests. Thus, when the *North Dakota* was placed in commission it was found that there was a sharp corner in the volute casting on the discharge side of the pump. This caused considerable vibration in the pump, which disappeared when the corner was removed. Another point in connection with the design of circulating pumps for use in connection with condensers on board ship referred to head and capacity conditions. The ordinary marine practice is to specify the head only approximately and to allow what is considered to be a liberal supply of circulating water. In the choice of the head an approximate figure is taken, no attempt being made to calculate the head from the actual condenser and piping, the result being that if the actual head varies considerably from this, the pump efficiency may be very low even with a good pump. This effect will be exaggerated if the water used is much less than the design calls for. The variation in the total head of condensers for the same horsepower is much greater than is commonly supposed. Thus, the total head at the same capacity is about three times as great for the *North Dakota* as it is for the *Nevada*. An attempt was made to analyze the various parts of the total head. (*Journal of the American Society of Naval Engineers*, vol. 30, no. 1, February 1918, pp. 23-40, illustrated, *e*)

Railroad Engineering

Winter Temperatures and Locomotive Capacity, W. L. Bean, Mem.Am.Soc.M.E. The unusually severe temperatures of the past winter have offered an opportunity to study the influence of decreased temperatures on the efficiency of steam locomotives. A drop in temperature decreases the capacity of the steam-locomotive boiler and also greatly increases the train resistance, the latter because journal friction increases as the temperature falls, owing to the increase in the viscosity of the lubricant. In fact, the first factor appears to be of much less importance than the latter.

Operating records in electric freight service between Harlem River terminals and New Haven, a distance of approximately 70 miles, with undulating curves of 0.6 per cent and considerable curvatures, afforded an opportunity to compare the consumption of power in winter with that of summer in a better manner than could have been done with steam locomotives.

The article explains in detail how "power-range" and "temperature-range" curves were found and compared. It was found that for each degree of temperature fall the demand for power increases 0.65 per cent.

This figure has been found from data secured with electric locomotives, but it is believed that the factor 0.65 per cent may be applied to steam-locomotive service as well, because there is no great difference in the heat losses and engine friction of steam and electric locomotives considered in percentage of maximum capacity, and heat losses in steam locomotives causing reduction in capacity in winter as compared with summer are practically offset for the purposes of this investigation by the consumption of current in heating cabs of electric locomotives, which latter required approximately 3 per cent of the total electric power used on a trip.

On the basis of the 0.65 per cent greater power required to move cars for each degree of temperature drop, excess-power requirements in last December and January as compared with those months in the three preceding years were as follows:

December, 1917

4.55 per cent greater than in December, 1914
5.55 per cent greater than in December, 1915
5.95 per cent greater than in December, 1916

January, 1918

8.71 per cent greater than in January, 1915
8.71 per cent greater than in January, 1916
7.15 per cent greater than in January, 1917

Assuming 800 locomotives normally in service, the result of such handicap, measured in the number of locomotives necessary to make up the increased demand for power on account of low temperature, was as follows:

December, 1917	January, 1918
36.4 engines more than in 1914	69.7 engines more than in 1915
44.4 engines more than in 1915	69.7 engines more than in 1916
47.6 engines more than in 1916	57.2 engines more than in 1917

Fig. 11 indicates the number of engines which would have to be added in a normal December and in a normal January to make up the loss of engines due to winter temperatures as compared with summer.

The writer calls attention to the fact that the foregoing estimates are based exclusively on the effect of low temperatures in causing increased resistance of trains through increased friction in bearings and increased heat losses in steam locomotives. There are numerous other ways in which low temperatures delay train operation and reduce the efficiency which have not been taken into consideration in the present instance. (*Railway Age*, vol. 64, no. 11, March 15, 1918, pp. 539-541, 3 figs., *epA*)

Repair and Maintenance of Locomotives in War Time, E. R. Battley. *Canadian Machinery and Manufacturing News*, vol. 19, no. 13, March 28, 1918, pp. 315-317.

U. S. A. Gasoline Locomotives. *Automotive Industries*, vol. 38, no. 14, April 4, 1918, pp. 686-687, 4 figs. Description of the gasoline locomotives manufactured for the United States Government by the Baldwin Locomotive Company. The general features of design do not materially differ from their standard type.

Progress Report of the Special Committee on Stresses in Track. *Bulletin of the American Railway Engineering Association*, vol. 19, no. 205, March 1918, pp. 875-1058, 141 figs., 13 tables. Report of an investigation carried out jointly by the American Railway Engineering Association and the American Society of Civil Engineers. A brief abstract of this investigation was published in the March issue of The Journal.

Need More Labor Saving Equipment; Two Discussions of the Situation and Some Typical Examples of What Can Be Done. *Railway Maintenance Engineer*, vol. 14, no. 4, April 1918, pp. 131-132.

United States Railroad Administration's Freight Car Equipment Standards. *Railway Review*, vol. 62, no. 13, March 30, 1918, pp. 459-467, 16 figs.

Difficulties of Locomotive Lubrication. *Railway Review*, vol. 62, no. 13, March 30, 1918, pp. 478-480.

Specifications for the United States Standard Cars. *Railway Age*, vol. 64, no. 13, March 29, 1918, pp. 785-788.

The Railway Engineering Convention. *Railway Review*, vol. 62, no. 12, March 23, 1918, pp. 417-425.

One Hundred Tons Capacity Steel Hopper Car, Norfolk & Western Ry. *Railway Review*, vol. 62, no. 14, April 6, 1918, pp. 495-497, 3 figs.

Research

The Research Couplet. Research in Pure Science and Industrial Research, Wm. Allen Hamor. The writer discusses the interrelation between pure science and industrial research and expresses the view that the fundamental differences between pure research and industrial research are traceable to the differences in the poise and personality of the representatives of each type of scientific investigation.

With special regard to chemistry, it is pointed out that the great triumphs of pure chemistry are philosophic achievements, while all the conspicuous accomplishments in the domain of chemical industry are the outcome of the application of channels of knowledge explored by the investigators in pure chemistry.

An interesting classification of research in pure chemistry and in applied chemistry is offered.

Next comes research as developed by corporations. This appears to move through more or less well-developed stages according to the character of the industry. These stages may be presented as follows: First, research applied to the elimination of difficulties in manufacturing, and at least six American organizations have sixty or more research chemists engaged in this field of industrial research.

Next comes research having some new and specific commercial object. Frequently the appreciation of a need in industry for some new tool, method or material stimulates a deliberate search for means to satisfy that demand; or, again, it is sought to produce a commodity imported from another country or locality. This field of research proved especially profitable since the beginning of the war. Among the most progressive firms there is a growing appreciation of the fact that almost every discovery in science may ultimately have influence on industry. This leads to researches in pure science with no specific commercial application in view. This kind of research can be carried out only by large corporations, such as the General Electric Company, the Eastman Kodak Company, etc. It is a very far-seeing business policy directed to outstrip competition by the continuous provision of discoveries, which may sooner or later be turned to industrial account.

Research for the purpose of establishing standard methods of testing and standard specifications connected with the purchase of raw materials is a very important field of investigation, the necessity for which is obvious. (*The Scientific Monthly*, vol. 6, no. 4, April 1918, pp. 319-330, *g*)

Aerodynamic Laboratory of the Leland Stanford Jr. University, Wm. F. Durand, Mem.Am.Soc.M.E. Description of this laboratory and its equipment, with special reference to tests on air propellers.

The purposes of the investigations for which the laboratory was designed were as follows:

First, the development of a series of design factors and coefficients drawn from model forms, distributed with some regularity over the field of air-propeller design and intended to furnish a basis of check with similar work done in other aerodynamic laboratories, and as a point of departure for the further study of special or individual types and forms.

Second, the establishment of a series of experimental values developed from models and intended for later use as a basis for comparison with similar results drawn from certain selected full-sized forms and tests in free flight.

The so-called Eiffel type of wind tunnel was adopted, described in some detail in the report.

An interesting feature of the design is constituted by the device for securing uniformity in flow into the test chamber from the mouth of the collector. With this in view a honeycomb structure was built in the delivery end of the collector. It is composed of hexagonal cells 3 in. in diameter and 10 in.

long made of roofing tin and soldered at the edges. This forms a stiff and true structure with thin walls presenting the minimum resistance to the flow of the air.

The form of the collector and diffuser tubes was determined by circular frames made by nailing up a double ring of $\frac{7}{8}$-in. board segments, sawn to the proper curvature on one side, thus forming a strong ring of wood $1\frac{3}{4}$ in. thick. These rings were then fastened to uprights made of 2-in. by 4-in. scantling spaced about 2 ft. between centers and so adjusted vertically as to line up with the axis of the tunnel about 8 ft. 9 in. above the floor of the room. These circular rings, spaced out in this manner and each of appropriate diameter, give thus a series of transverse sections of the tunnel. The next step was to run longitudinal battens $\frac{7}{8}$ in. thick by 2 in. wide along the inside of these rings, spacing them equally around the circumference. These battens were spaced about 6 in. between centers at the small end and 12 in. at the large end. This entire framework, when set up, cross-braced and stayed to the building, roof and floor, made a very stiff and secure skeleton on which to lay the inner covering forming the shell of the tunnel itself. This covering was of a good quality of heavy cotton sheeting laid on and stretched with care and secured along each longitudinal batten and running on the inside a small airplane batten approximately $\frac{1}{4}$ in. thick at the center by $\frac{3}{4}$ in. wide, thus holding the fabric down on the large battens.

The fabric was then treated with a standard airplane wing "dope" (celluloid dissolved in acetone), varnished and rubbed down to a smooth finish. At the propeller-fan end for a distance of about 4 ft. the number of longitudinal battens was doubled and for a distance of $1\frac{1}{2}$ ft. the inside of the tunnel was covered with galvanized sheet iron in order to give necessary stiffness in the immediate vicinity of the tips of the blades of the fan. This general procedure gave a tunnel with a smooth, true and fair surface, conforming to the law of cross-sectional areas as determined, and, as later test showed, stable and without sensible vibration or disturbance under the highest wind velocities employed.

The experiment room was made of matched boarding laid on the inside of joists and studding spaced about 18 in. between centers. The highest wind speeds contemplated were not much about 60 m.p.h., and with a reasonable coefficient of flow through the collector tube this would require a reduction of pressure in the experiment room not much exceeding 10 or 12 lb. per sq. ft. This is a very moderate load, and no trouble was experienced in carrying it with ordinary framing covered with the matched boarding as indicated. To give light in the experiment room, two window sashes were fitted and the glass was reinforced on the inside with supports, reducing the size of the pane to the equivalent of about 9 in. by 10 in.

The room was made practically airtight by papering on the inside with heavy builders' paper laid on with a specially heavy paste. For entry and exit an airlock was provided with doors closing on suitable packing strips and fitted with self-adjusting hinges, allowing close contact between door and packing.

The air speed is measured by a pitot tube of the usual type. There is, however, also a sensitive pressure indicator showing the pressure head between the experiment chamber and the surrounding room, thus serving as an instantaneous air-speed indicator.

This pressure indicator consists of two manometric cells carried each on opposite ends of a sensitive balance. The lower ends of the cells dip under coal oil, the space above the liquid being connected in one case to the air in the experiment chamber and in the other, to the air in the surrounding room. The zero position of the scale is determined with both cups connected to the outer room. With one connected to the experiment room the balance becomes disturbed and the weights added to restore equilibrium furnish a direct measure of the depression within the experiment room. These indications calibrated against the pitot-tube measures of speed give the direct relation desired between the measure of the depression and the air speed at the propeller position. The weights for the balance were so selected as to give readings of pressure directly in pounds per square foot.

A relation was found based on pitot-tube determinations of velocity and manometric-balance measures of difference of pressure acting as an air head. This relation was found to be practically constant and equal to

$$\text{Velocity head} = 0.876\ (P_1 - P_2)$$

where P_1 and P_2 denote the pressure heads without and within the experiment room.

An interesting telephonic torque dynamometer is described in the same report. (*Journal of the Society of Automotive Engineers*, vol. 2, no. 3, pp. 230-238, 14 figs., *d*)

Refrigeration

Economy of the Refrigeration Power Plant, Victor J. Azbe. *A. S. R. E. Journal*, vol. 4, no. 4, January, 1918, pp. 368-387, 11 figs. A discussion of the various sources of losses in a refrigeration power plant, with suggestions as to how such losses may be reduced or eliminated.

Heat Balance of the Ammonia Compression System, J. H. H. Voss. For determining the economy of the ammonia-compression system three values are required: first, the external work or indicated horsepower expended in the compressor which may be determined from the indicator card; second, refrigerating effect; and third, the heat of condensation. Graphical methods are given for the determination of these three factors. (*A. S. R. E. Journal*, vol. 4, no. 4, January, 1918, pp. 345-367, 13 figs.)

A National Industrial Research Laboratory. *The Engineer*, vol. 125, no. 3244, March 1, 1918, pp. 180-181. Description of the National Industrial Research Laboratory in England.

The National Industrial Research Laboratory, Sir Richard T. Glazebrook. *Engineering*, vol. 105, no. 2723, March 8, 1918, pp. 252-256, 5 figs.

The Hydraulic Laboratory of the Massachusetts Institute of Technology, Geo. E. Russell. *Journal of the Boston Society of Civil Engineers*, vol. 5, no. 3, March, 1918, pp. 121-130, 6 figs.

Steam Engineering

Boilers with Air Heaters. Description of an installation where an air heater is provided for each boiler.

The installation described contains a 3000-kw. turbo-alternator driven by a turbine. There is one chimney for each four boilers and an air heater for each boiler.

The air is supplied to the air heater through a duct, Fig. 12, leading from the main generator in such a way as to utilize the heat of the air from the generators. It is heated to a comparatively high temperature in passing through the air heater, and from thence to the suction inlet of the fans, from which fans it is discharged to the Underfeed Stoker traveling grates.

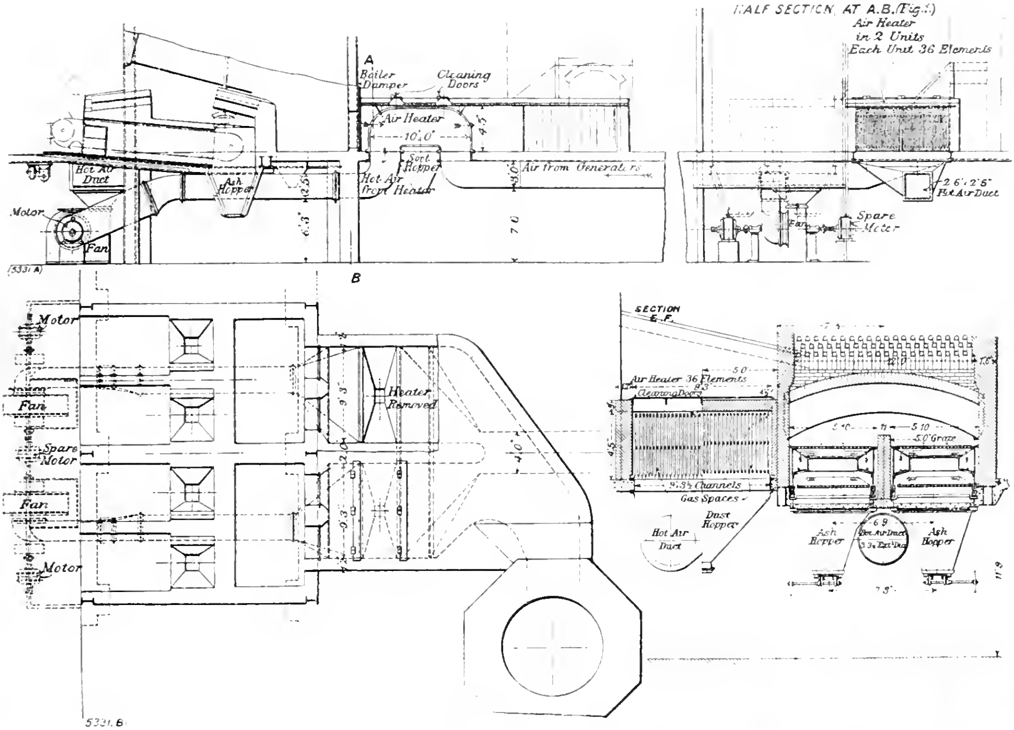


Fig. 12 Usco Air Heaters and Traveling-Grate Stokers

The air heaters, as illustrated, each comprise 36 elements between which the hot gases of combustion flow from the boiler to the main flue. The warm-air main from the generators is splayed into 36 inverted U-branches. Each branch is further divided by a diaphragm to equalize the flow in the upper and lower portions. The total length of an element is 10 ft. and the depth 4 ft. 5 in., while the width of each heater chamber is 9 ft. 3 in. Below the heater there is a dust hopper, and above it there are cleaning doors.

The warm air is drawn into and through each heater by a fan driven by an electric motor. To guard against stoppages, a spare motor is provided in addition to individual motors for each fan. (The original article gives extracts from the specification, showing the extent and requirements of the plant). (*Engineering,* vol. 105, no. 2722, March 1, 1918, pp. 228-230, 5 figs., *d*)

Boiler Baffles of Plastic Material. As a substitute for baffles for water-tube boilers consisting of tile, bricks or blocks of refractory material fitted in between the tubes, a composition is offered of refractory materials shipped in barrels in a plastic condition ready for use.

It is claimed that with this new material it is possible to secure jointless and gas-tight baffles, since the coefficient of expansion is so small that the change in shape due to variation of temperature may be neglected.

In forming a cross-baffle for a water-tube boiler of the Babcock & Wilcox Company type, the cast-iron baffle plate is employed as one side of the mold, while the other is formed by thrusting slats into the diagonals between the tubes, as illustrated in Fig. 13. The plastic material is then poked down through the diagonals to fill the space between the baffle plate and the slats, the material being sufficiently plastic to fit the tubes snugly. The boiler is then fired up slowly so that the slats will burn out while the plastic material is being dried and vitrified in place. (*Iron Age,* vol. 101, no. 12, March 21, 1918, p. 743, 1 fig., *d*)

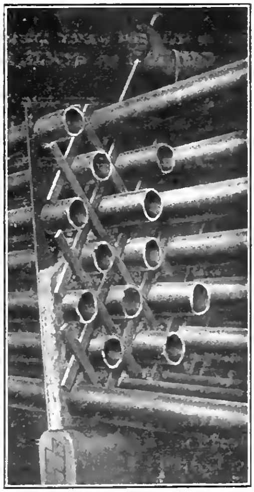


Fig. 13 Method of Putting In Boiler Baffles of Plastic Material

Increasing the Life of Economizers. With particular regard to New England, the average life of an economizer is from thirteen to eighteen years, depending on local conditions. After that the tubes become so thin that they are liable to fracture. This liability to fracture is greatly increased by any sudden shock, such as a water hammer, and, in fact, it is impracticable to carry the usual high boiler pressures.

The present article describes an arrangement for use with these older economizer installations whereby they may be protected from sudden shocks and excessive pressures.

The water is pumped from the primary heater through one stage of the chamber to the economizer at about 10 to 50 lb. pressure, and then from the outlet of the economizer to the suction of the second stage of the pump, where the pressure is increased to the required boiler pressure. See Fig. 11.

The application of this type of pump is said to have increased the life of several economizer installations. In one case where the repairs had become excessive a pump of this type was installed and the pressure cut down from 175 to 40 lb., which prolonged the life of the machine for a period of four years and eliminated practically entirely all the repairs due to tube and header fractures. (*Power*, vol. 47, no. 13, March 26, 1918, pp. 436-437. 1 fig., *d*)

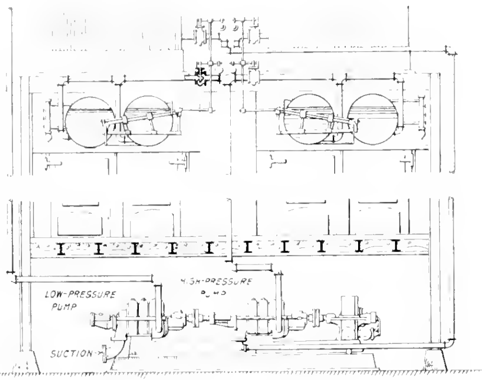


Fig. 11 Clark and Santry Arrangement for Feeding Water to Old Economizers at Less than Boiler Pressure

Wreck of a Thirty-five Thousand Kilowatt Turbine. *Power*, vol. 47, no. 12, March 19, 1918, pp. 390-395, 7 figs.

Cleaning a Condenser with Muriatic Acid, D. C. McKeehan. *Power*, vol. 47, no. 15, April 9, 1918, p. 504.

Varia

Ferro-Concrete Ships, T. J. Gueritte. *Engineering*, vol. 105, no. 2724, March 15, 1918, pp. 295-298, 3 figs., 4 tables.

Women as Foundry Workers in Germany. *Cassier's Engineering Monthly*, vol. 53, no. 3, March 1918, pp. 191-201, 4 figs.

Alcohol from Sulphite-Pulp Waste Liquor, Ellwood Hendrick. *Metallurgical and Chemical Engineering*, vol. 18, no. 7, April 1, 1918, pp. 360-362, 3 figs.

New Service to Check Teredo. *The Marine News*, vol. 4, no. 11, April 1918, p. 73, 2 figs.

The French System for Return to Civilian Life of Crippled and Discharged Soldiers, John L. Todd. *Publications of the Red Cross Institute for Crippled and Disabled Men*, Series 1, no. 5, February 28, 1918, 75 pp.

A Bibliography of the War Cripple, Douglas C. McMurtrie. *Publications of the Red Cross Institute for Crippled and Disabled Men*, Series 1, no. 1, January 4, 1918, 41 pp.

Problems of Hot Blast Stove Design, A. D. Williams. *The Blast Furnace and Steel Plant*, vol. 6, no. 4, April 1918, pp. 171-174, 1 fig., 10 tables.

British Reconstruction Plans. *American Machinist*, vol. 48, no. 14, April 4, 1918, pp. 574-577.

Methods of Gas Warfare, S. J. M. Wald. *The Journal of Industrial and Engineering Chemistry*, vol. 10, no. 4, April 1, 1918, pp. 297-301.

Some Applications of Electromagnetic Theory of Matter, Albert C. Crehore. *Proceedings of the American Institute of Electrical Engineers*, vol. 37, no. 4, April 1918, pp. 283-315.

Shall the Metric System Be Forced on the People? Samuel S. Dale. *Scale Journal*, vol. 4, no. 6, March 10, 1918, pp. 5-7.

Are You in Favor of Progress, Competency and Efficiency? *Scale Journal*, vol. 4, no. 6, March 10, 1918, p. 11.

Problems in Atomic Structure. *Engineering*, vol. 105, no. 2724, March 15, 1918, pp. 286-288, 5 figs.

Power Required by Cold Rolling Mills, C. E. Davies. *The Engineer*, vol. 125, no. 3246, March 15, 1918, pp. 221-222, 4 figs., 3 tables.

Charts

Alignment Chart for Herbert's Cubic Law, A. Lewis Jenkins. *American Machinist*, vol. 48, no. 13, March 28, 1918, p. 541.

Moments of Inertia, T. H. Jones. *Flight*, no. 478 (no. 8, vol. 10), February 21, 1918, p. 201.

Chart Showing Graphical Method of Computing Average Velocity of Flow of Air, A. H. Anderson. *Compressed Air Magazine*, vol. 22, no. 3, March 1918, p. 8695.

Chart on Relation Between Hydrogen, Excess Air and CO_2, and

Chart on Ratio of Moisture to Dry Air for Various Humidities, Haylett O'Neill. *Power*, vol. 47, no. 15, April 9, 1918, p. 502.

Alignment Chart for Dempster Smith's Formulas for Cutting Speed, A. Lewis Jenkins. *American Machinist*, vol. 48, no. 15, April 11, 1918, p. 615.

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Survey.

LIBRARY NOTES AND BOOK REVIEWS

ARTICLES of interest from the Library of the four Founder Societies, selected list of accessions during the month, and reviews of books of special importance prepared by members of the A.S.M.E. and others particularly qualified.

BOOKS AND MORE BOOKS

OUR soldiers and sailors here at home in the training camps, on transports, in the Navy and overseas in the trenches are urgently in need of good books. From every camp librarian we receive reports of a steady and large demand for technical works of every class. The need for engineering data is especially acute.

Over 600,000 books are now in use, but hundreds of thousands more are needed. Standing unused on shelves in our homes are many good books that would be of inestimable value in the camps. Office shelves bear books, seldom if ever touched, whose presentation to the Army would be a real service. Obviously, technical books sent should be recent editions.

The fund of $1,700,000 raised by the American Library Association to build and equip thirty-four libraries in the camps, to provide trained library service and to buy books, will not be adequate unless substantially reinforced by gifts.

To present books, all that is necessary is to mark them "War Library Service" and deliver them at any public library. They will be forwarded to the war-library storage plant and distributed to the points where they are most needed.

BOOK NOTES

Aids in the Commercial Analysis of Oils, Fats, and Their Commercial Products. By George Fenwick Pickering. J. B. Lippincott Co., Philadelphia, 1917. Cloth, 6x9 in., 133 pp.

Intended as a guide in works laboratories. The tests for determining the purity of the substances and their suitability for various purposes are given, together with tables of constants for each. These values, the author states, are here published for the first time.

Automobile Welding with the Oxy-Acetylene Flame. By M. Keith Dunham. A Practical Treatise Covering the Repairing of Automobiles by Welding, with a Non-Technical Explanation of the Principles to be Guided by in the Successful Welding of the Various Metals. The Norman W. Henley Publishing Co., New York, 1917. Cloth, 4x6 in., 167 pp. $1.

A manual for workmen which explains in simple language the principles of welding, and describes in detail their application in automobile repairing.

A Bibliography of the War Cripple. Compiled by Douglas C. McMurtrie.
The Economic Consequences of Physical Disability. By John Culbert Faries. A Case Study of Civilian Cripples in New York City.
Memorandum on Provision for Disabled Soldiers in New Zealand. By Douglas C. McMurtrie. N. Y. Red Cross Institute. New York, 1918. Paper, 8x11 in.

These pamphlets form the first three numbers of the publications of the Red Cross Institute for Crippled and Disabled Men. The bibliography covers 39 pages and will be further extended by supplements as new material accumulates.

Broaches and Broaching. By Ethan Viall. McGraw-Hill Book Co., Inc., New York, 1918. Cloth, 6x9 in., 221 pp., 188 illus. $2.

A summary of the present development of broaching work and machinery, written primarily to enable those interested to judge whether it is applicable to their particular class of work or not, and to provide working directions in the former case. Contents: Broaching and Broaching Tools; Standard Types of Broaching Machines; Examples of Pull Broaching Work and Practice; Examples of Push Broaching Work and Practice; The Design of Pull Broaches, The Design of Push Broaches, Making Broaches.

Brown's Directory of American Gas Companies, 1917. Compiled and Corrected Annually by E. C. Brown. The Gas Age, New York, 1917. Cloth, 7x11 in., 897 pp. $5.

This edition summarizes the statistics of 1179 manufactured, 768 natural, 134 acetylene and 70 gasoline gas companies, 161 parent or operating companies and 47 public service commissions. An appendix includes the financial data of 277 companies, the officers, directors and committees of gas associations and an alphabetical list of gas association members, with their company and association affiliations.

The Calorific Power of Fuels. By Herman Poole. With a Collection of Auxiliary Tables and Tables Showing the Heat of Combustion of Fuels, Solid, Liquid and Gaseous. 3d ed., rewritten by Robert Thurston Kent. John Wiley & Sons, Inc., New York, 1918. Cloth, 6x9 in., 267 pp., 65 illus. $3.

The introduction of new fuels, the improvements in the methods of investigating the calorific power of fuels and the increase in the amount of available accurate data have made it necessary to rewrite the book. The latest researches have been incorporated, inaccurate data occurring in earlier editions have been eliminated and the results have generally been reported in the English system of units instead of in the metric system used in former editions.

Chemical Patents and Allied Patent Problems. By Edward Thomas. John Byrne & Co., Washington, 1917. Cloth, 6x9 in., 58 pp. $2.50.

This work is intended to provide a statement of the law of the chemical patents, together with a practically complete list of the cases on which it is based, and of the principal cases intimately related in reasoning to them. Written from the point of view of the patent attorney and the expert witness.

Dyes and Dyeing. By Charles E. Pellew. Robert M. McBride & Company, New York, 1918. Cloth, 5x8 in., 274 pp., 24 illus., 8 pl. $2.

This book describes the modern dyes in non-technical language, discusses the theory and practice of color dyeing, and describes the methods of dyeing various fabrics and materials. Various methods of coloring objects in patterns are also described. It is intended for use by craftsmen doing small scale work.

The Elements of Railroad Engineering. By William G. Raymond. 3d ed., revised. John Wiley & Sons, Inc., New York, 1917. Cloth, 6x9 in., 453 pp., 107 illus. $4.

This book attempts to describe the fixed portion of a railroad plant and to give the underlying principles of the design of its layout. The present edition has been largely revised and the introduction has been modified to conform to the progress that has been made in the study of valuation and regulation of utilities, the discussion of engine capacity and the chapters on signaling have been rewritten, and a chapter on the principles of valuation has been added.

Essentials of Volumetric Analysis. By Henry W. Schimpf. An Introduction to the Subject, Adapted to the Needs of Students of Pharmaceutical Chemistry, Embracing the Subjects of Alkalimetry, Acidimetry, Precipitation Analysis, Oxidimetry, Indirect Oxidation, Idometry, Assay Processes for Drugs, Estimation of Alkaloids, Phenol, Sugars, Theory, Application and Description of Indicators. 3d ed., rewritten and enlarged. John Wiley & Sons, Inc., New York, 1917. Cloth, 6x8 in., 366 pp., 61 illus. $1.60.

This edition is revised to accord with the new United States

Pharmacopœia, and improved by the additions of many new assay methods.

Farm Forestry. By John Arden Ferguson. John Wiley & Sons, Inc., New York, 1916. Cloth, 5x8 in., 236 pp., illus., 10 pl. $1.25.

A textbook on the care and management of farm woodlots and the utilization of their products, intended for use by students in agricultural colleges.

The Gas Engine Handbook. By E. W. Roberts. A Manual of Useful Information for the Designer and the Engineer. 9th ed. rewritten and enlarged. The Gas Engine Publishing Co., Cincinnati, (copyright 1917). Leather, 5x7 in., 315 pp., 80 illus. $2.

An epitome of gas-engine practice, in pocket book form, intended as a handy book of reference. This ninth edition has been revised to include present practice. Contents: Descriptive; Design; Operation, Testing, Selection.

Gas, Gasoline and Oil Engines. By Gardner D. Hiscox, revised, enlarged and brought up to date by Victor W. Page. 22d ed. A Complete, Practical Work Defining Clearly the Elements of Internal Combustion Engineering. Treating Exhaustively on the Design, Construction and Practical Application of All Forms of Gas Engines, Describes Minutely All Auxiliary Systems, Considers the Theory and Management of All Forms of Explosive Motors for Stationary and Marine Work. Includes also Producer Gas and Its Production. The Norman W. Henley Publishing Co., New York, 1918. Cloth, 6x9 in., 640 pp., 435 illus. $2.50.

The present edition of this work has been very thoroughly revised throughout, and an attempt has been made to include all recent developments of importance. New tables, formulæ and illustrations have been included and obsolete material has been eliminated, except when of historical interest.

Handbook for the .303-in. Vickers Machine Gun. (Magazine Rifle Chamber). Mounted on Tripod Mounting, Mark IV. George U. Harvey Publishing Co., Inc., New York, 1917. Linen, 3x5 in., 82 pp., 1 pl. 50 cents.

A catalogue in pocket size for those who are called upon to use this gun, written by a British army officer. Edited by Capt. S. A. Dion.

A Manual of the Processes of Winding, Warping and Quilling. By Samuel Kline. Of Silk and Other Various Yarns from the Skein to the Loom. John Wiley & Sons, Inc., New York, 1918. Cloth, 5x8 in., 134 pp., 20 illus. $2.

The preface announces this as the first American reference book on the technique of these branches of textile manufacture; and states that it is based upon long practical experience.

Mechanical Equipment of School Buildings. By Harold Alt. The Bruce Publishing Co., Milwaukee, (copyright 1916). Cloth, 8x11 in., 111 pp., 160 illus. $2.50.

A discussion of the various problems which arise in the design and installation of the equipment for ventilating, heating, lighting, sewage disposal, cleaning, toilets, drinking water, fire protection, etc., by an engineer with experience as a designing and supervising engineer.

Monthly Cost Accounting for Varnish Plants. By E. W. Story. National Varnish Manufacturers' Association, Philadelphia, (copyright 1917). Paper, 6x9 in., 51 pp. $1.25.

A detailed description of a method prepared at the request of the National Varnish Manufacturers' Association which the author believes will be adaptable to any varnish business.

Musketry. American Edition (.303 and .22 Cartridges), Elementary Training, Visual Training, Judging Distances, Fire Direction and Control, Range Practices, Individual and Collective Field Practices. By Captain E. J. Solano. Hand Grenades. Their Construction—Jam Tin, Hair Brush, Rifle Grenade, Service, Vaneless, Mexican or ... Grenade, ... Hair Brush, etc. By Captain S. A. Dion. George U. Harvey Publishing Company, New York, Inc., 1917. Linen, 4x6 in., 288 pp., 72 illus. $1.

A pocket size manual for officers and men.

Notes on Ballistics. Direct Fire, by Captain George A. Wildrick. High-Angle Fire, by Lieut.-Col. Alston Hamilton. 2d ed. Journal U. S. Artillery, Fort Monroe, 1917. Paper, 6x10 in., 99 pp., 9 illus., 2 diagrams. 50 cents.

Lieut. Wildrick's paper treats the problems that are most likely to be encountered at the battery, showing current methods of applying ballistic data to their solution. Lt.-Col. Hamilton presents the formulæ and methods used in ordinary ballistic computations for high-angle fire.

Oxy-Acetylene Welding Practice. By Robert J. Kehl. A Practical Presentation of the Modern Processes of Welding, Cutting, and Lead Burning, with Special Attention to Welding Technique for Steel, Cast Iron, Aluminum, Copper and Brass. American Technical Society, Chicago, 1918. Cloth, 5x8 in., 102 pp., 111 illus. $1.

A well-illustrated description of the methods and appliances in use, intended for the workman and superintendent. Contents: Welding Processes; Technique of Oxy-Acetylene Welding; Miscellaneous Oxy-Acetylene Processes; Examples of Automobile Repair; Costs.

The Petroleum and Natural Gas Register. A Directory of the Petroleum and Natural Gas Industries in the United States, Canada and Mexico. The Oil Trade Journal, New York, 1917-1918. Cloth, 9x12 in., 548 pp. $10.

Includes in one directory material on all branches of the petroleum and natural-gas industry. The work is based on statements made by officials of the companies listed, and gives the usually needed information as to properties, capital stock, officers, etc.

Practical Sanitation. By Fletcher Gardner. A Handbook for Practitioners of Medicine. C. V. Mosby Company, St. Louis, 1916. Cloth, 6x9 in., 418 pp., 46 illus. $4.

This handbook is intended to provide a plain non-technical exposition of the duties of a health officer by one familiar with his needs, experienced in the routine and emergencies of the local sanitary service. Published in a single volume. The second edition is thoroughly revised. An appendix gives schemes for sanitary survey of cities, public buildings and schools.

Railroad Structures and Estimates. By J. W. Orrock. 2d ed., revised. John Wiley & Sons, Inc., New York, 1918. Flexible cloth, 6x9 in., 579 pp., 272 illus. $5.

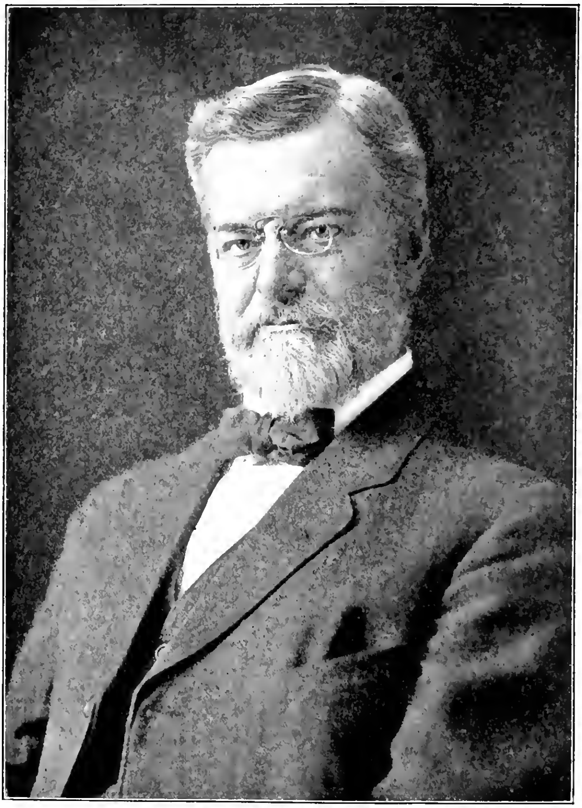
The author has rearranged the chapters in this edition to conform approximately with the classification of accounts as prescribed by the Interstate Commerce Commission in 1914, changed the prices to those which ruled in normal times, previous to 1915, has added much new material and, wherever possible, has given unit costs for all items of track work, track structures and buildings. A feature is made of quantities for track material.

Reference Notes for Use in the Course in Gunnery and Ammunition, Coast Artillery School. 3d ed. Coast Artillery School Press, Fort Monroe, 1917. Paper, 6x9 in., 123 pp., 19 illus. 50 cents.

A brief textbook compiled to meet the immediate demands of candidates for commissions in the Second Coast Artillery School at Fort Monroe.

Relief from Floods. By John W. Alvord and Charles B. Burdick. The Fundamentals of Flood Prevention, Flood Protection and the Means for Determining Proper Remedies. McGraw-Hill Book Co., Inc., New York, 1918. Cloth, 6x9 in., 175 pp., 53 illus. $2.

The authors of this book have not attempted a treatise on flood relief, but have tried to outline briefly the general flood problem in all its many phases, to show what remedies can be applied and to point the way to the selection of the proper works. Technicalities have been avoided, with the hope that the matter may be understandable to readers who are not engineers. A table of great floods is given in the appendix.



FREDERICK REMSEN HUTTON

DIED MAY 14, 1918

SECRETARY OF THE SOCIETY, 1883-1906

PRESIDENT, 1906

HONORARY SECRETARY FROM 1907

SOME ECONOMIC ASPECTS OF FIRE-PROTECTION PROBLEMS AND HAZARDS IN WAR TIMES

By J. DONALD PRYOR[1] AND FRANK V. SACKETT,[1] PROVIDENCE, R. I.

Non-Members

IN its essentials the fire-protection problem in war times does not differ from the fire-protection problem in peace times. It is true that war conditions aggravate and increase ordinary fire dangers, but the means found most efficacious for combating them in normal times are still most efficacious.

A great deal has appeared in the daily press on incendiary fires set by German agents, and the colossal amount of our fire losses last year—totaling as it did some $250,000,000, an increase of more than 25 per cent over normal—encouraged the belief that enemy aliens were responsible for the greater part of our staggering contribution to the fire Moloch.

Unquestionably, enemy agents did cause heavy fire losses—perhaps $30,000,000, but according to the National Board of Fire Underwriters certainly not more than this. It only about 10 per cent of our fire losses since we have been in the war have been due to enemy aliens, surely our attention should be focused on some means of stopping the remaining 90 per cent of the losses in quite as great a degree as it is on checking enemy spies.

The stationing of sentries outside of munition-manufacturing plants and other war industries appeals to the imagination of the public. It looks like real preparedness against the machinations of enemy agents, and it is, but as U. S. Attorney General Thomas W. Gregory says: "Statistics show that the chief dangers menacing private manufacturing plants are those which originate or are developed within their own boundaries. The real protection needed is protection within the plant itself, and the prime responsibility for the internal protection of workshops and factories rests, as it always has rested before, upon owners and managers."

What is really at the bottom of the present public interest in our fire losses is that our country for the first time is awake to the real meaning of fire loss. Before we entered the war, fire losses were regarded as a passing misfortune to individual business men, which misfortune they passed on to the insurance companies. And the public, business men in particular, shrugged their shoulders at fire-protection engineers and went on believing that fire-insurance indemnity was a panacea for fire losses.

Now the country is awake to the fact that a fire loss is no longer a private matter but a national consideration. They realize that insurance money is but a poor substitute for destroyed supplies. For the first time they realize that thinking insurance indemnity is a cure for a fire loss is just as sensible as thinking that German submarines are impotent simply because the ships they sink are insured. Faced with the task of supplying in great measure all of the sinews of war for the Allied cause, we have come to see that food and guns and machinery and clothing are themselves the valuable consideration, and not the amount of money they are worth.

Last year's increase in the fire loss is readily accounted for when we realize the tremendous speeding up of industry, the employment of unskilled labor, night-and-day operation and crowded storage, all of which have been part and parcel of our participation in the world conflict. Compared to other countries these considerations are those which have always made the fire losses of America the most amazing piece of wastefulness the world has ever seen.

In no country in the world has fire-protection engineering in the way of appliances for fighting fire, either manually or automatically, reached so high a degree of perfection as here. Nowhere in the world has fire-resistive construction been developed to such an extent as here. But in spite of this our fire losses, even in peace times, are staggering. In part this is due to our tremendous values. In some measure it is due to our large-area buildings and high-speed production, and in great measure it is due to our carelessness.

But at the present time our values are mounting higher and higher. Production is being speeded as never before. Surely the answer to our problem cannot be found by correcting either of these elements in the situation, for we positively must increase supplies and further speed up production. There remains for us only one way in which to effect the cure for this red disease which is sucking our resources; and that is to be more careful that fires do not start and more careful that we have at hand the means for putting them out when they do start, as some of them inevitably will.

The usual business building, be it manufacturing plant, storage warehouse, dock, pier or shipyard, is roughly classified by the insurance companies as being protected or not protected. It is a curious commentary that at present the three most essential classes of property in our country are those least protected. They are in order of their importance as follows:

a Shipbuilding yards
b Flour mills and grain elevators
c Piers, wharves, docks and storage warehouses.

There are two other great classes of vital industry—metal-working establishments, including foundries and machine shops, and textile mills, in which we have placed cotton mills, full-process knitting mills and woolen mills.

The average munition works, being a metal-working risk, has not the severe hazard of the foregoing classes of risk, and yet the fire loss among the metal workers is in itself astounding, and that industry, while its largest units fall into the protected class, has many small units where values have not to date been sufficient to induce owners to fully protect such property. Our textile mills producing clothes for our soldiers are the best and most completely protected class of property in this country, and probably in the world.

Fire Protection of Metal-Working Establishments and Textile Mills

Before passing to a consideration of the fire-protection problem of the three unprotected classes of essential properties noted above, it may be well to outline briefly the fire-protection equipment of the two protected classes of property, namely,

[1] General Fire Extinguisher Company.

For presentation at the Spring Meeting, Worcester, Mass., June 4 to 7, 1918, of The American Society of Mechanical Engineers. The paper is here printed in abstract form and advance copies of the paper may be obtained by members gratis upon application. All papers are subject to revision.

metal-working establishments and textile mills, and see what new demands the war has made on their fire-fighting facilities.

The increased hazard of fire in metal-working establishments has to do almost entirely with processes incident to their manufacturing ammunition, and a complete outline of the processes involved is almost essential to the thorough understanding of the new hazards involved. This whole matter was treated in detail at the 1917 meeting of the National Fire Protection Association, where a paper was presented by Mr. W. D. Milne, Inspector of the Underwriters' Bureau of New England. Except for one or two increased hazards in the treatment of steel, most of the new processes where serious hazards are involved are those having to do with the loading of the shells rather than with the making of the various parts, and those wishing to make a complete study of this matter are respectfully referred to Mr. Milne's paper, which will be found in the Proceedings of the National Fire Protection Association for 1917.

In conjunction with this paper on the manufacture of ammunition, Mr. Milne, in collaboration with Mr. N. Richardson, also presented some valuable suggestions on safeguarding industrial plants from labor troubles of various kinds.

As noted in an earlier paragraph, the ordinary fire hazards are still responsible for some 90 per cent of our fire loss, and consequently a consideration of the best type of protection against these hazards is of even greater importance than the consideration of means to overcome abnormal conditions due to the war.

Perhaps the quickest way to illustrate the comparative safety of most large metal-working plants from ordinary fire danger is to briefly review an investigation made a year ago in this class of property. That investigation showed that the average insurance rate paid by metal-working concerns, unprotected by automatic sprinklers, was \$1.47 per \$100, and that the average rate paid by these same concerns after having installed automatic sprinklers was 20 cents per \$100, a reduction of 86 per cent in their average rate.

It should be remembered, however, that the requirements made by the insurance companies for sprinkler protection, which is the main dependence of all of these concerns, include certain other protection devices such as chemical extinguishers, oftentimes hose and hose connections and the installation in some cases of fire doors, the closing up of vertical openings, and, in many cases, the installation either of open sprinklers or fire shutters to guard the plants from exposure fires.

Since the insurance rate is invariably the truest measure of fire danger, it is readily apparent that these metal-working plants which have automatic sprinklers and other auxiliary protection are about as safe from the ordinary fire as it is humanly possible to make them.

The only danger from ordinary fires in these protected plants is that the fire-fighting equipment, either through carelessness or maliciousness, may become impaired, and in 1917 there were several disastrous fires in completely protected properties due to water's being shut off the sprinkler system.

The same type of protection that is enjoyed by these metal workers has been carried to its ultimate development in the great textile mills of the country, which were the pioneers in installing automatic sprinklers, and which are today enjoying rates on the average of from 7 to 10 cents per \$100. They, just as the large metal-working establishments, are immune from ordinary fire dangers provided their fire-fighting equipments are kept in working condition.

As a further indication of how successful automatic-sprinkler protection has been in safeguarding metal-working risks and cotton mills, we refer to the sprinkler-fire records of the National Fire Protection Association. These records show that in 6412 fires in textile mills, 98 per cent were successfully handled by automatic sprinklers. Of the 128 fires which were classified there as unsatisfactory, 37 were due to the fact that the water was shut off the system and 57 to defective equipment or supplies and unsprinklered sections. These two causes, which obviously are not inherent in the standard sprinkler systems as installed by experts, can therefore account for about 73 per cent of the so-called failures in this great class of risk.

The same records show that in 1283 fires in metal-working risks, 95 per cent were successfully handled by the sprinkler equipment. Of the 59 fires which were classed as unsatisfactory by the insurance companies, 30 were due to the water's being shut off the system and 19 to defective equipments and unsprinklered sections, these two causes contributing 83 per cent of the unsatisfactory fires in this class of risk.

Keeping Sprinkler Systems Efficient

These records show that unfortunately the fire-fighting equipments of these risks are not always in operative condition, and naturally the cleverly directed incendiary would take care to see that the sprinkler equipment was shut off, or otherwise put out of order before applying the torch. This danger of enemy activities, and also the fact that more unskilled labor than ever before is being employed in both these classes of industry, makes it particularly worth while to consider in addition to sentries and watchmen some automatic means of safeguarding their fire-fighting equipment, which equipment, in the last analysis, is automatic sprinklers.

The sprinkler-fire tables of the National Fire Protection Association show that out of 19,000 sprinkler fires in all classes of risk there have been 851 specified by the insurance companies as unsatisfactory. Of these 851, over 25 per cent, or 230, occurred because the water was shut off the sprinkler system.

As far as keeping the sprinkler service in all classes of risk in operative condition is concerned, and particularly as regards keeping the service intact in these special classes of risk, the most absolute safeguard is what is known as sprinkler supervisory service. This service is installed and maintained by the American District Telegraph Company and, briefly, consists of having the vital elements in a sprinkler system equipped with electric alarm apparatus, which automatically transmits a code signal to the central office whenever anything out of the way happens to the sprinkler system, in addition to automatically transmitting an alarm to the control station in case of fire.

For instance, as regards the matter of water being shut off the system there would be a switch placed on all controlling valves of the system, and if any of these valves, either through malicious intent or carelessness, were closed, the A. D. T. office would at once receive a signal of such closing and would immediately send a runner to correct the difficulty, or at least to ascertain if the owners were aware of the fact that their fire protection was impaired. The same general type of device can be applied to other elements of the system, but the mere equipment of controlling valves by protecting apparatus is one of the essential precautions which war conditions impose upon manufacturers who have otherwise adequately safeguarded themselves against having their production stopped and thus seriously interfering with the country's war work.

Where supervisory service is not available, or for financial reasons will not be considered, the importance of this matter

as evinced by the figures above quoted warrants the stationing of a man at any controlling valve of a sprinkler system which is closed for any reason whatever, and the keeping of that man there until the valve can be again opened and the system restored to service. Theoretically, if this stationing of men were religiously carried out this problem of closed valves and consequent heavy losses in protected properties could be avoided; but, unfortunately, the human element is such that this plan can never be considered as the ultimate answer to the problem.

The other chief causes of so-called sprinkler failures are generally defective equipment or water supplies and unsprinklered sections, these causes contributing 279, or 32 per cent, of the 851 so-called sprinkler failures in all classes of risk. For the most part, defective equipments are those installed before the present standards of appliances and installation were reached, and engineers should take care to thoroughly investigate the equipment in plants in which they are interested to see that it is in every way up to standard.

The matter of unsprinklered sections has always been a bothersome one, and it is particularly so in metal-working risks, because to the layman there are a great many sections of such plants where it seems almost impossible for a fire to start and gain headway. But it should be remembered that no man can tell when and where a fire will start, and that as far as the ordinary sprinkler equipment is concerned, an unsprinklered section acts to all intents and purposes as a severe exposure hazard; and at this time, when metal production is so necessary, every safeguard should be taken to see that such production is not stopped.

While it is true that the larger metal-working establishments, including automobile factories, are completely safeguarded by automatic sprinklers, it still remains a fact that there are a host of smaller establishments in this industry which are not so protected. The products of these smaller factories are often used in the larger, and patriotism demands that they should be protected against fire. Just remember that since 1908 nearly sixty million dollars in unprotected metal-working risks have been destroyed by fire, and the necessity of further protecting the smaller units of this industry becomes obvious.

Safeguarding Shipyards Against Fire

The war has once more made the United States a great maritime nation. We are planning to build more ships in the next few years than any other nation in the world, probably in mercantile tonnage nearly as much as all the rest of the world combined. So great has been the haste to rush shipyards to completion that in a great majority of cases fire protection, which is not a production but a conservation factor, has been overlooked. This is perfectly natural, but it is also extremely dangerous, because we must look at the ship problem not in terms of the money involved, but in the terms of the men we must put on the western front. It is estimated that it takes five tons of shipping per year per man on the fighting front. The destruction, therefore, of a shipyard capable of turning out 200,000 tons of shipping is just the same as if the Kaiser's troops had captured practically a whole army corps.

In general, there are two great classes of shipyards: (*a*) shipyards like the Bethlehem plant at Squantum, where the building ways and the slips are completely enclosed, and (*b*) the smaller yards where the ways are built in pairs with a runway between, and where there is seldom a roof over the ways, and practically never enclosing side walls. In the first type of yard the fire-protection problem is in most respects similar to the equipment of any large metal-working establishment or combination wood- and metal-working risk.

The more common type of shipyard, especially on the Pacific Coast and on inland waters in the eastern part of the United States, consists of office, storehouse, carpenter shops, etc., and where steel ships are being constructed, machine shops. These buildings are immediately above the ways and are usually of light wooden construction, generally one story high with a peaked roof, and sometimes a concealed space. The driveways and yards leading down to the shipyards are often planked.

The shipways themselves are close to the water's edge and are arranged in pairs, each pair being separated by wooden platforms or piers. These platforms on the land side are nearly the ship's depth lower than the completed hull, and a wooden stairway leads to an overhead platform or runway between each pair of ways. The timbering of the ways sometimes supports a light roof to protect the workmen, but the sides are practically never enclosed.

Obviously, this type of yard is a very serious fire risk, for almost invariably there is a strong wind blowing on the water and a fire starting at one end of the yard might well wipe out the whole enterprise in short order. Obviously, also, no scheme of protection can be devised which will invariably and infallibly protect such a plant, as it is impossible to expect automatic sprinklers to protect adequately the open-sided roofs of the ways where there is a roof, and sprinklers cannot be installed advantageously in the timbered runways.

The plan which has met with the greatest favor in safeguarding shipyards of this type is to run a large water main the whole length of the yard between the shipways and the buildings. The buildings are then completely sprinklered and feed mains are run from the large main down each platform, between each pair of ways, and hydrants are installed with an ample supply of hose so that fire on a burning way or ship can be fought from both sides. Usually two hydrants on the platform are considered sufficient. An improvement on this plan would be to install a standpipe with hose connection, which could be operated from the overhead platform above the lower working pier. This would provide vantage ground for fighting fires in the holds of ships partially completed without the delay of dragging a hose line up the stairway.

In shipyards where wooden ships are being constructed, and where consequently there is an enormous amount of lumber stored, the risk approximates that of the ordinary lumber yard. Such lumber yards should, of course, have adequate protection in the shape either of a complete hydrant system, or, better still, a system of standpipe monitor nozzles.

Briefly, this system consists of a series of standpipes about 24 ft. high, each carrying a monitor nozzle and a platform at the top. The standpipes are spaced about 90 ft. apart, and such spacing allows the nozzles to absolutely command any fire in the protected area. A ladder leads from the ground to the platform so that one man can quickly get the nozzle into operation, and by reason of a set screw direct it on the fire and then proceed to set another nozzle into operation, thus effectually attacking the blaze from several standpoints.

The initial water supply to this system can, as a rule, be taken from the mains which feed either the sprinkler system or the shipway hydrant system, but in addition to this there should be a fire pump taking suction either from city water, a reservoir or any other large supply such as a pond or river. The pump is controlled by a switch on the platform of the standpipe, so that after the primary supply has been started

there may be no delay in providing the extra pressure which such sweeping outdoor fires require.

At the base of each standpipe there is a post indicator valve which the operator opens before he goes to the platform. In connection with this valve there is also a drain which should always be left open when the nozzle is not in use, so that there may be no water left in the standpipe. This insures against freezing, which is one of the serious faults of the usual hydrant system.

The thought naturally occurs that the yards building wooden ships would be much more hazardous than the yards building steel ships. But this is not always the case, because the constant dropping of red-hot rivets in steel ship construction on the wooden platforms causes many fires and the underwriters feel that the danger is practically equal to the danger in the yards building wooden ships.

Obviously the various types of system above outlined for protecting the ways are largely dependent upon human activity, and the importance of the shipbuilding program would seem to warrant the yards in having specially trained men to handle their fire-fighting apparatus. We are not informed as to how far any of the yards have gone in this respect, but certainly if the hydrants are to be used most efficiently, any shipyard manager is shortsighted indeed who does not immediately organize and train his own fire brigade and install some type of manual alarm so that the men can quickly be summoned in case of fire and be fully instructed as to their individual duties in controlling it.

The fire brigades organized in a great many of the factories insured under the mutual system or with the Factory Insurance Association are extremely efficient, and no better plan could be followed by the shipyards than to adopt these same measures, because a lot of untrained men with a long length of writhing hose will succeed in making themselves ridiculous about as often as they will succeed in making the fire so.

Fire Protection of Flour Mills and Grain Elevators

Next in importance to the active prosecution of our shipbuilding program is the protection and conservation of foodstuffs, particularly wheat. France and England are now on short wheat rations, and we ourselves have had to curtail our consumption seriously. But in spite of this tremendously grave situation, the National Board of Fire Underwriters declares that we burn up wheat in grain elevators and flour mills at the rate of about $10,000,000 annually, the total destruction of foodstuffs running to about $25,000,000 a year.

That this rate of burning can be very greatly cut down by adequate protective measures, the chief of which is automatic-sprinkler protection, is clearly evinced by a study of the sprinkler-fire records and by a comparison of the fire-insurance rates on such properties before and after protection.

The records of the National Fire Protection Association, covering 70 fires in flour and cereal mills protected by automatic sprinklers, show that in 54.3 per cent of the cases the fires were completely extinguished by the sprinklers and that in 37.2 per cent of the cases the fires were successfully held in check. Of the so-called unsatisfactory fires, making in all 8.5 per cent of the total, half were due to partial sprinkler installation or exposure fires, leaving only 3 fires out of the 70 where the type of construction was such as to handicap proper sprinkler performance, or where the hazard was too severe for the ordinary sprinkler system.

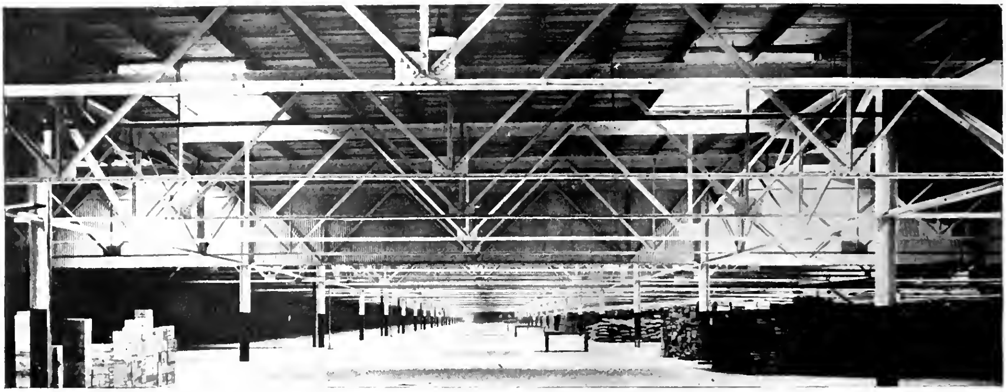


Fig. 4 A Sprinklered Pier in Brooklyn, N. Y. Note Curtain Boards Installed to Break up Ceiling Area and Bank Heat at Sprinkler Heads

The same records show for grain elevators a total of 52 fires, 38.5 per cent of which were completely extinguished by the sprinklers and 32.7 per cent successfully held in check. Out of the remaining so-called unsatisfactory fires there were only 6 where the hazard of occupancy or the nature of the building was such as to make unsatisfactory the performance of automatic sprinklers.

This record shows why the average insurance rate on flour mills and grain elevators before the installation of automatic sprinklers and other protective devices is $3.03 per $100 and why after such protection it is $1.01—a $66^2/_3$ per cent reduction. There is no doubt but that the hazards involved in this class of property are many and severe, not only as applied to the processes carried on, but on account of the general nature of the construction.

One of the greatest hazards in flour-mill operation is in the fast-running machines and in the processes of cleaning and reducing the grain. Nails and bits of wire are often drawn into the separator and cause sparks, resulting frequently in dust explosions. In this connection a report made many years ago is of interest. On May 2, 1878, the Washburn Flour Mills, Minneapolis, were wrecked by an explosion. A commission investigated and tested flour and coal dust. It was concluded

that "all finely divided carbonaceous material will explode."

The great number of elevators and conveyors running respectively vertically and horizontally through the plant make an enormous addition to the fire risk. The chances for fire to get a good start and to spread rapidly are so great that automatic sprinklers are placed somewhat differently from the method used in the ordinary factory building. The heads below the ceiling are spaced according to the usual standard, though frequently a little closer together. Around the elevators they are spaced as closely as they can be put without interfering with each other. They are also placed as near as possible to the elevator legs. The latter act in case of fire as veritable flues. To offset this an automatic sprinkler head is placed at the top of the elevator head inside the hood. The entire volume of water from this head would be discharged down the elevator leg and deluge any fire within it.

Freight and passenger elevators and stairways make another great hazard, and sprinklers are placed close to the elevator wells and under all stairways. Sprinklers are also placed at the top of the elevator shaft to protect the machinery, while the great number of nooks, crannies and other out-of-the-way places in such a building all have to be adequately protected.

The protection of the storage bins in the elevator section of the plant is a problem in itself. In cases where the bins are subdivided at the various floors, the same ceiling arrangement of sprinklers is adopted as in the mill building itself. In some installations, particularly where the storage is arranged in the form of silos, additional heads are placed beneath the floors of the silos, as well as in the space between the walls and the sides of the silos.

A considerable percentage of unsatisfactory sprinkler fires in this class of risk were made unsatisfactory by vertical openings or faulty construction. The maximum sprinkler efficiency cannot be expected where the automatic sprinklers are at a disadvantage with regard to distribution of water or rapid spread of fire, such as is produced by vertical openings, flimsy construction or concealed spaces sheathed in wood. All of these elements tend to spread a fire rapidly and should be avoided in every case possible.

An analysis of flour-mill fires during ten years, made by the Millers' National Insurance Company, showed that just half of the fires proved a total loss, while the other half gave a partial loss. Seventy-three per cent of all fires occurred at night, 58 per cent of which were total losses; 71 per cent of the total-loss night fires were from causes unknown.

In spite of the fact that sprinkler protection obviously minimizes the danger of fire in these properties, and in spite of the fact that insurance rates are so largely reduced for such installation, there are, comparatively speaking, but few of this class of risk under protection. The very large mills almost invariably have such protection, as do the elevators in connection with them. But up to the present time economic considerations have prevented carrying this protection into smaller mills, country elevators and terminal elevators on the wholesale basis that the hazard and irreplaceable values at stake demand.

A great number of these smaller mills are located in sections where there is no adequate city water supply, and the consequent expense of tanks in connection with the equipment has worked to keep these properties unprotected; for business men seem invariably to demand that as far as fire protection is concerned they must be shown a very large and attractive investment through insurance savings or else they will not install the equipment. Unbelievable as it seems, there are few men who consider adequate fire protection a thing which they themselves can afford to pay money for out of their own pockets. They insist that the insurance companies to all practical intents and purposes foot the bill. Even with the necessity for installing tanks, sprinkler equipments in a large number of these mills would show the owners 6, 8 or 10 per cent annually on their investment, but this is not sufficient reward to induce them to make their properties safe from fire and thus help to conserve our food supplies.

In the country grain elevators the same condition applies as regards water supplies, and in addition the grain stored in the elevators is in many cases not owned by the same parties who own the elevator. Moreover it is usually stored for a period of only three to five months. This combination of circumstances and the seeming inability of the owners of the grain and the owners of the elevator to get together on a coöperative basis has worked to create a financial barrier against the equipment of these properties with automatic sprinklers.

As regards the great terminal elevators, the question is not one of water supplies, as these are in most cases available.

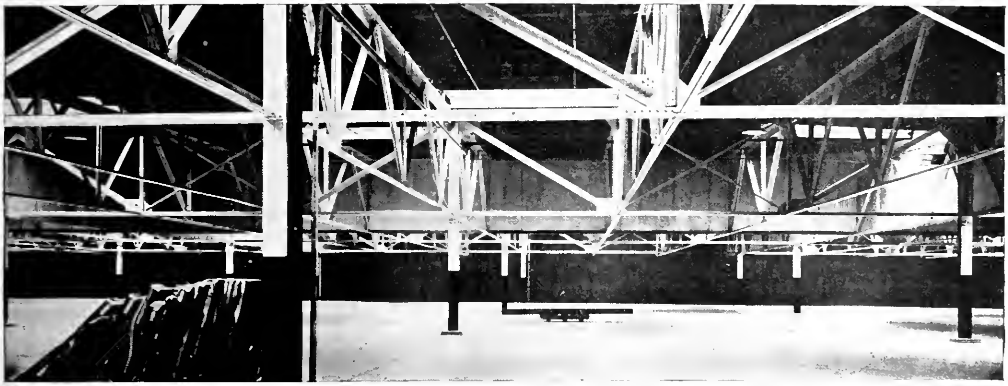


Fig. 2 Another View of Pier Shown in Fig. 1. Note Particularly the Curtain Boards Running Lengthwise of the Structure

FIG. 3 SPRINKLER LAYOUT FOR A TYPICAL PIER PROPERTY (SEE CONTINUATION IN FIG. 4). NOTE PARTICULARLY THE OPEN SPRINKLER EQUIPMENT TO GUARD AGAINST EXPOSURE FIRES

Even where they are not, the values at stake are so great that the savings by reason of sprinkler equipment would pay for the systems in a comparatively short time. The trouble here is an exaggerated case of the same thing that exists in the country elevators, namely, that the elevator owners and operators do not own all the grain being stored or in process. Since the great value at stake is in the grain itself, and since owners of the grain cannot see why they should spend their money to improve an elevator which they do not own, enormous quantities of irreplaceable food values are at the mercy of fire in one of the most hazardous classes of risk.

While the engineering problems involved are a little more difficult than ordinary, they have been satisfactorily solved, and the protection of these properties is held up for financial reasons rather than on account of the engineering considerations involved.

Seaport Problems

Let us suppose, however, that there are no catastrophes in our great shipyards and that the country is successful in producing the needed ocean carriers. Let us suppose that the great ten-million-dollar-a-year fire loss in flour mills and grain elevators is stopped and that the grain is cleaned and milled and ready for shipment abroad. Have we then escaped all of the fire dangers which threaten to seriously impair our active prosecution of that part of our war work which has to do with feeding our Allies and providing supplies for millions of men abroad, including not only food but munitions, clothing, guns, aeroplanes, automobiles, etc.?

By no means. One needs but to visit any great Atlantic seaport today to see almost unbelievable quantities of supplies congested in piers, wharves and storage warehouses for shipment abroad. Our seaports are literally packed with vital necessities for France. No better idea of the fire hazards incident to such seaport congestion can be given than to quote from a book written by Fire Chief John Kenlon of New York, who perhaps has had more experience in fighting waterfront fires than any other man in America. Here is what he says of fire-protection problems in American seaports:

> The sheds or wharves, common to America, form about the most dangerous structures of their kind in existence. Built on wooden piles, with wooden superstructures, they are comparable to nothing but horizontal flues, through which flames rush with a lightning rapidity, rendering abortive any efforts on the part of the fire department unless the greatest promptitude is shown by all concerned, and demanding the use of fireboats with specially designed and extraordinarily powerful equipment. Fill these sheds with every sort of combustible material imaginable; hogsheads of resin, bales of cotton, crated furniture, barrels of pitch, stacks of dry goods, and such unconsidered trifles as a few boxes of celluloid toys and novelties, and can the mind of man conceive a collection of heterogeneous merchandise more calculated to provide the wherewithal for a conflagration and matter enough to assuage the thirsty pens of all the newspaper reporters in the town? Yet this represents an every-day condition in an American port, and it is perforce necessary not only to guard this property but to calculate the even more important risk, namely, should fire occur, the danger of its spreading to adjacent dwellings.

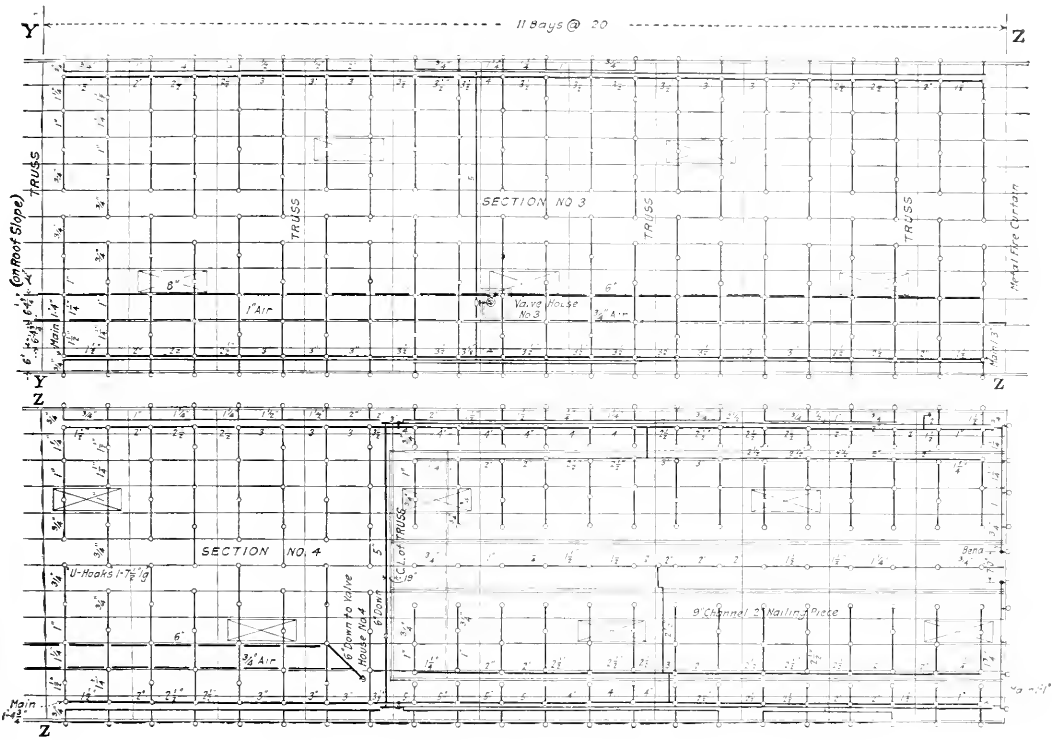


FIG. 4 SPRINKLER LAYOUT FOR A TYPICAL PIER PROPERTY—CONTINUATION OF FIG. 3

Fire Protection of Piers

The protection of pier properties involves special hazards which require special attention and constant following up, and on account of the extreme importance of this matter we outline briefly, in detail, the conditions found on piers.

Construction. Construction varies to a considerable extent, but in general the tendency of the past few years has been to improve the type of buildings used for this purpose. No doubt good construction would be of material assistance in safeguarding against the danger of fire, but, unfortunately, the present crisis will not permit of sufficient time to change existing construction defects. Frequently we find fire-resistive construction in the more modern properties, and a few sprinklered piers. Some are also found with fireproof floors and of slow-burning construction. In general, however, piers consist of one-story corrugated-iron buildings supported on wooden frames and wooden piles. Sometimes they are two-story buildings, but always with high ceilings and large openings in the sides for loading purposes. Almost invariably they connect by unprotected openings with adjoining bulkhead buildings of ordinary construction and considerable size.

Area. One of the worst features of piers is their large area, which is all open and subject to heavy drafts. Very seldom are these areas broken up by dividing walls, and unquestionably some good could be accomplished along these lines. For instance, fire breaks could be installed both above and below pier floors which would prevent the fire from spreading so rapidly and thus give the fire fighters a chance. Owing to the fact that piers are subject to heavy vibrations and movement, a great many could not be protected with standard fire walls, but fire breaks could help considerably and might be made of corrugated iron above the floor and heavy timbers below the floor, a construction which would not be affected by the movement of the pier.

Accessibility. From the very nature of piers they are less accessible than ordinary buildings. Their location near railroad terminals or on waterfronts means a frequent delay on account of congested traffic conditions. Furthermore, the ordinary building is accessible to fire fighters from all four sides, while piers are accessible only from one side, and that is always the short side. Approach from the water sides may be cut off by barges blocking the slips, and regulations should be made to keep these slips clear so that fire boats can approach from all sides.

Occupancy. The handling and storage of all sorts of supplies, from dangerous chemicals to aeroplanes, which must be received in whatever condition they are delivered by the transportation companies, is a dangerous operation. Furthermore, there is a constant change in the kind of material passing through from day to day, and this changing in itself produces a hazard, as elements that may be safe enough in themselves are frequently brought in contact with other elements which may cause them to be dangerous. Undoubtedly one of the worst features about this miscellaneous stock is the trouble with broken packages and containers, and the constant spilling of the various contents about the pier, where they may cause trouble later on.

Hazards. The lighting and heating hazards are about the

same as in the ordinary building, and apparently well taken care of, but, of course, they must be continually followed up.

Smoking. No matter what regulations there are regarding smoking, it is a hard matter to handle. The danger from this source is always present, and the only remedy is to keep after the matter and treat offenders severely.

Help. The scarcity of labor has resulted in the employment of undesirable and irresponsible help. It is a case of that or nothing, and certainly results in an increased hazard in handling. These men are not efficient, and are not trained in matters of fire protection as well as in ordinary times. There is no remedy for this condition except a careful and continual watching of these men.

Exposures. Piers are subject to exposure fires not only from adjoining frame structures on land and other piers but also from vessels alongside and floating material from other fires in the vicinity. They are much more susceptible to exposure fires than ordinary property, because the high winds prevailing on the waterfront carry flying brands greater distances and fan these incipient fires wherever they start. An excellent illustration of this feature was the Jarvis fire on the Jersey City waterfront, which spread across the river to a pier in New York. The vessels alongside and in the harbor are also hazards, because the employees on board are careless about fire-protection matters and are not under restraint by the pier owners. Frequently boats containing dangerous contents catch on fire and they may expose several piers in the same harbor.

Fire Protection. Too much emphasis cannot be placed upon the necessity and importance of ample water supply for fighting pier fires, and yet during this last winter a large section of the Jersey City waterfront was greatly endangered by low pressure in the city mains. Reliable reports indicate that at the time of the coal shortage and very cold weather the city pressure at many points near pier property was *under 10 lb.*

This danger was somewhat offset by good private supplies, but it simply indicates how bad things can get when not properly followed up. The size, location and condition of all mains and outside fire hydrants are matters that must have continual attention, or they are liable to fail during an emergency. Instances of this kind have already occurred.

Inside Standpipe and Hose. For instant use with incipient fires and to hold them until the fire department arrives, proper standpipe and hose connections are essential and are generally provided. It appears, however, that this form of protection is open to some objections not common in other property, namely:

a Subject to freezing, as shown by many cases that happened last winter

b Liable to be used by crews of boats alongside for purposes other than fire and damaged or left out of condition by them

c Frequently inaccessible or blocked by piling of goods too near hose racks

d Control valves are necessarily located out of reach, and when the operator finds the fire too severe he is liable to run without stopping to close the valve, allowing the waste of water when most needed

e Condition of piping where salt water is used frequently requires special attention on account of barnacles, pitting, etc. The only remedy for these conditions is constant inspection and frequent tests of the apparatus.

Extinguisher Pails and Casks. The value of this form of protection lies in the fact that every one knows how to use pails and casks, and if used in time they may save loss. They must be looked after frequently to see that they are ready for instant use.

Watchmen. This is one form of protection that means much or little, depending entirely upon the watchman himself. In the past the main trouble has been that men used for such purposes were not competent to fill the position, frequently being pensioners and others who were not physically fit. The importance of having strong, alert young men is becoming more apparent. When it is remembered that every night the entire protection of great value is solely dependent upon their good judgment and faithful efforts in a monotonous job, it will be understood that first-class men must be employed. It is also advisable to have a watchmen's checking system, and they must be thoroughly instructed in the detection and fighting of fire.

Fire Alarms. Both city and local fire alarms are desirable. The important thing is to give the alarm promptly upon the discovery of the fire, as assistance cannot be rendered too soon. For some reason or other there seems to be more trouble with delayed alarms in connection with pier fires than with other classes of property, and too much importance cannot be laid upon the necessity of early alarms for pier fires. Local fire gongs operated from the same box are desirable for the purpose of notifying all employees immediately, and furnish the best method of drilling them.

Fire Brigade. A well-trained fire brigade is a very great advantage because these men are constantly on hand and available. Their jobs depend upon getting the fire out. Further, on account of their familiarity with the property and the fire-fighting apparatus they are able to get at the trouble very quickly. They should be under the direction of some experienced head and drilled regularly in their duties. They should know all about the apparatus and what to do in any emergency. They should be men selected carefully for their qualifications along this line. Surprise tests should be made by the owners frequently to see whether they are properly responding to alarms.

Automatic Sprinklers. The value of these systems is well known, and where properly maintained there is no question as to their efficiency. Pier conditions require special consideration, as follows:

a They must be dry systems because the piers are not heated

b High ceilings and particularly draft conditions make necessary curtain boards to bank the heat at sprinkler heads for high efficiency

c Extra heavy water supplies are required because of the large area subject to one fire

d Outside sprinklers are sometimes necessary to protect from exposure fires on vessels, etc., that may be alongside of the pier

e Sprinkler supervisory service for the purpose of automatically calling in the fire department whenever a fire starts

f Proper housing for mains and dry valves to prevent freezing during cold weather.

Considering the serious hazards in pier property, it is a surprising fact that only a comparatively few piers have been protected with automatic sprinklers. For example, out of some 150 piers in Manhattan we find only one or two with standard sprinkler equipments. Brooklyn makes a better showing with 18 sprinkler equipments, and New Jersey with about a half dozen. In the entire country there are only about sixty piers safeguarded with sprinklers.

We find that it is practically the unanimous opinion of all the fire-protection engineers that sprinkler systems afford the best possible protection for this class of property, and many

of them believe it to be the only satisfactory form for their particular conditions.

Mr. E. P. Boone, of the New York Fire Insurance Exchange, has had more experience with sprinklered piers than any one else in the country, and he is an enthusiastic believer in sprinkler systems for piers. His experience covers a number of actual fires which have resulted in only nominal loss to the property on account of the quick action of the sprinklers. He has mentioned one case where fire opened some twelve sprinkler heads which extinguished the fire so promptly that there was no interruption to business. Although the smoke was thick, the drivers continued to operate their motor trucks, loading and unloading as though nothing had happened. Figs. 1 and 2 give a good idea of the way Mr. Boone adapts sprinkler protection to the special conditions existing on a pier. Large open areas are broken into sections by special curtain boards coming down from the ceiling which bank the heat at the sprinkler head in spite of the drafty conditions. Note that some curtain boards are parallel with the pier, and others intersect them at right angles, running across the pier together, forming large pockets for the heat to rise in. This construction is rather unusual, and is made necessary on account of the extreme width of the pier. Fig. 1 also indicates the great length of the pier. These views show one of a group of sprinklered piers owned by the Bush Terminal Company, whose property was recently taken over by the Government. Figs. 3 and 4 show the sprinkler layout for a typical pier property, and Fig. 5 a section through pier indicating provision for a metal fire curtain.

Conclusions

Everybody's business is nobody's business, and we firmly believe that serious trouble will result unless the entire matter is handled in a businesslike manner by some high authority with broad experience in this line. We submit:

a That there should be no question as to the reliability of all water supplies involved, either public or private

b That lighters and boats exposing piers should be compelled to conform to established fire-protection practice and not be permitted to endanger this property by using kerosene lamps, cooking stoves, etc.

c That dangerous chemicals, oils and highly in 'ammable materials should be segregated and kept separate from other supplies

d That barges and boats should not be permitted to block up slips, preventing access to the sides of piers

e That extra large areas should be divided by section walls or fire breaks

f That explosives, or explosive materials, should not be permitted near the important terminals

g That bulkhead buildings should be cut off from piers where-ever possible

h That sprinkler protection should be provided where conditions appear most serious

i That good, reliable watchmen should be employed at night to properly safeguard the contents

j That all dirt, waste and rubbish should be immediately removed and the premises kept scrupulously clean

k That, wherever lacking, all necessary fire-fighting apparatus should be provided and constantly tested and inspected

l That there should be a uniform practice established for handling all these matters, and particularly seeing that they are followed up from day to day.

In our opinion the desired results can be accomplished only in one way: The Government must create a special central authority, with necessary experts to make a complete study of the entire situation in all our seaports, and then place the responsibility of handling and following up such matters in this one central authority. It must be more than an advisory body, and should be composed of men with practical experience in such matters, and capable of enforcing the necessary regulations. This step is not only justified as a matter of business expediency, but is in reality a matter of military necessity.

We have sought in the foregoing to outline some of the broader principles of fire protection in essential industries, but in the last analysis each individual risk has its own particular problems which must be solved for the individual plant by the engineers in charge.

One thing that applies to all plants, all offices and all houses is the matter of cleanliness and carefulness. What this country needs is more careful national housekeeping, and in this connection the writer asked the Fire and Accident Prevention Committee of the National Fire Protection Association for a

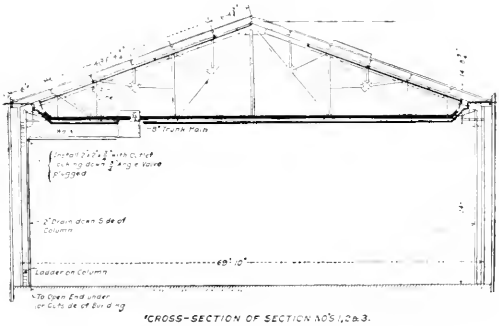


Fig. 5 Section through Pier of Figs. 3 and 4 Showing Provision for Metal Fire Curtain

brief outline of the work it is doing this year in trying to reduce the fire losses which are so serious a drain on our national resources. In reply they said:

"We plan to incorporate where possible, ordinances giving the fire department power to enter premises for clean-up purposes and to correct various undesirable features. We are at present formulating a program to include the education of school pupils in the details of fire prevention in the home, and to bring to the public a realization of personal responsibility for fires originating on their premises, whether homes or business.

"We are also arranging for parades and demonstrations and suitable literature through committees which are to be formed in various cities throughout the country. As to your paper before the Mechanical Engineers, that is an opportunity for you to place before them the great necessity for incorporating fire-protection features in their plans when they are called upon to outline any project. We must rely upon the engineers of the country to help us in the broader field, and where plants are being erected usually the first consideration should be the preservation of that property from fire. Their realization of this need will be a great help, not only in reducing the fire waste of the country but in preserving the necessary output of materials in this time of war."

OIL FUEL IN NEW ENGLAND POWER PLANTS

By HENRY W. BALLOU,[1] PROVIDENCE, R. I.

Non-Member

In the New England states there has of late been a rapid increase in the use of oil fuel in power plants, and in a convention partly devoted to the fuel problem a brief statement of the present status thereof may be of interest.

From data privately gathered it appears that oil fuel is now used in at least 60 different power plants in New England, having a total of 83,000 boiler hp. These installations are located as roughly indicated on the outline map of New England shown in Fig. 1. They are grouped according to states as shown in Table 1, from which it may be seen that two-thirds of the power plants and over one-half of the boiler horsepower so served are in Rhode Island.

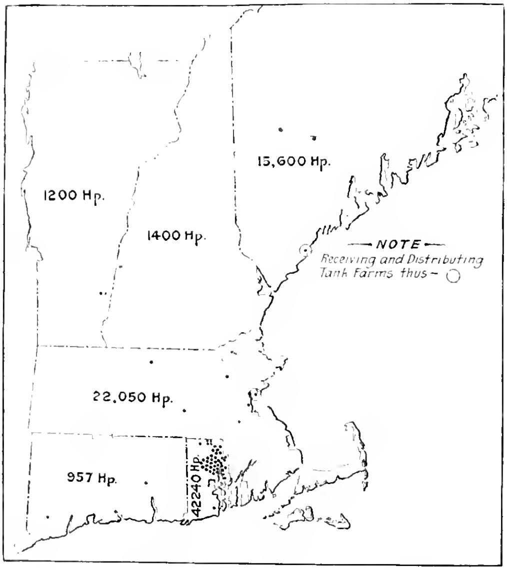


Fig. 1 Distribution of Oil Fuel Power Plants in New England, April, 1918

As shown in Table 2, most of these installations have been made in the past three years. When classified as to type of boiler, the result is as given in Table 3. When classified as to make of oil burner in use, the data are as presented in Table 4. It is estimated that in the year 1917 about 95 per cent of all of the fuel oil burned in New England power plants was used through Hammell burners.

Oil fuel is supplied almost entirely by the Mexican Petroleum Company from three tank farms located at Providence, R. I., Chelsea, Mass., and Portland, Me., having capacities of 257,000 bbl., 165,000 bbl., and 202,000 bbl., respectively. It is said that tanks have been ordered to increase the capacity of the Providence tank farm to 735,000 bbl., which is roughly equivalent to 200,000 tons of coal.

All of this oil is brought from Tampico, Mexico, a distance of over 2000 miles, in tank ships. The size of these tankers has greatly increased of late, the largest running into Providence being nearly 500 ft. long and drawing nearly 30 ft. of

TABLE 1 NUMBER OF OIL-FUEL POWER PLANTS IN EACH NEW ENGLAND STATE IN APRIL 1918

State	Number of plants.	Total horsepower
Maine	3	15,600
New Hampshire	1	1,400
Vermont	2	1,200
Massachusetts	10	22,050
Rhode Island	42	42,240
Connecticut	2	957
Total	60	83,447

TABLE 2 OIL-FUEL POWER PLANTS INSTALLED IN NEW ENGLAND, 1915–1918

Year	Number of boilers	Boiler horsepower
1915	74	24,450
1916	79	14,315
1917	98	22,382
1918	93	22,300

TABLE 3 BOILERS INSTALLED IN NEW ENGLAND OIL-FUEL POWER PLANTS, 1915–1918

Number of boilers	Make of boiler	Total boiler horsepower
130	Horizontal return tubular	22,582
88	Manning	16,525
81	Babcock & Wilcox	31,025
15	Heine	4,400
15	Stirling	3,800
5	Scotch marine	715
4	Gunboat	2,400
3	Edge Moor	1,000
2	Keeler	500
1	Aultman-Taylor	500
344	Total	83,447

TABLE 4 OIL BURNERS IN USE IN NEW ENGLAND POWER PLANTS, APRIL, 1918

Make of burner	Number of plants	Boiler horsepower
Hammell	55	81,040
Witt	4	1,157
White	1	1,250

[1] Jenks and Ballou

For presentation at the Spring Meeting, Worcester, Mass., June 4 to 7, 1918, of The American Society of Mechanical Engineers. The paper is here printed in abstract form and advance copies of the complete paper may be obtained by members gratis upon application. All papers are subject to revision.

water. Its capacity is 80,000 bbl., which is roughly equivalent to 20,000 tons of coal.

Local delivery from tank farms to power plants is by tank cars and auto trucks. Perhaps one-half of all fuel oil is delivered by auto trucks having capacities of from 1500 to 2280 gal. Such trucks, carrying 8 tons of oil, or enough to yield 2000 hp. for a 10-hr. day, will discharge their load by gravity in from 3 to 5 min. Oil trucks from the tank farms at tidewater in Providence make the round trip to the Tamarack power house in Pawtucket (a distance of 10 miles) in $1\frac{1}{2}$ hr., including both loading and unloading.

The oil is usually delivered at a temperature of from 80 to 85 deg. fahr. The quantity delivered is seldom checked by weighing or by temperature observations, the "delivery slip" of the oil company usually being accepted as evidence of quantity, after observation by the purchaser's agents that the truck is full on arrival and is allowed to thoroughly drain. Analysis or other test of the oil is seldom attempted by the purchaser.

The chemical constitution and freedom from impurity of the oil appear to be remarkably uniform, especially when considered in contrast with coal. Uniformity is presumably favored by marine shipment in bulk. So far as known, there is no accumulation of water or silt in the receiving tanks at power plants. The small quantity of water in the oil, frequently about one-half of one per cent, is said to be present as a sort of emulsion.

The typical New England power-plant equipment is often about as shown in Fig. 2. Cylindrical steel tanks, of capacity to serve from a day to several weeks, are usually set in the ground or in concrete vaults. Concrete storage tanks are also extensively used. A steam coil keeps the oil in the tank at a temperature of from 90 to 120 deg. fahr., whence it passes through an ordinary duplex pump and thence to the boilers at a pressure of from 18 to 30 lb., being heated to perhaps 180 deg. fahr. by the exhaust steam from the pump. A return oil pipe discharges into the tank, thus providing warm oil at starting and discharge for the relief valve. Oil pressure is maintained by a pump governor, and meters on both supply and return pipes register quantities. Strainers, pressure gages, thermometers and twin pumps are customary. The simplicity of the typical oil equipment when compared with that for coal is, of course, one cause of the popularity of oil fuel.

Insurance requirements appear to have ceased to be burdensome as standards of fuel and equipment have been found to be uniform and reliable. At present the two main requirements appear to be that the tank shall be below ground outside of the building walls and below the level of the pumps and boiler-room floor. Even these requirements have been modified in some cases. No difficulty is experienced in pumping oil as warm as 130 deg. fahr. with a 10-ft. suction lift; and one installation with a 15-ft. suction lift is said to be successful.

A statement of the causes and conditions which have led to this sudden adoption of oil fuel in New England may be of interest. Of course, a primal cause was active propaganda by oil and equipment companies; and the basic cause was the superiority of oil to coal. The merits of oil fuel, however, although long recognized in other parts of this country, are somewhat of a surprise to the manufacturers of New England.

About nine-tenths of these oil-fuel installations are a substitution for coal in existing plants rather than primal installations in new plants, and it is believed that fully nine-tenths of them have been made without the advice of a consulting engineer. This statement may seem more significant than is really the case, both because in a number of instances where a consulting engineer's opinion has been sought the change to oil has not been made, and because of the excellent grade of engineering skill employed by the equipment companies in solicitation.

In general, the owner has been convinced by the remarkable contrasts between coal and oil, and the simplicity and freedom from labor troubles, ashes and dirt have appealed to him most strongly. In a number of cases additions to power plants have been avoided by the use of oil fuel, and such a feature is one to conjure with in New England.

There is no other method of increasing the capacity of a boiler plant so quickly and so cheaply as by substituting oil for coal fuel. Defective-draft troubles disappear coincidentally and the lone fireman dozes peacefully in ten-minute naps. In a number of cases the change to oil fuel has made it possible to shut down one or more boilers. The resulting saving

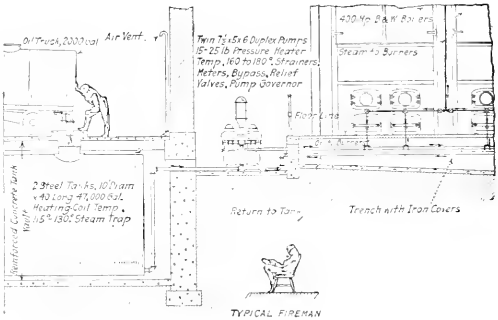


FIG. 2 DIAGRAM OF OIL-FUEL EQUIPMENT TYPICAL IN NEW ENGLAND POWER PLANTS

in radiation losses and maintenance is a typical illustration of the collateral economies of oil fuel.

In the judgment of managers, the minor nature of alterations in a boiler necessary to use oil fuel and the possibility of readily changing back to coal are vital features.

A few plants in New England have accomplished the automatic governing of the flow of oil and of the atomizing steam. Hand control of operation is almost universal, and is now attaining a standard of excess-air proportions never reached even in the highest grade of coal plants, some tests having shown as little as 20 per cent excess air. It is inspiring to contemplate the probability that automatic regulation of the oil, the atomizing steam and the draft pressure will all become a standard reality within a few years. Then will be the golden age of regulated combustion in New England power plants.

The advantages of oil fuel are ably set forth in the TRANSACTIONS for the year 1911 in a paper by B. R. T. Collins,[1] in which there are formulated seventeen well-defined ways in which oil fuel is superior to coal. Papers by C. R. Weymouth[2] in 1908 and 1912 are also noteworthy, and the U. S. Navy tests of 1905 and of 1916 are excellent evidence, if proof were needed, that, per heat unit contained, oil fuel is from 10 to 20 per cent more efficient than coal.

In an excellent paper on fuel oil, read before the Boston Section of the A.S.M.E. in 1917, Mr. F. W. Ewing estimated

[1] Trans.Am.Soc.M.E., vol. 33, p. 83.

[2] Trans.Am.Soc.M.E., vol. 30, pp. 775 and 797; and vol. 34, p. 639.

that parity in the price of coal and oil is reached when 26 per cent more is paid per heat unit of oil than of coal. This would be equivalent to about a 60 per cent higher price per pound of oil. While noting that this generalization should not be taken too seriously, the writer is inclined to believe that the many collateral economies involved in the use of oil fuel cause it to be true that in numerous cases even more than 60 per cent extra can be paid for oil.

The saving of labor due to oil fuel as compared with coal, while in itself large, has often been given a greatly exaggerated importance. Of the operating expenses in a New England boiler plant other than fixed charges, 80 to 90 per cent are usually for fuel. Accordingly a slight variation in the cost per pound of fuel may amount to as much as the total cost of labor. It has been said that a variation of a tenth of a cent a gallon in the price of oil will offset all saving in wages due to oil fuel.

It is obvious to engineers that, assuming a dependable supply of oil fuel at a price per heat unit equal to that for coal, the latter would soon cease to be used in the power plants of New England. The choice between oil and coal is therefore a matter of supply and not of quality. The only way in which coal may rival oil fuel is in price. It accordingly becomes of interest to consider what the future may have in store for the power plants of this section.

A recent review of the coal supplies of the world by the National City Bank of New York sets forth the remarkable fact that the coal deposits of the United States exceed those of the rest of the world combined and are seven times as great as those of all Europe. Of these prodigious deposits a large part of the finest steam coals lie in the states of Pennsylvania and West Virginia, within 500 miles of New England.

As to production, in the year 1917 the United States mined within 10 per cent of as much coal as the rest of the world combined, over one-half of which came from Pennsylvania and West Virginia.

The greatest supply of coal in the world being within 500 miles of New England, what, now, is the case for fuel oil?

It is notable that the question of supply is not simply about *oil*, but about *fuel oil*, which latter has been defined as oil which is more valuable as fuel than in the form of refined products.

It appears that crude petroleum may be divided into two classes, namely, one with a paraffin base and the other with an asphalt base. That with the paraffin base is so valuable for its derivatives—gasoline, kerosene, lubricating oils, and a thousand others—that its price will always be prohibitive for fuel. Moreover, rapid improvement in methods of distillation has made the refined products from the lighter asphalt-base oils so valuable that many of these oils have disappeared from the fuel market. Much that was fuel oil ten years ago is no longer fuel oil. Thus it is that of the four great oil companies, each having extensive tank farms at Providence tidewater, namely, the Standard Oil Company, The Gulf Refining Company, The Texas Company, and the Mexican Petroleum Company, only the latter is furnishing fuel oil for power plants. Indeed, at the present writing the Mexican Petroleum Company is unable to take any more contracts for fuel oil, and on the face of things it appears that oil is even now more scarce than coal. The question is not as to the world-wide supply of crude petroleum, but merely as to that small part of the whole supply which may not be readily distilled.

The extremely heavy grades of asphalt-base oils from Mexico are practically the only fuel oils now available to New England. It will be shown later that this Mexican supply (amounting to 55,000,000 bbl. in 1917), though in itself of great volume, is destined to cut but a small figure in the world's supply of fuel. Consequently, Mexican fuel oil will naturally gravitate toward those uses for which it will command a premium.

The question then arises as to what uses will pay a premium for fuel oil, and the answer is, those uses in which its superiority to coal are most important. The greatest of these is marine use. Consider the item of labor alone. It is generally conceded that in a large boiler plant the boiler-room labor with fuel oil may be only one-tenth of that with coal. On shipboard the labor of coal passing and trimming bunkers greatly exceeds similar labor on land. When, as on shipboard, it becomes necessary not only to transport the heavier and more bulky coal but also to transport the laborer, his housing and keep, it is unquestionable that fuel oil will command a premium for marine use as compared with its use on land. The seventeen superiorities of oil fuel formulated by Mr. Collins apply with greater force on shipboard than on land. And the same statement is true in a slightly less measure in the case of locomotives as compared with stationary power plants.

The coal review of the National City Bank estimates the marine use of coal at 75,000,000 tons per year, or five times as much as the entire output of the Mexican oil fields. The Pennsylvania Railroad alone would take a large part of the total oil output of Mexico. Moreover, the relative ease of marine transportation of fuel oil will cause it to displace coal in places that are remote from coal deposits and difficult of access. Already, in 1917, over 3,000,000 barrels of this fuel oil went to the west coast of South America.

While prophecy is ever hazardous, it is probable that in the long run the use of fuel oil in New England will be confined to those special uses and sporadic cases which, for one abnormal cause or another, can afford to pay the premium that oil fuel will command for uses outside of power plants. Oil fuel will within a very few years become a luxury for power plants.

The kinds of power plants which may be warranted in paying the premium that oil will ultimately command for transportation uses might include those plants which must maintain banked fires for considerable periods, such as plants auxiliary to water power or boilers serving fire pumps.

The premium may also be paid by small, prosperous plants in cities where smoke, dust and dirt are especially objectionable, coal storage difficult, ashes disposal expensive, and the labor expense and managerial oversight disproportionately burdensome.

In a word, oil fuel is incomparably superior to coal; but that very superiority, together with its relative scarcity, will ultimately debar it from New England power plants.

Just at present the user of oil fuel is enjoying those benefits incidental to extreme labor scarcity and abnormal prices for coal, and the lucky few who happened to have long-time contracts are reaping a golden harvest; but these conditions are ephemeral. Doubtless the whole cost of many oil-burning installations will be saved well within a period of five years.

The present rapid increase in the use of fuel oil in New England power plants is but a lucky incident in the marketing of a great natural product. Immense as is its absolute volume, the insignificance of its relative volume as a source of world-wide fuel has thus far been the main obstacle to the adoption of Mexican oil on the high seas. That obstacle is rapidly disappearing, and, regrettable though it be, it is inevitable that its very virtues will ultimately deprive the power plants of New England of fuel oil.

THE WORKMAN'S HOME: ITS INFLUENCE UPON PRODUCTION IN THE FACTORY AND LABOR TURNOVER

BY LESLIE H. ALLEN,[1] BOSTON, MASS.

Non-Member

THE events of the past twelve months have shown up in no uncertain way many serious defects in the structure of our social system. So many things in which we prided ourselves and rested with confidence have fallen apart or shown essential weaknesses. The earnest efforts of all who have at heart the welfare of our country and its people are needed to redesign and reconstruct the defective parts of our social machinery in order that we may maintain the leadership of democratic nations that we now hold and enjoy.

Among the industrial and economic problems which have disclosed themselves and are pressing for an immediate solution is that of the housing of the working classes, the subject of this paper.

Let it be recognized at the outset that this problem is entirely distinct from that of the housing of the poor, a problem of equal urgency and of greater difficulty, a problem in which we all are, or ought to be, equally interested. In addressing The American Society of Mechanical Engineers in their professional capacity, I have, however, restricted myself to the subject of housing the working classes, a subject that bears an important relation to the professional work of the engineer rather than to his social sympathies.

The high wages that now prevail are not bringing to the workingman either wealth or comfort. The shorter hours that the unions have devoted so much time and effort to secure and have often fought for with so much bitterness have not produced any corresponding improvement in the workman's condition. This is largely because the workman is unable to secure a comfortable home in which to spend and enjoy his hours of leisure. If he earns high wages rents are raised by landlords generally and prices of other commodities go up in like manner, and in growing centers of industry houses are usually impossible to obtain. At the present time, when the cost of building is so high, new houses are not being built to accommodate the growth of population or its concentration in industrial centers engaged in munition work and shipbuilding, and the result is an altogether disgraceful amount of overcrowding. It is becoming the rule rather than the exception for two or even three shifts of men to occupy the same beds in overcrowded rooms, and it is practically impossible for any workman, skilled or unskilled, coming to a new town to bring his family with him; he has to come alone and crowd in as a lodger with others.

None of us have attended this meeting to discuss matters of abstract interest, and in addressing the members of the Society it is most important that the connection between the housing problem and their professional work be clearly established.

Lack of Housing a Frequent Cause of Labor Turnover

Recent investigations have shown that one of the most important causes of the present abnormal labor turnover is the lack of sufficient homes to house the population around industrial plants and the altogether unsatisfactory nature of such houses as there are.

It is hardly necessary in this paper to present figures regarding labor turnover to a meeting of engineers; it is a pressing problem that you all know more about than the speaker. Ten years ago we should have felt rather ashamed of a turnover of 100 per cent per annum. Many large plants now consider themselves very fortunate if they can get below 200 per cent. Those who do not keep track of their figures may be inclined to dispute this, but those who through their employment department keep records of their labor turnover will unanimously bear out the general statement made above.

The fact is, that in spite of high wages the living conditions in our manufacturing centers are so miserable that a workman cannot endure a long stay in one place, and he soon throws up his job and moves on to the next town for the sake of a change in the vain hope that he will find something better than the conditions he has just left. Such men separated from their families and roaming from place to place soon degenerate into the "floater" class that is such a big problem to our employment departments.

Results of a Questionnaire on Means of Reducing Labor Turnover

In order to bring out more clearly the importance of good and adequate housing as a means of reducing labor turnover, the Aberthaw Company has just prepared and circulated a questionnaire among employers of labor, asking for figures on their labor turnover and on the character and sufficiency of the house accommodations around their plants. Prior to this, as far as could be ascertained, no data had been assembled on this relation, although the opinion has been widely held that housing has an important influence on labor.

Eight hundred and forty replies were received, containing a mass of most interesting information. The replies were from typical plants in the eastern and middle-western states, some in cities and some in small towns, and may be taken as a fair average statement of conditions.

As we expected, only a small proportion ($18\frac{1}{2}$ per cent) of our correspondents kept any record of their "hiring and firing"; of those who had kept records on turnover nearly a third had started keeping their records within a year.

Very few of those answering stated that they housed all their help, but 17 per cent owned some houses.

In answer to our request for an expression of opinion as to the influence of good housing, nearly all replied that it was a benefit to a manufacturing plant, tended to hold the men and made them more contented and happier, but there was some division of opinion as to whether it reduced time lost through sickness.

The opinion is held by all manufacturers located in large cities, such as New York, Philadelphia and Buffalo, that in very large communities housing has no bearing upon labor supply—with the exception of one firm in Detroit, which attributes a large reduction in turnover to selecting its new employees from those who live within half a mile of the plant. No firm in a very large city shows any interest in housing, al-

[1] Aberthaw Construction Company.

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though in many cases the turnover is just as large. Whether this opinion is a correct one due to there being an excess of supply over demand for houses or for labor or both, in our big cities, or whether the opinion is fallacious, we are unable to say.

TABLE 1 RELATION BETWEEN LABOR TURNOVER AND HOUSING

Turnover	Percentage of localities reporting adequate housing	Percentage of localities reporting insufficient housing
Less than 50 per cent	52.5	34
50 to 100 per cent	21	35
100 to 200 per cent	14	14
200 to 300 per cent	7	6
300 to 400 per cent	3.5	8
Over 400 per cent	2	3

Table 1 has been compiled from the answers received. It indicates that over 50 per cent of plants reporting turnover which have adequate housing around them have a turnover below 50 per cent, while only one-third of the plants where housing is insufficient report as low a turnover as this.

Combining all plants reporting a turnover of less than 100 per cent, the figures are only slightly in favor of those which have adequate housing; above this point the advantage rests with the well-housed plants.

Extracts from Replies to Questionnaire

The figures obtained cannot be called conclusive, and it is probable that many with records of high labor turnover did not care to disclose them. Of far greater interest and value are the replies returned with the questionnaire. Some of the more interesting follow:

A Pennsylvania mill has some very positive evidence of the cash value of good housing. Their manager writes us:

Our two blast furnaces are located about twenty miles apart, and between them is the blast furnace of a rival company. We consider our housing facilities superior to theirs, and to give you an idea of the effect of this would state that for years past they have had to pay more per day, of the same number of hours, for all of the men they employ around their plant. Of course the wages differ for different positions, but any position at their plant pays more money than a corresponding position at either of our two plants.

Furthermore the general living conditions around one of our own plants are somewhat better than the other, and in view of this we find we have to pay a differential in the labor scale although the plants are only twenty miles apart.

Hardly a month goes by that we do not get some men to come to us from this rival furnace, stating that the reason for moving is, though they get less wages, the housing conditions are better around our plants.

I might say that while we have not got the exact figures for comparison, we believe our labor turnover is exceptionally low compared to other plants in the same line of business, and we find the difference between the labor turnover at our different plants bears a relation to the desirability of the houses and living conditions at the respective plants.

A New Mexico mining company that has laid out one of the most charming and artistic villages owned by a copper mine, writes us:

When this camp was new, it was composed mainly of single men, the number of married men gradually increasing with the age of the camp until now a large majority of the men are married. This has necessitated the building of additional houses from year to year to take care of the demand, although there has been no material increase in the number of employees.

Without a doubt, a married man settled down in a house with his family is much more contented than a single man who is living in a boarding house. It is a fact that a married man will not jump up and leave his work on the slightest provocation, whereas a single man without a family connection frequently gets up and leaves without notice, for no reason whatever.

During the war period miners' wages are increasing rapidly, and in the very recent past there has been a great shortage of men. With the increase in wages and the shortage in labor, men have a tendency to want to move around from place to place to see if they cannot find something better. We have had a great many cases of men coming for the fourth or fifth time and giving us a list of fifteen or twenty places where they have worked in the past four or five months. During normal times we can safely say that an employee is more contented, happier and attentive to business when comfortably domiciled.

Indianapolis is a city we should all like to live in. Each manufacturer who writes from Indianapolis speaks of it as a city of homes. For instance, one letter says:

Indianapolis is a town where a great many workmen own their own homes. It is possible for a man to buy a piece of property in a decent part of the town with a good house on same by making a small cash payment and making the balance of his payments at about what he would pay for rent. We believe that this is a very good thing for the city, and for the industries and the men located therein. It has a tendency to stop the shifting and constant changing of men, and is of an economical value because it promotes saving and altogether produces a better grade of workmen and citizens.

It is our belief that there is not the great shifting among the workmen of Indianapolis that you will find in other manufacturing cities. At the present time we do not doubt but what the population is shifting more than under normal conditions, but we do not believe that this percentage of change is as large with us as it is in other communities.

A small Connecticut town of home owners seems well content, as one reply says:

A great many of our employees own their own homes, a factor which tends to hold the men, makes them more contented and happier and is evidence of an earning power greater than in many lines of industries, and the result is that we do not have to give any particular thought to housing conditions.

We all envy such a happy state of affairs.

From a thriving New York city the Broadhead Worsted Mills write us:

We have only three or four houses and do not believe in building houses for laborers. We have a class of labor a little above the average, who build their own homes. Jamestown is noted for its laboring people owning beautiful homes. When an employee owns his own home and is interested in the city where he lives he will stand by the company that employs him much longer than he will if he lives in a tenement house belonging to the company.

The experience of the general manager of one of our largest collieries confirms the views expressed. He says:

From close observation and study of results experienced at fourteen operating collieries, I can state specifically that where housing conditions excel there the better class of labor exists, as is demonstrated by higher efficiency in their work, cleaner play during their play time, and better homes for the wife and family.

At such of these collieries operated by this company and where conveniences of a modern character have been placed at the disposal of workmen and their families, our labor is of the most efficient and also of the most stable character. We have found under these good conditions that even though the man did not fully appreciate the conveniences provided, in a great many instances after he and his family had moved away the wife has written to our superintendents asking if her husband can be placed at work again, and if a house can be obtained. At other of our collieries, especially those acquired by purchase after housing plans had been fully developed under the previous owners, we have observed that where inadequate thought and consideration had been given to house plans and conveniences difficulty was experienced in retaining the desired class of labor, even though the

working conditions at the mine were equal to the working conditions at our collieries built throughout by ourselves.

Another colliery has had some interesting experiences to relate in keeping men by means of improving their houses.

Our company is engaged in mining bituminous coal, and has over one thousand houses. Owing to the depressed conditiou of the trade for many years we were unable to keep our houses in proper and attractive condition, and had it not been for that condition prevailing generally, we would unquestionably have lost labor that otherwise we retained. During 1916 and 1917 we put all of our houses in very much better condition and improved the surroundings. We have not any doubt that we have retained labor which would have gone to other places had we not done so, and our judgment is that it is wise to provide comfortable houses and attractive surroundings for the employees of any industrial establishment and that such a policy returns indirectly satisfactory financial results in the operation as a whole.

It is only fair to record adverse opinions. From a large te..tile concern in Moutreal we learn that company housing is a disadvantage to them.

It makes them independent; if the company had not built they would have built their own homes and become fixtures.

Mr. E. H. Barnes, superintendent of the large General Electric Co. works at Fort Wayne, Ind., writes us:

This is a town where a great many people own their own homes, or are buying them at the present time. After these have got located then the outsiders float in and out. Of course, with the abnormal growth of our concern in the last two or three years without any corresponding increase in the housing facilities the matter of overcrowding and indifferent housing naturally makes it rather difficult for people seeking a new place to work and live. Our ratio of people hired to those kept has run unusually high in the last year. This we find it impossible to analyze; as automobile and munition factories slowed up we probably got the result of their culling out dumped on us at that time, due to our geographical location, but we have no data to prove or disprove this.

The question of companies building houses and renting them to their employees is one which very few people seem to agree on. Personally I think that any company makes a mistake in doing this. The working people as a whole suspect some ulterior reason for the company's apparent beneficence. To the average American, who usually has very fixed ideas about these matters, it is more or less repugnant.

From another metal-working firm we have:

We know that good housing tends to hold the men, as we find that many men give their excuse for leaving us that they cannot always obtain the kind of a house they desire.

Another of our correspondents emphasizes the importance of employees living within walking distance of the plant.

A Buffalo manufacturer's evidence is interesting.

We find that our most contented and steady, and probably best paid employees are those who live within walking distance of our plant.

Our main difficulty at this time in getting and holding employees is that the transportation problem would be largely solved by better housing conditions in the vicinity of our plant.

The opinion of Mr. A. W. Sanderson, Director of Labor of the B. F. Goodrich Company, Akron, Ohio, is doubly interesting because of the great outlay made on housing by the Goodyear Company in that city. Mr. Sanderson writes:

We have at times felt that if housing conditions were better throughout the whole city of Akron, turnover might be somewhat reduced, but we have never felt that any participation in the housing scheme would benefit us sufficiently to justify the undertaking.

Mr. R. S. Childs writes regarding the financial value of good housing:

At Marcus Hook, Pa., is the Viscose Company, makers of artificial silks, with a pretty housing development which takes care of about one-half of the employees. They have a labor turnover of 15 per cent per month at the present time. Next door to them is the Congoleum Company, making floor coverings, with no housing and the turnover is 30 per cent per month. The Viscose Company employs a larger proportion of skilled labor than the Congoleum Company. Living conditions in that region are very bad and labor is very restless, due partly of course to the great shipyard developments. The Congoleum Company recognizes the need of housing as the only solution of their manufacturing problem and figure they would save $200,000 a year thereby, inasmuch as they have unskilled labor handling fragile goods where a careless sweep of the arm will ruin $20 worth of goods.

Further confirmation from an Erie Iron Works:

Among our mechanics who own their own houses the labor turnover is very small; this also is true to a large extent among the unskilled labor who have lived in the city and own their homes.

The president of a large paper company near Philadelphia testifies to the steadiness of home-owning workmen:

Our industry is the principal one in the town and most of our employees have been with us for a great many years. There seem to be enough houses in the neighborhood to provide room for all. The company owns some land which it sells to those employees who want to buy and build their own houses. We sell the land at a low price and on any terms which the purchaser may desire. We encourage our employees to buy their own homes, as our experience is that those who do so are much more dependable than those who do not. Our relations with our men have always been most pleasant and all of them take a personal interest in the property and success of the business.

Another Massachusetts textile concern is desirous of seeing his men home owners independently of his company:

As a general proposition there is no question but what good housing near the plant is a benefit to any manufacturing business located in the country. We are under the impression, however, that good housing built by other people is of more benefit to the community and the manufacturing plant than housing controlled by the manufacturing plant itself. We are continually having to build more tenements, although we find that tenements owned by other people usually rent more readily and for more money than our own houses.

There seems to be distinct desire ou the part of our better class of employees to spread out and not house themselves as thickly as in years past. Among some of the Southern European aliens, however, the tendency to overcrowd still persists.

We believe that a plan that enables the employee to build and own his own house is a benefit to the community, to the employer and to the employee. We have not, however, been successful in interesting our employees in any proposition of this kind to the extent we have desired.

A well-known crane manufacturer believes in selling houses to his men even at a loss:

From the fact that nearly all of the company capital is needed in its business it is a very difficult matter for them to divert much of it to the construction of new houses, much as they would like to do so.

We find that the employees were very anxious to buy these houses, but of course, the burden of the expense will have to be carried by the company for approximately ten years.

We consider it desirable to have as many of our employees own their homes as possible, because it makes them more thrifty and their families are better satisfied ordinarily, because of the added interest.

The pressure of the housing situation is very apt to make it necessary for us to utilize women in the shop to some extent. The fact that they are already housed makes it easier to use them than to get help from outside sources and then have the housing problem get more serious than it is at present.

While we have no definite statistics relative to the time lost by men who are properly housed and those who are not, we are of the opinion that a man working to pay for his own home will not lose any more time than is necessary and therefore will be on

the job as steadily as it is possible for him to be. The satisfaction of owning one's own home and improving it is real. So far as we can recall we have only had one man who has bought his home leave the employ of the company in the past three years.

The houses which the company built during the past year were sold to the workmen for considerably less than the actual cost of them; however, the difference between the actual cost and the selling price of the houses will not be lost in the long run, because we feel that the men will be better workmen and will stay longer with the company because of the situation.

Many can sympathize with the following frank admission:

We were of the opinion that it would be beneficial to house our employees located in good houses in the village, and bought a large tract of land with that end in view, but gave it up for a bad job and have not done any building of that nature for some time, and would be glad to sell all we own or to hear they were burned up.

Our correspondent did not enlighten us further. In face of the successful work done by other concerns we suspect that some initial error was made in the organizing of the project. Such a letter only emphasizes the need for careful organization and management in a housing development.

Mr. D. H. Andrews, President of the Boston Bridge Works, lays stress on the laudable desire of the workman to make his own home arrangements:

For the great mass of people human welfare seems to consist largely in comfortable, healthful homes with income enough to provide food, clothing and some provision for the future, with a reasonable amount of recreation. The undisturbed possession of comfortable, healthful homes is such a prime factor in the contentment of employees that every far-seeing employer should and would, if circumstances will permit, have a deep and personal interest in this phase of the welfare of employees. Our experience with employees is that generally if the location of their employment will admit of it, they prefer to settle the question of their homes independent of any consideration which may, to them, savor of paternalism on the part of their employers. If the employment is of stable permanence and the employer can provide homes for employees with an arrangement for the gradual rental purchase of same by the employee, that would seem to relieve the laudable sensitiveness of the employee and to promise the best solution of the housing problem.

This can be done in a big metropolis. It is not so easy in the smaller towns.

Another believer in company housing anxious to "control" his men writes from Pittsburgh.

We have a great number of plants. We don't attempt to house all our men at the plants, because they are all located near small towns, and a certain number of them are drawn from these towns, but we house as many men as we can near the works and are building houses just as fast as we can get employees to rent them.

We find it is best to have employees live near the works, and if you have them in your own houses, you can control them better. During the shortage of labor which we are all now experiencing, if we did not have houses near our plants, in many instances we would have been shorter of labor than we now are.

At one of our factories where we employ between two hundred and three hundred laborers, we house the majority of them. We have built practically the whole town.

As a general proposition, the writer has handled large lots of men direct for the last thirty years, and would, if possible, house every man on company property.

A contented Maine textile concern says:

We have been building a few houses every year or two and almost never lose a well-housed family.

An Ontario manager writes:

We think that no one at this time could deny the advantage arising from the possession of houses in which employees could be taken care of.

Unfortunately we haven't any residences in which to house our men, and the fact that we haven't operates against us because the town is crowded, and the first thing an out of town mechanic asks in answering our advertisement is about housing facilities.

This experience is borne out by a Connecticut metal worker who is building houses:

Not to house my present force—they are already located, but to add to my force by bringing in out-of-town men. They will not come unless I can find a home for them.

The general restlessness of labor is emphasized by many; for instance, Mr. F. R. Still of the American Blower Company, Detroit, Mich., writes us:

Proper housing conditions have a very decided influence on the turnover of the employees in any industrial institution. The best indication that this theory is a fact is demonstrated by plants located in very small places, where the rents are low or employees own their own homes. In all large cities where industrial institutions are numerous and mechanics are in great demand due to the scarcity of first-class mechanics, temptations are held out to the employees of first one institution and then another, which has a very decided influence in causing a spirit of unrest that leads to frequent changes of position, and it is hard to determine whether this is the deciding influence of the fact that housing facilities are adequate.

Undoubtedly if the employees in one institution have cheap rent or own their own homes, they are less inclined to move to some other institution, if the work and factory conditions are satisfactory. On the other hand, where rents are increasing from 25 to 50 per cent each year and the cost of everything is rising more rapidly than perhaps their wages are rising, they are naturally inclined to become restless and look about for positions that will pay them more than they are receiving at their present positions.

This view is indorsed by a machine shop in Providence who write:

We cannot attribute the labor-turnover problem which we experience to lack of proper housing. It is due in our particular case largely to a spirit of unrest. The operatives in our line seem to feel that they cannot work in one shop but about so long, and have to move along to a competitor, and finally come back to the old stamping ground for a period preceding another cycle of similar nature.

We are located in a community where good houses are available, and quite convenient to the plant. The company has not felt it necessary to consider entering into the house problem on its own responsibility, for this reason.

In our particular case, we doubt very much whether any house could be built that would hold our help beyond a limited period, unless it were a portable house.

A Buffalo textile firm says:

We have a splendid organization, and while there is considerable changing amongst our employees, particularly the girls, we think it is due to the existing unrest amongst the laboring class. Most of our employees live in the immediate neighborhood, and about 60 per cent of our entire staff has been with us ever since we located here in 1913.

The living conditions in the immediate vicinity of our mill are splendid, and we believe that this is one of the main reasons why we haven't experienced a labor shortage to any extent.

We, of course, realize that our possibilities of getting new and additional help are not as good today as they were when we located here; on the other hand, we have never been handicapped to any extent on account of being unable to secure employees.

In our estimation, good housing facilities have a tendency toward holding men that are married particularly; and the loss in time through sickness that our men have sustained is so small that it is not to be taken into consideration.

Mr. W. H. Ham, Manager of the Bridgeport Housing Company, comments on the prevailing "restlessness" and has some important and interesting suggestions to make.

Labor is restless at the present time. The single man is bound to be a rover. The young married man is somewhat better, but still has a tendency to rove and to seek better conditions and better wages because of lack of ties. The unmarried man should

be free from any restraints which would handicap his ability to advance himself. My feeling is that the best way to prevent roving of the harmful type is to build up the associations in manufacturing towns to such an extent that the unmarried man may have membership in proper kinds of associations, which will teach him to advance rather than stay still. Sports for both winter and summer are very important items. Winter sports are very lacking in most of the manufacturing cities. The competition in physical exercise is very keenly appreciated by the average working man.

I believe in the school for advancement of knowledge in the trade and the wholesome surrounding of a sufficient number of playgrounds so that we can have athletics for a very much larger number. This will have a great deal to do with the turnover of the unmarried man in the factory.

I believe the turnover among the married men with small families can be prevented by building attractive small homes (with emphasis on the adjectives that modify "homes").

A Philadelphia general manager attributes much turnover to errors in employing unsuitable men, stating:

It is the young, shiftless, irresponsible class who make the greater number of changes. Labor should be carefully selected and must be tried and culled in order to secure reliable workmen. I do not believe that any system of investigation will entirely or even largely prevent the misfits and dissatisfaction which frequently occur. A trial seems to be the only method for determining the matter finally.

This view is endorsed by the industrial superintendent of the Brown & Sharpe Manufacturing Co. Like all big city men he disregards the housing problem. He says:

The increased turnover in 1917 is due to military service and war conditions and has no relation to the housing question.

The main part of our experienced force has been stable to as great a degree as could be expected, the greatest turnover being among new and inexperienced help "hired out" to increase our force.

A Newark foundryman feeling the shipyard competition writes:

It is the shipyards that have made these men unsettled and continually dissatisfied.

The big wages paid by them have hurt many smaller manufacturers.

In the big centers the employer does not consider housing such an important element. From the Laboratory of Thomas A. Edison, Orange, N. J., Mr. Clark writes:

The Edison interests do not attribute any of their labor turnover to lack of proper housing. We are so situated that we draw our employees from a very thickly populated district, which does not make it necessary for us to house any of our employees.

Particular emphasis is made to the lack of proper housing at this time. This is due to the war work factories and shipbuilding plants that grow up over night. In these cases it is not a question of housing, it is purely a question of who pays the highest wages. The large labor turnover at this time is due entirely to what I might term competitive bidding for men's services, and the housing conditions are unquestionably a secondary consideration.

A well-known cement company is of the same opinion:

All of our plants with one exception are so located that a large proportion of the employees live in adjacent cities or towns. The plant which is the exception has the largest turnover of labor that we have and we are now building some houses we hope will better conditions.

An Empire State manufacturer has discovered another reason:

Adopt national prohibition of the liquor traffic, and many of the labor problems will solve themselves. Thousands of derelicts will never again be available to help do the world's work.

We suspect that the wish here is father to the thought, but we trust that if the drastic remedy is administered it will produce the expected cure.

Mr. R. L. Caldwell, well known to all interested in good housing, compares our care of our workmen to our care of our tools—to the disadvantage of the former:

Undoubtedly no class of Americans are more progressive generally than employers. They are keen for the quick adoption of any improvement in machinery, in facilities, in methods. Why is it that they are so slow to cultivate better relations with their employees, upon whom much more depends than on any machine? It cannot be because the question is difficult, for difficulties never deter an habitually successful executive, whose success lies largely in his ability to overcome difficulties.

Employees are very watchful of their machinery and take every precaution for its preservation and lubrication to insure its being maintained in good working order.

What would an employer think of a superintendent who scrapped 50 per cent or even 15 per cent of his complement of machinery per annum? Yet that this record is common in labor turnover is evidence conclusive that lubrication is needed in relations between employers and employees. To scrap workmen is expensive as every employee knows. New help is poor help. Inexperienced labor is inefficient labor, therefore costly labor. Low production per operative and per machine due to poor operatives means high costs in addition to low wages, so neither side is satisfied. Dissatisfaction results in more labor turnover and so the process continues interminably.

Here is a manufacturer in trouble. He states:

Our problem is housing single foreigners, who are more or less transient. They keep no heat during the day, freeze all water pipes, live without furniture, and have wrecking parties occasionally. Have suggested heated barracks with common lounging room, kitchen and food store, but they do not favor this on account of group likes and dislikes.

Experiences like this are common where proper regulation and inspection is not carried out. But the experience of the Octavia Hill Association and many others shows that even in the worst localities tenants can be made to live decently and treat houses properly.

CAUSES OF LABOR TURNOVER AS SHOWN FROM REPLIES

The general impression gained from a study of these and many other letters establishes the following causes of labor turnover today:

1 Improper or insufficient housing
2 Inadequate transportation
3 The general restlessness due in part to the abnormal war conditions
4 "Misfits"—lack of care in employing men for work for which they are best fitted.

An important cause not touched on by any of my correspondents is the lack of proper relations between employer and employee, under which heading I would include lack of supervision of the hiring and firing of men, lack of care or interest in the men, friction with the labor unions, etc.

We cannot state definitely which of these is the most potent cause of trouble; but enough has been said to justify the statements made in the earlier parts of this paper on the supreme importance of good housing.

The lack of good and sufficient houses is now recognized as a most important hindrance to the winning of the war. Because of it factories are losing men, losing work, losing output and losing profit. Losing men, because they will not stay when houses are unsatisfactory; losing work, because in many cases work has to be refused because of lack of help, and also losing output because of lack of men—and loss of efficiency in breaking in new men is a serious factor in limitation of output, and losing profit because of all these.

A Start on Solving the Problem

During the last six months this is being very generally admitted, but little has been done to remedy conditions. Speculative building and real-estate development have practically stopped and the manufacturer confronted with rising costs and war taxes has pleaded his inability to release capital for extensions like housing work, which do not show any direct profit. As a result strong pressure has been brought to bear upon the Government to provide funds for housing, which has resulted in \$50,000,000 being allotted to the Shipping Board and \$60,000,000 to the Department of Labor for improvement of housing and transportation facilities around shipyards, munition plants and the like. In England since the beginning of the war \$700,000,000 has already been spent and the future housing program in England runs into millions more, although the English housing problem has never been so urgent as it is here. It seems probable that the \$110,000,000 with which the Government will initiate its housing program will be but a small part of the capital that must be invested by federal or state governments or by municipalities and manufacturers in the near future.

The Workman's Home: How It Should Be Built.

One of the striking things that investigation of housing conditions brings out in almost any city, is the unsuitability of the type of houses to the inmate. It seems that houses are hardly ever built to suit the needs of the working man, but those above him in earning power or standards of living. When such houses become dilapidated or neighborhood conditions change he enters the houses and adapts himself to them as best he can. Comparatively few workingmen need a six- or seven-room house or can afford to occupy them without subletting half of the house or taking lodgers.

Some of the worst housing conditions we find are in old mansions left stranded by the receding tide of fashion and now occupied by four or five families, all sharing the same toilet and water supply.

The experiment is now being tried in many localities of building three- and four-room apartments, and four- and five-room houses with much success. The workman as a rule does not desire to have the privacy of his home invaded by lodgers and welcomes the opportunity to live in a small house or apartment without them.

Any discussion of the kind of house he requires should be prefaced by a statement drawing a distinction between the skilled workman and the unskilled. The former are usually Americans or live according to American standards; the latter are mostly foreign-born or negroes, receive lower rates of pay and do not desire, or if they do desire, cannot afford all the refinements and conveniences that are usually built in the American home.

I have been criticized for emphasizing this; particularly by those who are working for the Americanization of the foreigner. I sympathize with those who seem to see in my suggestions a lowering of the American standards of living, to which all should aspire and eventually be raised, standards that I endorse and ideals that I stand for also; but I stand my ground, realizing that the goal we aim for cannot be reached at one bound, and if we insist on building only that type of house which we think is ideal we shall be of no help in relieving the wretchedness of the present generation of unskilled workmen and their families. They may look with longing at the accommodations being built for them but they cannot afford to enjoy them and have to be content with the overcrowded tenements and old houses of divided occupancy that they now live in.

There is a certain minimum however that we all agree should govern the design of any workman's home. He should have at least one living room for general use of an area not less than 150 sq. ft. entirely separate from his sleeping rooms, and he should have enough bedrooms for himself and for his children of different sexes to sleep apart, each bedroom having at least 400 cu. ft. of air space per occupant, and every room having direct sunlight and ventilation through windows of ample size. Every tenant should have his own private toilet equipped with water closet and bath tub, and a sink with running water in the kitchen; and all plumbing should be connected to the sewer and pure water for drinking be supplied through faucets in the kitchen and bathroom.

American standards demand in addition separate parlors, separate dining rooms, pantries, large cellars, porches, furnace heat, electric light, laundry tubs, lavatory bowls, etc. All these are desirable and should be provided if possible, but it is better to build whatever can be got for a reasonable cost than to add all these things and make the cost so high that it is out of reach of the tenant.

In discussing types, methods and materials of construction ought not to be omitted. The difference in first cost between good construction and poor construction is not great and is speedily amortized in reduction of repair bills.

It seems to be fairly certain that the Government will build only permanent houses. It is not at all certain that these will be sold to the occupants and it is very necessary that the construction should be sufficiently good to make a good security for a long-term mortgage or sinking fund. The better the construction, the smaller the depreciation and the better the security.

The difference in cost between a six-room frame house and one of brick, concrete or tile is at present prices less than 15 per cent. The price of the lot is the same in either case, so that the difference between a frame house costing \$3000 and lot worth \$600 and a brick house on same lot would be about \$450 or 8 per cent. Assuming 5 per cent for interest, the triennial outside painting would more than repay interest in his extra investment. By setting a lower rate for depreciation and amortization, it is possible to rent such a house at as low a rate as a frame house of the same size.

The Bureau of Industrial Housing and Transportation of the Department of Labor, created for the purpose of providing living accommodations for workers at munition plants and other establishments having Government contracts, has adopted a series of standards for permanent construction that will be enforced as to all the housing to be provided under the \$60,000,000 appropriation granted by Congress.

Nine principal types of houses for permanent construction have been adopted, as follows: Type 1, single-family house; type 2, two-family house; type 3, single-family house with rooms for lodgers or boarders; type 4, lodging house for men; type 5, hotel for men; type 6, lodging house for women; type 7, hotel for women; type 8, tenement house; type 9, boarding house.

All row or group houses are restricted to a depth of two rooms. No living quarters will be permitted in basements. Brick, terra cotta, stone or concrete will be preferred. Fireproof construction will not be required, but roofs are to be fire-resisting. (*The Iron Age*, May 16, 1918, p. 1270)

MANUFACTURING IN RELATION TO BANKING, RESEARCH AND MANAGEMENT

By WALTER RAUTENSTRAUCH, NEW YORK, N. Y.

Member of the Society

PERHAPS there has been no other time in the life of our nation during which the social and economic problems confronting us have been so vital, so perplexing, and of such colossal magnitude as those which confront us now. Nor have there been such times as these not only to test the strength of our material resources, but also to prove the good and the bad in the articulation and functioning of the elements of our business system through which our resources are created and distributed. Our engagement in this most gigantic of wars is serving not only to present new and more perplexing problems, but also to emphasize the needs and accelerate the demands for an entire reconstruction of our whole business and social relations. Not only are we compelled to bend every energy to carry to a successful issue a campaign for principles by which nations may live in harmony and peace, but circumstances demand that we also reconstruct the foundations upon which shall stand economic and social institutions capable of leadership in the new world which shall rise from the ashes of the old.

Under most unusual circumstances, therefore, are we required to seek solutions for difficulties which even in normal times would demand the keenest minds and the strongest characters to accomplish.

Many agencies, governmental, industrial, and corporate, are at work in an endeavor to adapt present facilities and create and operate new facilities for carrying on the business of war, and not only for war, but also for the many perplexing industrial, agricultural, and social situations incident to the problem of living, which the war has seriously disturbed. We have vast potential forces, which are matters of just pride, but we are thankful that we are conscious of our weaknesses and inexperience and that we recognize the difficulties and failures which surround us. The many heated debates in the councils of our leaders and criticisms in the daily papers on the conduct of governmental and industrial affairs make us more and more conscious of the need of a business system which is more fundamentally sound and the need of higher ideals upon which such a business system may successfully be founded. We have long held the reputation for wastefulness which abundance of resources creates. The quick acquisition of wealth without the moral strength of character which arises from the toil and sacrifice of production has raised up many leaders who predominate over the controlling forces of our civilization and tend to destroy right standards of service and create false standards of living. The reflection of these influences in the conduct of affairs has occasioned much waste in resources and effort and created many of these problems which confront us today.

But as we contemplate the many instances of waste in resources and effort which accompany our endeavor to carry this war to a successful issue, we find that the inherent nature of the conditions by which these wastes occur is no different than that which many of us have observed in normal times, only in a lesser degree. It would seem that our failures reside in these particulars:

1 Individualistic effort as opposed to coöperative effort

2 An undue regard for the might of "purchasing" power as opposed to the might of "creative power"

3 A lack of appreciation for science or the scientific spirit in the conduct of our business system.

The introduction of corrective measures which will enable us to counteract and reconstruct these tendencies reaches every field of human endeavor, and the very nature of the changes demanded positively indicates that this must needs be. We are dealing now with an attitude of mind, the creation of a philosophy, if you please, upon the foundations of which we hope to rear an economic and social machine which will withstand the onslaughts of a world catastrophe—indeed, by means of which such catastrophes may be made impossible.

In every movement or effort to betterment there are certain avenues of approach or mediums of operation through which most effective results can be accomplished, and as we review the problems before us and the particular institutions factoring therein, it seems that among these the manufacturing industries take a high place. Any right effort to place our wealth-creating agencies, as represented by the manufacturing interests, on a higher plane and in proper coördination with other controlling factors of our civilization will render a lasting service to mankind. A close analysis of the manufacturing problem will indicate that corrective measures must be applied both from within and without the immediate province of the enterprise. It will be our purpose to consider three particular avenues from which relief may come, and these are in:

1 The closer relation of our banking institutions to productive enterprises

2 The closer relation of our universities and educational institutions to the industries

3 A broader conception of responsibilities in the management of factories.

1 Relation of Banking to Productive Enterprises

For many years the economics of barter and trade have so engrossed the interest of capital that the opportunity of profits in dealing with what others have produced has overshadowed any interest in the economics of production and the obligations of capital toward it. Wealth distribution and acquisition therefore have become of primary importance in our industrial philosophy, while the wealth-creating agencies have been factored to only a limited degree. Only as necessity has forced the issue, and not as a matter of fundamental policy, have the wealth-producing agencies been raised to the plane of excellence which their value demands. This attitude of mind is well reflected in the usual methods employed by banking institutions in extending their credit facilities to those engaged in productive enterprises. Because of their obligations to their depositors, the banks have had to have regard for the quick assets of the borrower, so that the acceptance of all customers' notes is primarily conditioned on this particular.

Abstract of paper presented before the Philadelphia Section of The American Society of Mechanical Engineers, November 27, 1917, and before the New York Section, January 8, 1918.

Indeed, sound banking demands the customer's liquidation of obligations at stated periods, and for this reason the customer's possession of quick assets has been the deciding factor in credit extensions. When we realize that about 4 per cent of the daily business transactions of this country are conducted in money or currency and 96 per cent are recorded in open account credits, checks, notes, and bills of exchange, and that a disturbance of this ratio, say a demand for 10 per cent cash settlement, will inaugurate a panic, we appreciate that emphasis in the matter of the borrower's quick reserves is well placed.

While the Federal Reserve Board is causing our banking institutions to have more regard for the borrower's ability to liquidate his banking obligations at maturity, its influence is

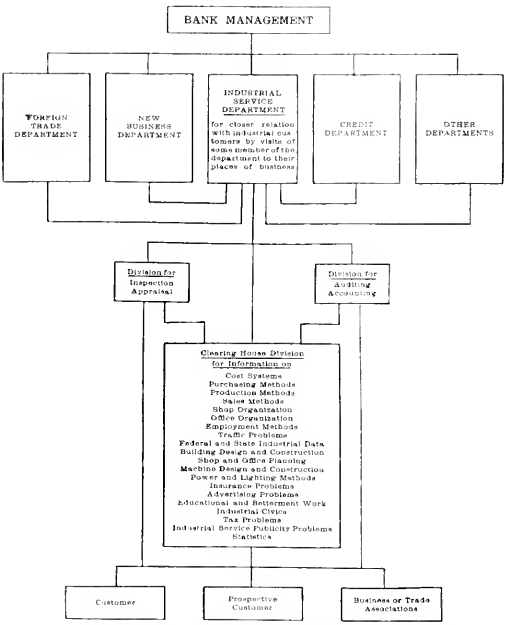

Fig. 1 Organization of Industrial-Service Department, National City Bank of New York

such as to point out that this ability does not alone rest in the possession of quick assets, but that it is also dependable on certain factors which condition the life and prosperity of the enterprise itself. Wealth-creating ability as represented in factors which every engineer understands is being appreciated, together with purchasing ability as represented in readily convertible assets. The inauguration of credit control through the medium of the Federal Reserve Banks, therefore, has not only served to promote a more sound banking policy in the matter of credit extensions, but it is also causing the more progressive bankers to view seriously the whole banking problem in relation to industrial enterprises. In other words, there is being created a larger sense of obligation and of opportunity to serve the industries that through the closer coöperation of the two both may grow into stronger institutions.

Not only has this influence been working in the relation of banks to manufacturing industry, but also in their relation to the agricultural interests. In this instance it is particularly true that the foundation of credit must rest on anticipations which are realized through sound business methods, and therefore the banks are compelled to interest themselves in this phase of the borrower's soundness.

Instances of coöperation between the bankers and the productive industries evidence an awakening to opportunity in which we may take great hope. Not only is there a recognition of a "more business-like application of credit" which rests upon the fundamental laws conditioning the prosperity of the wealth-creating industries, but there is also evidence of a real spirit of interest and helpfulness, in that there is maintained a personal and intimate contact through scientifically-trained bank representatives.

In the field of industrial banking we have also just reason to feel that an appreciation of the broader field of usefulness of banking facilities is being felt. Under wise leadership the National City Bank of New York has inaugurated an industrial-service department which it is believed will have a most helpful influence in the field of industrial development.

In establishing this new department of "Industrial Service," the bank hopes not only to increase the usefulness of its banking facilities to business by adding to its means of recognizing and crediting merit where credit is due, and thus to blaze the way for more constructive coöperation between banker and client, but also, by placing the emphasis on better methods of doing business, to help swell the tide of interest in scientific cost-keeping and more efficient management—regarded by keen observers as essential to our success in the worldwide economic struggle certain to follow the present war. The chief effort, therefore, of industrial service will be exerted along strictly coöperative and educational lines.

With the permission of Mr. Schwedtman, of the National City Bank, is presented herewith in diagrammatic form the embodiment of the new Industrial Service Department in the scheme of the bank's organization.

A study of this chart will show quite clearly the thorough manner in which the bank is prepared to be of specific help to the manufacturer in every field of technical and financial service. A new industrial philosophy is springing into being, and the spirit of intelligent helpfulness is guiding our endeavors to establish more firmly the foundations of our national welfare and growth.

2 The Relation of Our Universities and Educational Institutions to the Industries

It is impossible to record the development of our manufacturing institutions without bearing testimony to the labors of the scientists whose investigations and researches have been the very cornerstone upon which the industries are founded. While this is so obviously true, its significance is not always realized, and there has accordingly developed in many quarters a departure of the industry from the help of the scientist and a failure of the scientist to coöperate with the industry. Consequently the scientific spirit or attitude of mind is lacking in many of our industrial institutions, and the engineering and scientific schools where the activities of the scientist are largely confined have not always embodied those methods of operation which make apparent their industrial usefulness.

The time has passed, if indeed it ever has been, when the industries and the engineering schools can come to their full possibilities without close coöperation. The separation of the two institutions, whose technical interests at least are one, has been a loss to both in spite of the rapid development of each. The men coming from our schools have not been as well

prepared for immediate usefulness as they might have been, and the industries have failed to profit by the results of scientific discoveries which have never become known beyond academic circles. In fact, one of the greatest services to be rendered by our engineering schools lies not so much in the discovery of new facts and principles as in the introduction in the industries of many scientific discoveries dormant in the archives of the scientist, the commercial possibilities of which have never been appreciated. The patient search for scientific laws and principles underlying industrial processes and economic relations by those skilled in methods of research, and, moreover, the careful and judicious application to an almost limitless field of human endeavor of the already established facts and laws which have never been put to effective use, together with the preparation of highly skilled engineers capable of making and supervising these applications, is a plane of usefulness to which our universities must rise that they may take their proper place in the development and growth of our nation. Here, also, the obligations of this development lie both within and without the academic walls.

While engineering is highly technical, it is essentially an economic study. Just as the banker operates through the medium of bonds and stocks and is successful as he understands the laws which condition their value, so the engineer operates through materials, machinery, and men, and is successful as he understands the laws which condition the existence and prosperity of manufacturing institutions. While the most direct effect of engineering education in the past has been its contribution to purely scientific facts and principles, to the exclusion from consideration of those conditions under which these may be commercially useful, the economic necessities of the industries demand that we modify both the content and the spirit of the subject-matter handled and more closely parallel the economic requirements of engineering practice. The tendency in our engineering schools today, therefore, while emphasizing the necessity of excellence in the treatment of scientific facts and methods of analysis, must be increasingly toward that commercial and economic treatment which is so essential to an adequate knowledge of the use of science in engineering service. We find, accordingly, that those subjects in engineering instruction which were formerly thought to have their sole foundation in the sciences of physics, chemistry, and mathematics, and which conveniently admitted of formulated treatment, must be modified in their presentation to the inclusion of questions of cost and the influences of economic environment. Though it was once believed that, because engineering practice required a knowledge of scientific facts and principles, instruction in these alone was a sufficient preparation for the practice of the profession, it is realized that this is not sufficient, and that a knowledge of the economic adaptability of facts and principles is of equal, if not of greater, importance to an adequate understanding of engineering practice.

Accordingly, while formerly a student was taught to manipulate with the mathematics of thermodynamics in explanation of the behavior of steam in an engine, instructed in the principles of performance of waterwheels through the sciences of hydraulics and mechanics, and shown how to compute the stresses in a framed structure through the principles of graphical statics, he must now be taught, in addition to these, that the cost at which power may be generated is determinable by clearly defined principles and laws by means of which he may decide whether a steam-power plant or oil-engine installation or water-power development, each with a given type of housing structure, is capable of producing power in this locality or that locality with minimum cost of investment, depreciation charges, and cost of labor and materials, and will operate to satisfy a real demand and justify its creation. He must learn not only how a machine pattern is made by some method selected for demonstration by the instructor, but also that it may be made in a variety of ways, each of which is justifiable according to the quantity of production, demand for rearrangement of parts, adaptability to economic methods of molding, and to other conditions affecting the cost of producing castings by it. Not only should he learn to determine the proportions of machine parts to suit the loads imposed upon them, but also that the proportions must be modified to permit the part to be duplicated in a series of sizes of a given class of machine, or to facilitate founding and machining operations, that the completed machine may be supplied to the market at a price and in competition with other manufacturers of the same class of goods.

These attempts of our engineering schools in the past to make the instruction in engineering subjects more nearly representative of standard practice have met with more or less success, depending on the closeness of contact of the instructors with engineering practice and their ability to incorporate the spirit of engineering in methods of instruction. The effect of a proper amalgamation of the purely scientific and technological aspects of engineering with the economic and commercial principles upon which successful practice is founded is to create in the student that sense of proportion and judgment which tends to economize his efforts in contributing to scientific progress and invention. Not only will he know how to proceed to judge the scientific feasibility of a project, but also to determine what commercial limitations make a scientifically possible project impracticable; and, moreover, if he has that rare spirit of inquiry developed by proper methods of instruction, he may be able to determine that commercial limitations in a given field of practice exist because of an insufficient or entire lack of knowledge of scientific facts and principles, and thus be led to an investigation of scientific foundations the successful issue of which may be a most important contribution to the revolution of engineering practice in a given field.

Perhaps the most striking instance of this latter kind of scientific investigation is that conducted by the late Dr. Fred W. Taylor. His studies in the ancient art of cutting metals and the discoveries resulting therefrom have not only caused the redesign of nearly all of our metal-cutting machines to the improvement of their functional characteristics, but have completely revolutionized the methods of machine-shop management, the influence of which is felt in many quarters not at all concerned with engineering processes.

But this attitude of mind necessary to a proper conduct of an educational campaign for industrial betterment cannot develop without the coöperation of the industries themselves. We may inquire, therefore, into the nature of this coöperation demanded and the ways in which it may be accomplished.

For many years we have been accustomed to look upon the work of the Department of Agriculture as rational and necessary to the development of our agricultural resources. Through the operations of its agricultural experiment stations in every state in the Union, its scientific laboratories and the work of its trained investigators at Washington, and more recently through its trained agricultural agents in every district of the nation, the department has been of invaluable help in promoting the most efficient methods of crop and livestock production.

When we seek for the same evidence of coöperation between science and industry in the manufacturing field, we find that no organization of this sort is to be found. There is, of course, good evidence of individualistic effort in many quarters, both in research and in the promotion of better methods of production, yet there does not exist the coöperative effort which the importance and value of the industries demand.

It may safely be estimated that the capital invested in manufactures is perhaps \$25,000,000,000, and the annual value of manufactured products of all sorts nearly \$30,000,000,000. Approximately 8,000,000 people are employed in the strictly manufacturing industries, and the value added through their labors is nearly \$12,000,000,000.

Surely the economic importance of our manufacturing interests, as above reviewed, indicates a real demand for organized scientific effort to conserve and develop to its fullest possibilities this strong right arm of the nation.

Those industries which could afford industrial research laboratories have demonstrated their value beyond doubt. The wonderful laboratories of the General Electric Company, the Eastman Kodak Company, and others with abundant means, are counted among the big assets of the organization, since they have materially contributed to the strength of these institutions.

It is in such times as these, when all industries, both great and small, are depended upon for the creation of those products which our recently established \$19,000,000,000 credit hopes to purchase, that we realize the need of helping those who surely need the assistance of industrial-development laboratories but cannot afford the investment or maintenance charges. In this connection it is extremely interesting to note the following paragraph from a recent issue of a New York newspaper:

"COÖPERATION IN RESEARCH

"*British Way of Bringing About Progress in Industries*

"Realizing that many industrial firms are barred from the benefits of scientific research into their particular lines of activity by the great cost, reports Consul Franklin D. Hale, Huddersfield, England, the Committee of the Privy Council for Scientific and Industrial Research proposes the introduction of the coöperative idea. In this way a firm that is unable to bear the entire expense of research could contribute to the cost and share in the benefits accruing to an industry as a whole. It is planned to establish trade research associations in England, to be formed as needed for each industry or group of industries, and aided by certain funds which the committee has in charge. One association is about to be organized for the cotton industry, and others will be formed as soon as possible for the wool, flax, oil, and photographic industries.

"The work that has already been accomplished through the committee's efforts, according to Mr. Hale, includes the discovery of three kinds of optical glass, the investigation of light alloys for use in aircraft, and the production of a new hard porcelain from purely British raw material. Researches into the recovery of tin are expected to save that industry a very large amount each year."—*New York Times.*

All phases of this subject cannot be considered, but it is sufficient to point out that the particulars of this need for industrial betterment seem to reside in the creation of industrial-research facilities and in the training of men through whom research may be conducted and introduced in the industries. In the last analysis the successful issue of this project must rest primarily upon the training of men, for not only must better production methods be discovered for particular industries, but there must also be those who shall actually introduce and operate them. Quite clearly, therefore, does there seem to be an obligation resting on the universities and the industries which can only be accomplished on a high plane of coöperation.

In what form shall this coöperation exist, and what shall be the specific means through which it shall become effective?

Of the several possibilities which suggest themselves, it seems that most fruitful results will follow from the establishment at our universities located in industrial centers of industrial development laboratories, to which all industries, both great and small, may have an equal access. The endowment of these laboratories that they may be independent of any income from specific industrial interests is absolutely essential to their free development and operation. With the establishment of such facilities there can be little doubt but that the great potential energies of our universities can be made directly available to the improvement of industrial processes. Not only will this be of benefit to the industries, but it also will react favorably to the universities and stimulate productive scholarship and scientific research which will be felt in every field of human endeavor. It is believed that these laboratories will soon demonstrate their usefulness in the manufacture of every commodity, and, although their introduction into the university organization must be gradual, it will not be long before the demands of the industries will require an equipment and organization which will compare favorably with that now possessed by the agricultural interests. A conception of what these laboratories may be, may be obtained from the illustration published in THE JOURNAL, June 1917, p. 547.

Together with the investigation of the technical problems of the industries, these laboratories must also fully consider the methods of organization and management by means of which the results of industrial research may be effectively employed in the industries. Therefore it is believed that such a project as this should also serve to promote better methods of management through which industrial-process development may most effectively be realized.

3 BROADER CONCEPTION OF RESPONSIBILITY IN FACTORY MANAGEMENT

So much has been written on the problems of production, both in regard to their general aspects and in relation to their specific solutions in particular cases, that it seems as if enough had already been disclosed upon the basis of which successful procedure in particular industries might be formulated.

For the past twenty-five years there have been accumulated volumes relating to details of facts, methods of analysis, and routine organization plans for the effective conduct of tool rooms, stock rooms, planning departments, general offices, specific production departments, and for the efficient use of men and machines. There is scarcely an industry about which literature of the above sort cannot be found. Unfortunately, however, we are so constituted that the creation of this literature is not alone sufficient to stimulate improvements in methods of production. In spite of the fact that information on methods of scientific cost-keeping can be had almost for the asking, the Federal Trade Commission has reported that only 10 per cent of our industrial establishments have a cost system worthy of the name. This lack of cost information is indicative of inefficiencies in processing and management which can be effectively controlled only through a knowledge of cost factors. Thus it appears that there is real need for an educational campaign which shall seek to establish as a basic prin-

ciple in American industries those methods and policies which have been so successfully tried in particular cases. And this campaign must be waged among those who are in positions of authority, who exercise the managerial function and are responsible for the policies which govern the business over which they preside. Engineers discuss these things among themselves, and institutions presided over by engineers benefit by these discussions, but there is not that freedom of association between engineers and financial interests which dictate policies to create a scientific attitude of mind in the management of affairs. While the engineer is in some measure responsible for this condition, nevertheless it seems that ownership interests must evidence a real desire for the acquisition of the engineering point of view before much real assistance can be rendered. Crises such as the present have broken down many forms of control based on inadequate knowledge of affairs to be controlled, and thus the value of the engineering aspect of industrial organization and control is being more adequately recognized. It seems, therefore, that one of the principal problems of the managerial function is to determine the basic prime variables of the industry it proposes to control and establish means by which these may be quickly and conveniently recorded and analyzed.

Under such methods the management will not be required to call in a department head and ask for a statement of affairs. This immediately makes known to the department head that the manager does not know what is really being accomplished, and his influence is accordingly lessened. If, however, these affairs are known to the management through adequate records, it will be possible for the management to call in any particular department head and tell him that his department is *not going to show results if present conditions continue*, why it is not, and what particular things must be remedied to obtain better results and how it may be done. There is nothing so helpful to the keeping of all divisions of manufacture up to a high state of perfection as the feeling that the management really knows what is going on and can be of real help when assistance is required. When the management adopts the attitude of real helpfulness and looks upon itself as the chief servant of the industry, then we will have made a great advance toward a more adequate control of enterprises. It is the duty of the management to foresee and prevent difficulties arising, and this can only be accomplished by the establishment of adequate channels of information on the factors which condition the success of the enterprise.

It has been the experience of many to learn of well-conceived schemes of plant management falling away from the plane of perfection on which they have been established and thus discrediting the value of scientific-management principles. This again seems to indicate the need of an educational campaign among those who are to be depended upon to operate and keep in adjustment the new machine by which manufacture is to be controlled. No one would expect a delicately adjusted machine to operate well in the hands of an unskilled mechanic, yet many highly developed plans of management have been expected to continue in good operation in the hands of unsympathetic and poorly informed foremen. It seems that those who are capable of conceiving the broader principles of management and devising means for their embodiment in industries have gone too far beyond the capacity of those who are supposed to coöperate understandingly. In any improvement in management methods there must accordingly be promulgated a sympathy and understanding on the part of those affected thereby. It is dangerous to proceed in improvements beyond this point, for the plant will soon drop back to the level of understanding of the force and the investment will be lost.

Employers must surely take an interest in the education of their men, for no progress can be made beyond the general plane of intelligence of the shop.

This can be accomplished through coöperation with trade schools, correspondence schools, and the industrial departments of the Y. M. C. A. No matter how excellently the scheme of management and the methods of operation may be devised, no permanent progress will be made nor results attained if the vitalizing influence is lacking. This sort of problem cannot be solved in terms of x and y, and its importance is great in proportion to its difficulty of formulation. It is the thing which holds men together and creates in them a real desire to coöperate. It prevents men from taking a secret pride in the downfall or failure of others. It makes each department head feel that he is there to serve every other department, and his success is measured in terms of real service and helpfulness. An organization without this spirit is dead and will never hold together for a long period of time. While, therefore, it is incumbent on the management to see that the best methods of operation are devised and the most reliable means of control are established, it is believed that these will never accomplish the desired result without a proper selection of personnel through which the real life of the organization may be maintained.

It is beyond the province of this discussion to consider the details involved in the formulation of methods of procedure by means of which these problems of management may be solved in any industry, for, while each kind of industry presents the same general management problems, the means employed for their solution are very often quite different, because of the nature of the commodity dealt with and local conditions to be encountered, and therefore these details are not particularly helpful. We wish rather to realize that there is lacking in American industrial life that conception of the management function which is the foundation upon which all successful methods of factory operation must rest. When the engineer is more intimately associated with our financial interests and the university is more closely identified with productive enterprises, it is believed that the resulting amalgamation will effect a change in attitude toward the problems of management which will inaugurate the creative measures necessary. It seems there must be a closer coöperation of all interests factoring in industrial development in order that a true perspective may be had of the scientific, financial and human elements of the management problem. It is believed that this must be effected by a campaign of education which shall include the man at the bench as well as those who control his environment.

A paper on the problem of labor turnover and its cost, which was read at a recent meeting of the executives of the Albaugh-Dover Company, of Chicago, and which is quoted at length by M. C. Hobart in the May 16, 1918, issue of *Power*, includes the following estimate of the cost of placing a new man at work:

For advertising	$0.50
For hiring and clerical work	0.75
For instruction	5.50
For wear and tear on machinery and tools	12.00
For loss of production	25.50
For spoiled work and mistakes	12.00
For accidents	3.00
For interest on extra equipment	0.50
	$59.75

MAN POWER: ADDRESS AT MEETING OF BOSTON SECTION

By J. PARKE CHANNING

Chairman of the Engineering Council

A SUBJECT of the greatest importance and of most serious consequence to the American nation at the present time—man power—was discussed at some length in an address delivered by J. Parke Channing before the Boston Section of the Society on the evening of March 16, 1918. Most favorable comment was elicited by this address, which is here given in abstract form:

We are probably accustomed to think that we are efficient in the United States, particularly when it comes to such things as mining and manufacturing. The conduct of the war has demanded in England and in France a complete readjustment of manufacturing methods and plans and today England is probably as efficient a country as there is in the world, not even excepting Germany. England is in a position in which practically everyone in the country is engaged in some industry necessary for the conduct of the war, and this has been accompanied by an increase in the efficiency of her tools and the efficiency of her man power.

In the United States we certainly have been efficient as far as machines and perhaps as far as methods have been concerned, but we have not been efficient in the utilization of our man power. The problem that confronts us today and will all the more confront us after the war, is to make our man power efficient. There is one thing in England that has permitted her to reach this condition of state socialism with comparative rapidity, and that is that practically all of her laborers are English. While an Englishman may be a strong union man and ready to fight his employer tooth and nail, still at heart he is a British subject, and when his country was in danger he rose to the occasion.

In the United States we have such an admixture of unassimilated foreigners that the problem is more difficult, and so far we have not been brought to the point of stress which has arrived in England. But if we are to carry the war to a successful conclusion and if we are to increase our efficiency after the war we must introduce methods which will Americanize these foreigners and give them our own point of view.

I wonder if any large number of you have read the so-called proposed reconstruction program of the British labor party. This program will of course be subject to a great many modifications before it is adopted by the party. It is very largely socialistic and has for its basis four principles, namely:

1 The universal enforcement of the national minimum
2 The democratic control of industry
3 The revolution in national finance
4 Use of surplus wealth for the common good.

If these four demands are carried out, then surely England will be a socialistic state. I am not prepared to say how much of this program can or will be carried out, but it shows the trend of thought of the laboring man in England. He realizes that when the war is over, unless the greatest care is used in the reorganization of the regular industries there will be an immense amount of unemployment, and that this, if unchecked or uncared for, will result in an oversupply of labor and, if the old standard is maintained, a corresponding diminution in wages. Hence his insistence on the first principle of a minimum wage.

In demanding democratic control of industry he has seen such good results obtained in war work that he sees no reason why this control of industry should not be just as efficient in after-war conditions.

In the third principle, the revolution in national finance, he demands that taxation shall be so adjusted that it will yield the necessary revenue to the government without encroaching upon the prescribed national minimum standard of life of any family whatsoever, without hampering production or discouraging any useful personal effort, and with the nearest approximation to equality of sacrifice.

The fourth principle of the English laborites is that the surplus wealth shall be used for the common good. They say we have allowed the riches of our mines, the rental value of the land superior to the margin of cultivation, the extra profits of the fortunate capitalists, and even the material outcome of scientific discoveries, to be absorbed by individual profiteers, and they demand that in the future a large proportion of this surplus shall be applied to the common good.

It is not for me, nor am I a sufficient student of economics, to pass upon this program. It has certain merits and I am only calling it to your attention so that you may see that just this same thing is liable to come up in the United States. And the trouble will be that the pendulum will very likely swing too far if the employer class in the United States does not give more attention to the laborer and see that his condition is improved. You, as engineers, are in the position to act as instruments for carrying out this necessary work. Whether it be in a mine or in a manufacturing plant, I believe I can say that today a large proportion of the managers and executives are engineers.

The question to bring clearly before us is, are we properly trained to bring about this improvement in our social condition to improve the living conditions of our laborers and at the same time to improve their efficiency? I fear that a great many of us are not. We may be good technical men but we are not sociologists nor psychologists. We understand production of kilowatt-hours from coal or from water power, we understand the machine by which it is utilized, but we do not understand the machine which produces our man power.

This week I attended a conference at Columbia University in which the question of giving the engineering students a course in human engineering was discussed, and I came away with the idea that the authorities were beginning to realize that this was of paramount importance and that this training must be given the engineering student before he can be turned out as a man capable of eventually holding a high executive position. In my opinion there never was a time when it was so necessary to impress upon engineers and engineering students the importance of this human side of engineering.

I wonder how many of you can tell me what trade unionism is—you men who have had to deal with unions and who have had strikes. The fact is that none of you can tell what trade unionism is, because trade unionism is not an entity but a term of broad generalization covering a great many distinct aspects of the labor problem. A few weeks ago I presume I would have been rash enough to have attempted to give a definition, but in the meantime I have read Professor Hoxie's work on Trade Unionism in the United States and my ideas on the subject have been much clarified. On reading it you would find

that trade unionism can be classified under two broad general heads, one giving structural varieties and one functional varieties. There are four divisions in each class and any one of the structural varieties may function in any one of four different ways. There is one basic and most important thing which you would realize, an ever-present fact, and that is, that the interest of the laborer and the interest of the employer are diametrically opposed, just as the interest of the buyer and the interest of the seller are opposed, and that from the very nature of things they can never be identical and that all that can ever be reached is a compromise. And who is better qualified to bring about this compromise than the well-trained engineering manager, who, with his broad knowledge and experience of both capitalist and laborer, is enabled to act as an arbiter or a judge and arrive at a decision at least fairly equitable? It is the engineers of this country who are in a position to solve the labor problem, or at least to produce a solution as nearly ideal as possible.

The claim is made in Washington that it is difficult to get executives for war work, particularly executives who understand the handling of man power. I am told that some of the new plants for war industries have been most carefully laid out, taking into consideration the routes by which material is to arrive at the plant, its progress through the plant and its method of removal, the supply of water, coal and other material, but in a great many cases no thought has been given to the handling of the men or to their housing. These have been left to a hit-or-miss adjustment after the plant was up.

In 1916, under the auspices of the Y. M. C. A., the first convention to discuss the human side of engineering was held in Ohio. They lay great stress upon the advantages which would accrue to engineering students if they had an insight into the mental operations of the laboring man, and this had been fostered by getting the engineering students to volunteer one or more hours in the week for instruction to laborers employed in adjacent plants. This instruction is either in the English language, in citizenship or in athletics. A man who has volunteered for this work and who has done it for a year or more, when he goes out into active life is a much more capable foreman than one who goes out from an engineering school and meets his first laborer on the job. Lately the National Americanization Committee of New York has been conducting a similar propaganda, sending to the various educational institutions of the country a proposed basis of a course on industrial engineering. This proposed course goes into the scope of industrial engineering, describes the problem and the field, and takes up the question of the engineering insight of the work in reference to plant building, its location, and the fundamental considerations in its construction; it also takes up the management and division of the work, the analysis of the costs, the machinery, the materials and the efficiency methods. It goes into the questions of employment, management, and the methods for hiring, promoting and transferring men. It also takes up industrial welfare, with the various incentives to the workman and the provisions for his health and recreation and for the vocational training of either himself or his children. It also gives him instruction in conditions outside of the plant—the housing of the men and the planning of the town, and the health and recreation and education of their families. It takes up the problem of Americanization and what shall be done to make our melting pot efficient with no dross, and finally it gives him instruction as to what has been done and what should be done in legislation.

You engineers who are college graduates should use your influence to see that courses in human engineering are introduced in your Alma Maters, if they are not already there.

CORRESPONDENCE

CONTRIBUTIONS to the Correspondence Departments of The Journal by members of The American Society of Mechanical Engineers are solicited by the Publication Committee. Contributions particularly welcomed are suggestions on Society Affairs, discussions of papers published in The Journal, or brief articles of current interest to mechanical engineers.

Aircraft Production

To the Editor:

The trend of the criticism of our aircraft production lays great stress on our failure to turn out machines, and particularly the delay in the production of the Liberty motors.

Men who have been through the mill of organizing new industries, or making changes in the personnel or the product of an industry, know that the element of time is one for which there is no equivalent. Unlimited capital cannot quickly produce one of the most highly developed and intricate machines of the present time.

The airplane as a whole stands preëminent as one in which every element of design, workmanship and material must be the best; in fact, the present contest in the air is one that makes a supreme test and can only be satisfied by a supreme effort of each one of the designers, managers and skilled workers on the production side, combined with the ablest military aeronautical direction and skill.

We all recognize the importance of specialization for both the individual and the industrial plant, but we sometimes fail to give this matter sufficient weight in dealing with industrial problems.

We frequently make changes in the personnel or product of a plant without calculating the handicapping effect of such changes. Changes in either personnel or product must be warranted by very important demands. The degree of handicap of such changes is measured by the degree of special ability or skill that is required in the production of the product.

The airplane engine stands at the highest point that has been reached by man in his production of a machine in which each of the elements is subjected to the highest possible stresses. This approach to perfection can only be attained by the highest degree of special ability and skill; hence, the delay in production. This applies to the refinements of the design as well as precision of workmanship.

If many blunders have not been made in reaching the present stage of development, then our achievement at the present time will go into history unparalleled. We have had available the best men in each field of endeavor, but since this is a new art ninety per cent of these men have had no previous experience in this line of work.

The recent change in which the highest executive ability has been made head of the entire production plan is in keeping with the fundamental need of the aircraft-production plan. It gives it that stabilization in which alone stands our hope for success. It will prevent the disturbance of that natural evolution of the industrial plant that takes place when there is the minimum shifting in personnel and product.

This is particularly well known to industrialists, but difficult to explain to an investigating committee. The industrialist knows that the best way to obtain results under present circumstances is what we may call the natural way. The natural way makes the minimum change in the personnel and the working methods of each individual. It uses men as they are found in the organization.

A new industry always goes through two phases that are seldom fully anticipated. The first one, in which the aircraft industry is at present, is one that brings most serious disappointment. The second one, which is ahead of us, brings a happy surprise. Both are due to the same fundamental element and cannot be wholly forecast.

Experience tells us that it takes a great deal longer time to get a new industry established than is expected. This is due to the fact that industrial life rests on the functioning of the individual and the coördination of all the men in the organization, and although this is a fact borne out by many examples, yet the average board of directors in an industry is disposed to make important changes in the personnel of its executives, and this in turn frequently results in changes throughout the entire plant; and it is at this point that we must not blunder at the present time. No greater menace to our success in this war stands facing us than the mere possibility of our disturbance of the natural evolution that is going on in the aircraft industries.

This natural evolution will bring about the skilful operation of each worker at his task and the natural coördination of all forces.

The tendency to put in impractical inspectors carrying out impractical specifications must be scrutinized with greatest care. Important changes in the executives should be made in the direction of practical men rather than talkers.

Regarding the difficulty of getting under way, we have many examples. We have seen mammoth buildings erected in incredibly short time. We have seen these buildings fill with the best machinery and with the best men of the country as executives and workers. In the early stages of the development, as we observed the spectacular advance of getting together so much material, we failed to realize the full significance of the meaning of coördination, and we have overlooked the fact that a "going" industry is the result of continuity of action on the part of each worker and manager.

Unfortunately, examples of this kind do not leave a permanent impression. We accept the facts when stated to us, and then as a people we go ahead and make the same blunder over again.

In the aircraft work I am confident that no such blunder is impending. The purpose of this, however, is not only to pay tribute to those who have been working effectively in this great program, but also to spread the gospel of stability of organization, the value of specialization, and the ultimate supremacy that will come to us if we will only follow along the lines that have been well established by our greatest industrial successes in this country.

Financiers have reached the point where they pin their faith on stable organizations. They know that success grows out of specialization, which carries with it standardization and stability of personnel, and they know that where there is continuously change of management or the "hire and fire" plan in the plant, or perpetual altering of the design of the product of the plant or the character of the work in the plant, these elements interfere both with the character of the workmanship and its profit making. They know that great successes are wrought by men who keep in mind this simple fact.

The highest and best production will be attained by each one considering it his patriotic duty to aid those under and over by the heartiest coöperation, for it is only by coöperation in the right spirit that we can hope to equal in organization an organization that is built up under a despotic government.

We are rich in resources of skilful workers, in material, and in highly efficient machinery, but our ultimate supremacy is facing a terrible menace in the tendency to make a change in management that will disturb the executives or workers in the acquisition of ability and skill in their new duties and tasks and will delay the coördination that is the foundation of an industrial organization.

To bring this matter closer to a concrete example, close observers of industrial economics know that in the machine-building industry it is practically impossible to design and quickly construct a satisfactory machine. They know that each new machine can only reach a satisfactory stage after it has been made in numbers and through a period in which each of the workers will have had an opportunity to work up a precision of operation and skill in the performance of each of the tasks.

This makes it impossible to make a successful machine in a short period, even if all the workers of the plant were available. This fact, that repetition of operations is essential, is the key to the whole situation; and they know that the condition in an industrial organization in which the work flows quickly through the plant without congestion at any one point is brought about by experience. It is aided by practical supervision and handicapped by impractical interference.

It is our work to emphasize the simple every-day rules of common sense on which have been based our greatest industrial successes.

We must recognize that Germany's success in the industrial world, previous to the war, and her present industrial strength are due to the fact that by nature and government continuity of action of the individual was the rule instead of the exception. During the thirty years of industrial progress of Germany there was an increasing trend toward specialization. We know, too, that it was specialization that gave America the leading place in the industries.

Growing out of our specialization there came into existence those who became specialists in industrial management. These men are of the greatest possible value to the Government if they are forced to bend their systems to fit natural law.

Our ablest young men have gone into this profession and have been rendering a distinct service, but their work must be coördinated with the natural flow of work from man to man that can only be discovered by experience in each industry.

It seems paradoxical that our best minds, our most patriotic citizens, those who have the highest esteem for man's independence and liberty, may in this critical hour, by methods that are scientific as far as they go, actually produce a result opposite to that for which they are working.

In times of peace a monkey wrench thrown into the gears of one machine in an industry, or a false scheme of management into one industry in the country, was not such a serious matter as it is today. Today this country is being transformed into one big industry for producing war machinery, and finds

itself associated with the Allies in a contest that is too difficult to risk any one element in our plan, and it is absolutely necessary to have a definite policy on this kind of management in order to prevent duplication of certain blunders that have been made in recent years.

Our successful industries have grown by natural processes and management that understood human nature. Some have had the benefit of the modern school of industrial management, and some have been seriously handicapped by it.

In this war program we should take no unnecessary chances, and from now on we should see to it that the plan of action should tend toward continuity of service for each worker in order to get that natural coördination that is necessary to accomplish results.

As for the ultimate outcome, we can confidently depend on results that will even transcend the statements that have been made by the optimistic who overstated the possibility of the early stages of the work. Each succeeding year will see America coming in with greater and greater force. This will be true if we adopt a plan that allows a reasonable continuity of action; but we will rise to our highest supremacy through our resources in man and machinery if we will follow the plan of greatest stability in personnel and product that has been demonstrated in our most successful industries.

James Hartness.

Springfield, Vt.

The National Sections Should Always Coöperate with Local Societies

To the Editor:

In comment on the paper by Mr. Louis C. Marburg on the new By-Laws governing the Sections of the A.S.M.E., recently published in The Journal, it may be worth while to emphasize further the idea that the development of the local sections of the national societies should by no means be permitted to interfere with the growth and development of the local engineering societies in various cities. All the national societies are now encouraging the building up of local sections or chapters, and it is universally agreed now that this forms the best means by which the national societies can be truly national and can avoid concentrating all their activities at their New York headquarters. If, however, it is attempted to maintain in any city of moderate size separate, independent local organizations of civil, mechanical, mining and electrical engineers, each meeting entirely independently with separate headquarters and staffs, the result would inevitably detract greatly from the strength of the local society.

Practically every one who has given careful study to the question agrees, I think, that in the building up and strengthening of the local engineering societies all over the country lies the best hope of strengthening existing organizations of engineers. In many cities, St. Louis and Philadelphia, for example, the problem was long ago successfully solved of establishing full coöperation between the local sections of the national societies and the strong, well-organized local engineers' clubs. Under such a coöperative plan, the different organizations are mutually helpful instead of competitive. Mr. Marburg clearly states the reasons why coöperation is helpful and necessary, and the committee of which he is a member has shown wisdom in so plainly recognizing the situation and providing for it in framing their By-Laws for the conduct of the A.S.M.E. Sections.

Charles Whiting Baker.

New York, N. Y.

The New Local Sections By-Laws

To the Editor:

The address by Louis C. Marburg on the new Local Sections By-Laws of the Society which appears in the March issue of The Journal is to my mind one of the most important papers which has appeared in its pages for a long time. It points out the fact that our Society is for the benefit of the engineer, no matter whether he is located in New York City or in some remote part of the country.

The new By-Laws make our Society a truly democratic organization, and the members of every Section throughout the country should take advantage of the opportunities thus given them to strengthen the standing of the profession in their community and thereby also benefit the parent body.

In these strenuous times the busy engineer has little time for reading, and I fear that Mr. Marburg's address will not receive anywhere near the publicity it deserves. I wish there was some way in which it could be brought to the attention of every member of our Society, and I would like to suggest that the Committee on Local Sections urge each Section to have a meeting in the near future where this address will be made a special feature and given more than the usual amount of publicity. To add to the interest of the meeting, I would suggest that a member of the Council be requested to present the address to the Section, instead of having it read by one of the local members. If something of this sort could be done, and this very important matter brought to the attention of the majority of our members, I believe the Increase of Membership Committee would find that there was no further use for its activities. Such a step would put our Society in such a position that there would be no question in the mind of any engineer as to which engineering society was the strongest and most influential. The only question would be which society stood next to the A.S.M.E. in the good it is doing to our country and to the profession in general.

I want to congratulate the Committee on Local Sections and the Council on the splendid work that they have done in the way of broadening the influence of our Society.

I. E. Moultrop.

Boston, Mass.

The Second Law of Thermodynamics

To the Editor:

As e pressed by Clausius[1] and Lord Kelvin,[2] the second law of thermodynamics has been generally understood to mean that work may not be obtained from the inherent heat of the atmosphere.

Although these statements apparently have been mathematically demonstrated, the mind nevertheless rebels against a law which denies the possibility of using any portion of the thousands of millions of horsepower existing at all times in the atmosphere. Such mental rebellion led the writer to attempt the utilization of this energy in spite of what is declared to be the second law of thermodynamics.

The result of this effort, which thus far has been imaginative rather than through mathematical treatment, seems to indicate several methods by which work may be realized from the heat in the air.

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[1] "Heat cannot of itself pass from a colder to a hotter body."
—Clausius.

[2] "It is impossible, by means of inanimate material agency, to derive mechanical effect from any portion of matter by cooling it below the temperature of the coldest of surrounding objects."—Kelvin.

A simple apparatus which demonstrates the fact has been constructed and operated by the writer and will be understood by referring to Fig. 1. This apparatus consists of but three essential elements, viz., the boiler 1, the turbine 2, and the condenser 3. A pipe connects the top of the boiler to the nozzle of the turbine and the casing of the turbine opens directly into the condenser. The condenser is provided with means for evaporating water from its outer surface. In the sketch this is shown as a fibrous covering 4, which keeps moist by drawing water from the receptacle 5 by its capillarity. A pipe connects the bottom of the condenser to the bottom of the boiler.

The operation will be most easily understood by assuming the plant completed and ready for starting. The first act is to exhaust the air from the entire system through the valve in the boiler. A quantity of liquefied gas sufficient to partly fill the boiler is next introduced through the same valve, which is then closed. Finally the receptacle at the bottom of the condenser is filled with water.

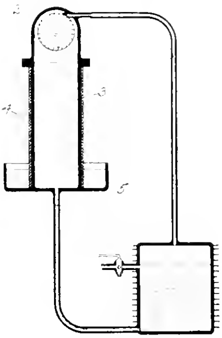


FIG. 1 APPARATUS FOR OBTAINING MECHANICAL WORK FROM THE HEAT IN THE AIR

The heat interchanges or cycles, of which there are two, commence as soon as evaporation of water takes place from the exterior of the condenser. The water, in the act of evaporating, removes an increment of heat from the condenser, causing a reduction in temperature and consequently a condensation of the vapor therein. This, in turn, brings about a difference in pressure between the condenser and the boiler which is available for operating the turbine. The condensate from the condenser enters the boiler at a temperature lower than that of the atmosphere, which enables the boiler to absorb an amount of heat from the atmosphere equivalent to the amount rejected by the condenser to the atmosphere less the amount converted into work. The difference of level between the liquid below the condenser and that in the boiler serves in place of a pump for feeding the boiler.

The little plant shown in Fig. 1 has been running continuously for some time, using sulphur dioxide as the working fluid. It will be seen that the capacity of the plant is a function of the relative humidity of the atmosphere, being greater in a dry climate than in one of more humid character. Operation would cease when the relative humidity reached 100 per cent, or when the temperature fell to 32 deg. fahr.

That the mechanism operates at all is due to the fact that nature, in the course of her unending processes, is continuously depositing moisture out of the air, rendering it again capable of absorption in the manner and with the result described. If we were compelled to remove the moisture content, no doubt the work cost would balance the work derived, but if nature does this work without cost to us, it would seem that, as far as our interests are concerned, mechanical work may actually be derived from the heat in the air. Furthermore, it appears that under these conditions and through the agency of evaporating water, heat does in fact pass from a cold body to a hotter medium, for the heat from the cold condenser is rejected to a hotter atmosphere.

If these conclusions are correct—and they must be, since the machine runs—then the statements of Clausius and Kelvin are not strictly true.

The efficiency of the cycle, based on the standard of Carnot, is low, but it may even be that the Carnot cycle itself is not the final word in heat efficiency.

The question as to commercial possibilities has been asked, and after a careful study of the matter the writer is convinced that no commercially successful results may be hoped for, although remarkable performances might be realized if no attention were paid to investment costs. The heat interchanges may be of interest to other members of the Society as they have been to me.

PERRY OKEY.

Columbus, Ohio.

REVISION OF BOILER CODE

THE Council of the Society directed that a hearing be conducted in accordance with the recommendation in the Boiler Code that a meeting at which all interested parties may be heard be held at least once in two years to make such revisions as may be found desirable in the Code, and to modify the Code as the state of the art advances. The first of these meetings was held at the Society's headquarters in New York, December 8 and 9, 1916.

The Council also directed that the proposed revisions in the Boiler Code be published in THE JOURNAL, with the request that they be fully and freely discussed, so as to make it possible for any one to suggest changes before the Rules are brought to the final form and presented to the Council for approval. This has been done, and the revisions were presented in the March issue of THE JOURNAL, pp. 234-247, in the April issue, p. 316, and in the May issue, pp. 398-400, in the form proposed for submission to the Council, except as they may be modified by editing without change of sense.

The revisions finally agreed on are those that have been published in the March, April and May issues of THE JOURNAL, with the modifications which follow. Although these modifications are in a sense final, the Committee would like any one who has an important criticism or suggestion to offer to submit the same immediately to Mr. C. W. Obert, Secretary of the Boiler Code Committee, 29 West 39th Street, New York, N. Y.

MARCH JOURNAL, P. 235

PAR. 9:

IN THE THIRD LINE OF THE ADDED SENTENCE IN PAR. 9 AFTER THE WORD "IN," CHANGE "AND" TO "PROVIDED," AND IN

the fourth line replace the words "shall be" by "is."

Par. 19:

In the first line of Par. 19 after the word "straps" insert the words "for double strap joints."

March Journal, p. 236

Par. 167:

After the word "diameter" in the second line of Par. 167*a* insert the following:

Having a thickness less than 10 per cent of the outside diameter, provided the thickness does not exceed No. 6 B. W. G.

Change the last sentence of this paragraph to read as follows:

For other tubes the flange test is not required:

Boiler Code, Page 41

Par. 168. Change the first sentence of Par. 168 to read as follows:

168 *Flattening Tests.* A test specimen 3 in. in length shall stand flattening between two parallel plates until the distance between the plates is not over five times the wall thickness, without showing cracks or flaws.

March Journal, p. 236

Par. 169:

In the last part of the last sentence of Par. 169 replace the words "the blow to be equivalent to 2 lb. falling 2 ft." by the words "or the equivalent."

Boiler Code, Page 41

Par. 171. Change Par. 171 of the Boiler Code to read as follows:

171 *Number of Tests.* One of each of the physical tests specified shall be made from each of two tubes in each lot of 250 or less. Each tube shall be subjected to the hydrostatic test.

March Journal, p. 236

Par. 190:

In the fifth line of Par. 190 before the word "plate" insert the word "shell."

March Journal, p. 237

Par. 198:

In the third line of Par. 198 transfer the words "measured from the outside" to the second line after the word "depth."

Par. 199:

In the first line of Par. 199 after the word "stays" insert the following:

with heads not less than 1.3 times the diameter of the stays.

In the fourth line of this paragraph place a period after the word "plate" and eliminate the rest of the sentence.

Par. 200:

In the eighth line of Par. 200 change the word "or" to "of."

Par. 203:

In the fourth line of Par. 203*b* in place of the words "in Par. 199 which applies to" insert the word "for."

In the fourth line of Par. 203*d* omit the words "in Par. 199."

In the second line of Par. 203*e* change the word "of" to "or."

March Journal, p. 238

Par. 212:

Revise Par. 212*c* to read as follows:

c A cylindrical furnace which requires staying shall be stayed as a flat surface as indicated in Table 3, except that the pitch may be increased to p_1 as provided in the following formula:

$$p_1 = p\sqrt{\frac{PR}{PR - 250t}}$$

in which

p = maximum pitch measured between the centers of the staybolts in the longitudinal rows, and between the centers of the staybolts in circumferential rows, in.

P = maximum allowable working pressure, lb. per sq. in.

R = internal radius of furnace, in.

t = thickness of plate in *sixteenths* of an inch.

Fig. 12*a*:

Change the second section of lettering at the side of the cut, Fig. 12*a*, to read as follows:

Not less than $\frac{1}{2}t$ if $C = 150$ or less, and not less than t if $C = 175$.

Par. 214:

Change the side heading of Par. 214 to read as follows:

Areas of Heads to be Stayed.

Add at the end of Par. 214 the following:

In water tube boilers, the tubes of which are connected to drum heads, the area to be stayed shall be taken as the total area of the head less the area of an annular ring of width d measured from the inner circumference of the drum shell.

Par. 215:

In the first line of Par. 215 insert before the word "heads" the word "tube."

March Journal, p. 239

Par. 239:

Change the first sentence of the last paragraph of Par. 239 to read as follows:

Where an unstayed furnace has a riveted longitudinal joint, it may be of the lap type for inside diameters not exceeding 30 in., irrespective of the height or length of the furnace. For inside diameters not exceeding 36 in., a riveted longitudinal joint may be of the lap type, provided the furnace does not exceed 36 in. in height or length.

March Journal, p. 240

Par. 253:

In the seventh line of Par. 253 before the word "bolted" insert "firmly," and in the eighth line after the word "position" insert "by tack bolts." In the ninth line after the words "tack bolts" place a period and eliminate the rest of the sentence.

Fig. 17*a*:

Change the first word of the caption under Fig. 17*a* to read "Dimensions" instead of "Proportions."

Par. 256:

In the fourth line of Par. 256 after the word "bolts" insert the following:

to hold the plates firmly together.

In the last sentence of this paragraph omit the words "The tack bolts shall be not over 12 in. apart and" so that the sentence will begin with the words "A rivet."

Par. 257:

In the sixth line of Par. 257, capitalize the word "calking," to begin a new sentence.

Boiler Code, Page 66

Par. 261. In addition to the revision proposed in the March Journal for Par. 261, which appears on p. 240, make the following changes.

Change the two formulae under the first paragraph of Par. 261 in the Boiler Code to read as follows:

$$\text{For single ring: } W = \frac{(1 + 2nd)}{2t} t_1 + nd$$

$$\text{For double rings: } W = \frac{(1 + 2nd)}{4t} t_2 + nd$$

Below the formulae, in the list of definitions insert the following:

n = number of rows of rivets.

In the definition of "S" insert before the parenthesis the following:

in single or double shear.

March Journal, p. 240

Par. 268:

Change the last paragraph of Par. 268 to read as follows:

When the maximum allowable working pressure exceeds 100 lb. per sq. in., a connection riveted to the boiler to receive a flanged fitting shall be used for all pipe openings over 3 in. pipe size.

Par. 269:

In the third line of Par. 269 after the word "relieving" change the rest of the sentence to read as follows:

capacity of 2000 lb. per hour or less is required by the rules.

Par. 272:

Add a new sentence at the beginning of Par. 272 to read as follows:

272 Safety valves shall be of such a type that no failure of any part can obstruct the free and full discharge of steam from the valve.

March Journal, p. 241

Par. 273:

In the fourth line of Par. 273 in place of the word "riveted" insert the words "irremovably secured."

Par. 274:

Change the second sentence of Par. 274 to read as follows:

For all other types of power boilers, the minimum allowable relieving capacity shall be determined on the basis of 5 lb. of steam per hour per sq. ft. of boiler heating surface for boilers with maximum allowable working pressures above 100 lb., and on the basis of 3 lb. of steam per hour per sq. ft. of boiler heating surface for boilers with maximum allowable working pressures at or below 100 lb. per sq. in.

Par. 292:

In the first line of Section 3 of Par. 292 change the words "ball checks" to "check balls." In the fourth line of Section 3 change the words "ball check" to "check ball," and omit the word "valve." Also in the fourth line change the words "The annulus around the ball" to "The space around each ball." Omit the last sentence of this section.

Omit Section 4.

Renumber Section 5 to read Section 4, and in the second line of this section after the word "opening" insert the words "or otherwise arranged."

Renumber Section 6 to read Section 5.

Renumber Section 7 to read Section 6, and in place of the first sentence insert the following:

The balls must be accessible for inspection.

In the second sentence of Section 7 (renumbered Section 6), omit the word "also."

March Journal, p. 242

Par. 296:

In next to the last line of Par. 296 insert the word "the" before "exclusive."

March Journal, p. 243

Par. 345:

In the second line of Par. 345 before the word "washout" insert the word "sufficient," and after the word "holes" omit "for," and insert the following:

"or other openings to permit."

May Journal, p. 400

Par. 254:

Cancel the revision proposed in the May Journal and allow Par. 254b to remain as it appears in the March issue of The Journal, p. 243, so that the entire Par. 354 will read as it appears in the March Journal.

March Journal, p. 243

Table 9:

In the last line of the title of Table 9, change the word "of" to "for."

Par. 356:

Add a sentence to Par. 356 as follows:

A relief valve used on a hot-water heating boiler need not have a lifting device.

March Journal, p. 243 and May Journal, p. 400

Par. 361:

Change the next to the last sentence in Par. 361 to read as follows:

Pipe connections to gages less than 1 in. pipe size shall be of brass, copper or bronze composition.

March Journal, p. 244

Par. 374:

Cancel the revision of Par. 374, and make it read as it appears in the present edition of the Code.

Par. 392:

Cancel the revision of Par. 392, and make it read as it appears in the present edition of the Code, except that where "Table 8" is mentioned substitute "Table 16."

Par. 422:

After the formula in Par. 422 insert the following:

where

W = weight of steam generated per hour, lb.

C = total weight or volume burned per hour at time of maximum forcing, lb. or cu. ft.

H = heat of combustion of fuel, B.t.u. per lb. or per cu. ft. (see Par. 427).

The Pennsylvania State College, Engineering Experiment Station, has completed a reprint from the annual report of 1913-14, in which are set forth methods of purchasing coal by specification and of sampling coals for analyses. The subject is treated of by J. A. Moyer and J. B. Calderwood. The bulletin gives the methods of gathering coal samples as used by the Bureau of Mines, Interborough Rapid Transit Co., New York City, United States Steel Corporation, General Electric Co., and Detroit United Railways, and also methods of coal sampling and analyses of the American Chemical Society and of The American Society of Mechanical Engineers.

SOCIETY AFFAIRS

A Record of the Current Activities of the Society, Its Members, Council, Committees, Sections and Student Branches; and an Account of Professional Affairs of Interest to the Membership

During the last month the Secretary has, by his attendance at local meetings, carried both to the Sections and to the local societies the evidence of interest, and he has received the inspiration of those meetings. The most impressive thing is, that this war is making a people of many races and opinions—a nation with a common and not altogether selfish aim. These higher purposes and thoughts have not been suddenly evolved, quite the contrary. It needed but this crisis to bring them out. The master mind of President Wilson has expressed them and, lo, the conduct of the World War has changed!

It is peculiarly consistent with the ideals of the several groups of the engineering profession that they should have joint meetings, by virtue of the tremendous part they have in the prosecution of the war and that they should come together more intimately than ever, and that all should consecrate their endeavor on the altar of freedom.

In one of the local meetings I have just attended, an army officer stated that up to the last spurt of our troops, as I understood it, about the first of April, fifty per cent of the expeditionary forces were engineer troops.

The relation of the engineer to the war is vital. He has corresponding responsibilities. Our standing as a profession will be in proportion as we meet them. Self-sacrifice is the foundation of nobility.

To my horror, an editorial in the current number of an usually excellently edited technical paper pleads that "It becomes the duty of engineers in particular to combat the theory that normal construction activities must be curtailed because of the war."

Nothing could be more false. A simple e planation will suffice to convince everyone, and especially the engineer, that all activity not contributing to the conclusion of the war must be stopped.

Belgium, France, England and Canada are 100 per cent efficient. See to it that we are likewise.

The failure of the United States to live up to her production program, while caused by many contributing factors familiar to those who read the newspapers, yet is due fundamentally to the general lack of appreciation of each individual person in this country of the fact that it is necessary to cease "normal construction." Congress is making huge appropriations, but not much more than half last year's appropriations have been expended to date due to the "normal," "business as usual" demands interfering with Government requirements.

In England during the last twenty months not one pleasure car has been manufactured! Compare this with a recent statement in the newspapers that one prominent manufacturer in the United States had cut down his output to only one-third. As a general estimate, at the present time, only one-third of the labor of this country is engaged in war work.

In order to get out the production that the Congressional appropriations provide for, we must:

a Convert all our activities to war work

b Secure an increased output of each individual, either by increased rate of execution, or by longer hours, and

c Secure the labor of 10,000,000 more people—what is termed "dilution of labor" in England.

Failure of every individual man, woman, and child to accept the absolute cessation of all "normal construction" postpones that much the date of victory.

The one man, more than any other, who is teaching this lesson to the nation is an engineer, Herbert Hoover; and while he is putting the emphasis on food, nevertheless the principle applies to every activity of every individual and is going to influence the ability of this country to conclude this war.

When we are about to do anything or purchase anything, we should ask ourselves if we can do without it. If we can, then it is a non-essential. Obviously this applies to every one of our families, and to as many others as we can influence.

To sum up, we must unite our forces. "We must produce more *and* use less—not produce more *or* use less." The supreme effort must come from the American Nation. Let us, as engineers, lead.

Calvin W. Rice,
Secretary.

Council Notes

On the invitation of the Philadelphia Local Committee, the Council paid an enjoyable visit to Philadelphia on Tuesday, April 23. The program was announced in the last issue of The Journal, and all the features as arranged were successfully carried out. The following is an abstract of the business meeting which was held in the afternoon.

Abstract of Minutes

The following members were present at the Philadelphia meeting: Charles T. Main, *President;* Wm. H. Wiley, *Treasurer;* John A. Stevens, Spencer Miller, D. S. Jacobus, Ira N. Hollis, John Hunter, John H. Barr, Jesse M. Smith, C. H. Benjamin, W. F. M. Goss, Arthur M. Greene, Jr., C. T. Plunkett, D. Robert Yarnall, L. P. Alford, *Chairman Committee on Meetings;* L. C. Marburg, *Committee on Sections;* Henry Hess, *Chairman Standardization Committee*, and Calvin W. Rice, *Secretary.*

Honorary Vice-Presidents. The President reported the appointment of Honorary Vice-Presidents for the following several occasions:

> *National Industrial Conference Board*, Hotel Astor, New York, April 18, 1918, L. P. Alford, the President and the Secretary.
>
> *National Foreign Trade Council*, Cincinnati, April 18 to 20, 1918, E. A. Muller.
>
> *League to Enforce Peace*, Philadelphia, May 16 to 18, 1918, R. H. Fernald and D. Robert Yarnall.

Congratulations to Sir John A. F. Aspinall. The President reported that a letter of felicitation had been sent to Sir John A. F. Aspinall, Honorary Member of the Society, upon his

recent election as president of the Institution of Civil Engineers.

Belgian Industrial Mission. The President was instructed to extend the welcome of the Society to the Belgian Government Mission on Industrial Management about to arrive in this country to study our methods and apply them in the reconstruction of Belgium after the war. The Commission has since arrived and the Society has had opportunities to assist them in their work, and the Belgian Minister at Washington, His Excellency M. de Cartier, has expressed his thanks to the Society for its efforts.

Non-Essential Industries. In response to a request of the New York Local Committee, the President was asked to appoint a Committee on Readjustment of Industries for War Work to outline a plan in which the Society can best aid in readjusting the industries of the country to meet the needs of the war, and to report back.

Research Committee. The following sub-committees were discontinued and discharged with thanks: Clinkering of Coal, Materials of Electrical Engineering, and Safety Valves.

Boiler Code Committee. Boiler Code Interpretations in cases Nos. 187, 188 and 189 were approved with slight modification and ordered printed.

Electric Welding Council. On recommendation of the Boiler Code Committee, the following Sub-committee on Electric Welding was appointed to coöperate with and report to the Boiler Code Committee: F. L. Fairbanks, *Chairman;* F. J. Cole, J. A. Dixon, E. R. Fish, S. F. Jeter, N. W. Kellogg, William F. Kiesel, Henry Torrance.

Steel Roller Chains Committee. The progress report of the Committee, which is a joint committee with the Society of Automotive Engineers, was received and ordered printed.

Power Test Committee. The resignation of Mr. E. M. Herr from the Advisory Board of the Power Test Committee was received with regret, and Mr. Francis Hodgkinson was appointed in his stead.

Engineering Foundation. It was voted to approve the amendments to the By-laws of the United Engineering Society, providing for an increase in the number of the members of the Engineering Foundation Board, and fixing the dates of the regular meetings of the Board.

Anti-Efficiency Legislation. Letters from Mr. Henry R. Towne, past-president of the Society, and from the National Council of Industrial Defense called attention to "anti-efficiency" riders attached to appropriation bills now before Congress, which would exclude from all Government work time-study methods, bonus systems, etc. The President reported that the Engineering Council was alive to this situation, and it was voted to heartily approve any steps taken by them tending to prevent the enactment of such blighting legislation.

Letter from C. C. Worthington. A letter was read from Mr. C. C. Worthington, son of Henry R. Worthington, deceased founder of the Society, giving reminiscences of the Society and its formation.

Commission to Standardize Screw Threads. The Society having been notified of the prospective early passage of a bill to create such a commission (since passed the House, May 8), it was voted that Past-President Hartness be nominated to represent the Society on the Commission when authorized.

National Board of Fire Underwriters. In response to the invitation of the Board the President was authorized to appoint a Committee to coöperate with them in the standardization of fire hose threads.

Adjournment was taken to reconvene on May 17, 1918, in New York City.

CALVIN W. RICE,
Secretary.

The Spring Meeting is On!

By the time THE JOURNAL reaches many of our members, sessions of the Spring Meeting at Worcester will be in progress. The prospects for a well-attended and useful meeting are excellent, and it is expected that the discussion will draw out a great deal of information that will be of material benefit to the membership. A full report of the meeting will appear in the July number of THE JOURNAL, including an account of the business transactions, the discussion upon the various papers presented, and a summary of the topical discussion on the fuel situation, concerning which a great deal of interest has been manifested, showing that the engineers of the country appreciate the need for their services in bringing about more economical use of fuel during the next winter season.

The features of the meeting were fully described in the last issue, and are here summarized for the benefit of any who may wish to refer to them in this number of THE JOURNAL.

Date of Meeting, June 4 to 7.

Headquarters, Hotel Bancroft: Part of the sessions will be held at the Hotel and part at Worcester Polytechnic Institute.

Tuesday Evening, June 4

Meeting at Hotel Bancroft, with reception following at Worcester Art Museum.

Wednesday Morning, June 5

Business Meeting, at which several important reports will be presented.

Addresses on Industries of New England.

Luncheon at Polytechnic Institute.

Wednesday Afternoon

Papers contributed by the Local Sections of New England and the Providence Engineering Society.

General Session, at which technical papers will be presented.

Session relating to courses of instruction in Safety Engineering.

Special excursions have been arranged for the ladies, including Tea at the Tatnuck Country Club.

Wednesday Evening

General War Session, with addresses on the Procurement Program of the United States Government.

Evening to close with a social time on the roof garden of the Hotel.

Thursday Morning, June 6

Session for the discussion of general technical papers.

Fuel Economy Session.

Vocational Training Session.

Thursday Afternoon

Excursion to the Norton Company's plant to inspect the community houses of that company. Luncheon served.

Brief session on Housing for Workmen.

Thursday Evening

Dinner at the Worcester Country Club.

Friday, June 7

All-day excursion to Camp Devens, Lexington and Concord, going and returning by automobile.

FREDERICK REMSEN HUTTON

FREDERICK REMSEN HUTTON, Honorary Secretary, Past-President, and for twenty-three years Secretary of the Society, died suddenly from heart trouble on Tuesday morning, May 14, when leaving his residence in New York for an automobile trip to the country. Services were held at his home on the Friday following, attended by many personal friends.

Up to the time of his death he had appeared to be in excellent health, and only the afternoon before had been in the Society's rooms, so that his death came as a shock to his many friends, who had only so lately met him in the course of their every-day duties.

Professor Hutton was born in New York, May 28, 1853. After preparation in a private school in New York, he entered Columbia College, receiving the degree of A.B. in 1873. After graduation he entered the School of Mines, and was given its degree in 1876. A year later he was appointed instructor in mechanical engineering as an associate of the late Prof. W. P. Trowbridge. This was the first recognition which Columbia gave to the important relations of mechanical engineering to other engineering courses. He entered the faculty as adjunct professor in 1881 and became professor in 1890. Upon the death of Professor Trowbridge, in 1892, the chair of engineering which he had occupied was divided, and professorships in civil engineering and electrical engineering were added to the already existing professorships of mining and mechanical engineering. Professor Hutton was made the head of the mechanical engineering department, which he directed until July 1, 1907, when he resigned, and in appreciation of his valued services was elected professor emeritus.

At the time of Professor Hutton's election to the presidency of the Society, an excellent summary of his work at Columbia was prepared by Mr. Fred. J. Miller, editor of the *American Machinist,* and published in that journal, from which the following is taken:

> Perhaps his most significant achievement during these years of service has been the development of the great mechanical laboratories of the University, during the period from 1897 to 1900, just subsequent to the transfer of the institution from the downtown site to its present location on Morningside Heights. This equipment includes the Baldwin locomotive mounted upon its testing equipment, the triple-expansion Allis-Reynolds engine, which is a three-stage air compressor, and the hydraulic equipment of the Henry R. Worthington Laboratory. A conservative estimate of the value of this equipment as installed, is not far from $100,000.
>
> It has been the professor's belief that to make experiments in illustration or confirmation of engineering formulas on engines or machines of small size, is to introduce an error not only of degree, but of kind, and that therefore the units should be of sufficient size to guard against this difficulty; and, furthermore, to make research into new fields sufficiently near to the actual conditions of practice so as not to prove actually misleading when their results are applied. The air compressor has been, with him, a favorite form of laboratory apparatus by reason of its illustrating to the student the complete cycle of generated mechanical energy, its storage in compressed air, and the liberation of that energy in a motor having a cycle similar to that of the original steam cylinder. In no other educational institution are there any larger units than those which have been here gotten together.
>
> The professor is also an earnest exponent of such a method of conducting laboratory instruction as to compel the student to exercise his thinking faculties, not only in devising the experiments and connecting up the apparatus, but in the interpretation of the results. In his discussion of this subject he has referred to the more formal system of definite instruction to the students by the use of printed logs which can be used half automatically as failing to make men out of the raw material. The automatic or log method he has called the "cook-book" system.

Professor Hutton became Secretary of the Society in 1883, three years after its organization, which was a critical time in its history. The membership was less than 400, and there was great difficulty in meeting expenses from the small sum received for dues, so that initiation fees had been treated as available current income. The previous Secretary, Mr. Rae, had received no salary and the office rent had been provided by reason of his relations with Mr. Henry R. Worthington, one of the founder members.

Professor Hutton was then a young man of thirty, Junior Professor of Mechanical Engineering at Columbia University,

THE HOUSE AT 12 WEST THIRTY-FIRST STREET: THE SOCIETY'S HEADQUARTERS DURING 16 YEARS OF PROFESSOR HUTTON'S SECRETARYSHIP

and able to arrange to give part time to the management of the Society in connection with his duties as a teacher. He was appointed Secretary in March at a salary of $1000 per annum. The Worthington office was given up and for a time the headquarters were in Professor Hutton's study at Columbia University; but it was soon found desirable to have a downtown office, and he rented at his own expense a room in what was known as the Smith Building, at 15 Cortlandt Street, and engaged an assistant whose salary he also paid. Professor Hutton states in his History that: "The location was chosen for its nearness to the ferry and approaches through Cortlandt and Liberty Streets, which were then the downtown entrances to the city from New Jersey and Pennsylvania. The

stock of volumes and extra stationery were taken to Columbia University and stored in a dark room available only for such uses. The office furniture of that modest undertaking was a Keuffel and Esser drawing table, some camp chairs and a specially designed stationery holder, somewhat along the lines of the revolving bookcases. There was no typewriter in use for more than a year. Later a bookcase made of pine, with certain locked-up cupboards, was added to receive the periodicals and exchanges."

From that time on, through the wise management and strong personality of the new Secretary, supported by the staunch founder members, who were the backbone of the organization in the early days, the Society grew and prospered consistently year by year, and one by one its many problems and difficulties were overcome. In this regard Professor Hutton displayed the same broad vision of future possibilities that so characterized Professor Thurston, who was the first President. This viewpoint was strongly emphasized by Professor Thurston's presidential addresses, which are recorded in the TRANSACTIONS.

In 1890, the house at 12 West Thirty-first Street was purchased for $60,000. This had been occupied by the Academy of Medicine, now located on Forty third Street, and was admirably adapted for a Society, but its acquirement was an ambitious project for a society without funds. The financing was left to a committee, of which J. F. Holloway, Stephen W. Baldwin and Professor Hutton were members.

Bonds were taken up by the membership to the amount of $32,000. A few of the older and wealthier members became guarantors to make good any deficiency should the Society be unable to meet its obligations, but they were never called upon, and the Academy of Medicine took a mortgage of $33,000. Five thousand dollars of the amount raised was used for alterations and furnishings.

It was this home where Professor Hutton became so closely identified with the work of the Society and formed so many pleasant associations with the members who came to the meetings or dropped in for a social time. The wisdom of acquiring the property was shown when it was sold in 1906 for $120,000, realizing a profit of nearly $60,000, and providing a fund which was a most helpful factor in procuring property for the new Engineering Societies Building, the gift of Mr. Carnegie.

With regard to the house on Thirty-first Street, Professor Hutton has written:

"It is perhaps difficult at this day and with the present strength, standing and income of the Society to realize what an enormous step and undertaking the purchase and responsibility for that house were to the modest men of that day. If it had failed, the consequences to the Society would have been most disastrous. Its success was the greatest thing that ever happened to it up to that time and for many years."

AUDITORIUM AND LIBRARY OF THE HEADQUARTERS AT THIRTY-FIRST STREET, SO CLOSELY ASSOCIATED WITH PROFESSOR HUTTON IN THE MINDS OF MANY OLDER MEMBERS

Professor Hutton's first meeting as Secretary was the Cleveland meeting in 1883, where the papers were for the first time distributed in advance by means of galley proofs, with the cuts printed on separate sheets. From time to time other events occurred which for some special reason were particularly notable. Among these was the trip to Europe in 1889, which had a wide influence in giving international recognition to the Society and establishing the bond of professional fellowship between this and the countries visited. Another was the Chicago Meeting of 1893, at the time of the Engineering Congress held during the Columbian Exposition.

Gradually the Society outgrew its quarters on Thirty-first Street, and after sixteen prosperous years moved to the splendid Engineering Societies Building, which it now occupies jointly with the other engineering societies. Professor Hutton was a member of the Joint Conference and Building Committee appointed to carry out the generous intention of Mr. Andrew Carnegie to provide a necessary building for the use of the several societies and a building for the Engineers' Club, and

to plan the proposed structures. He was also Secretary of the Building Committee, and later Secretary of the United Engineering Society. From the fact that the Civil Engineers decided to remain in their own building and the Mining and the Electrical Engineers had no buildings of their own, a great many meetings of the Committee, of which a total of seventy-four were held, besides numberless conferences, took place in the house of the Mechanical Engineers on Thirty-first Street, and during the construction much of the accounting and other business was transacted there.

Professor Hutton was one of the Board of Trustees of the United Engineering Society, which is the holding corporation for the building.

At the end of twenty-three years' service and coincident with the removal to the new building, Professor Hutton resigned his position as Secretary. He felt that the time had come when the Society needed the full time and energies of a secretary, and should not be compelled to share these with the engineering department of a university. It seemed proper that the retiring secretary, who had led the Society from the modest beginnings where he paid the office rent out of his own pocket up through the successive stages of development, to the point where it constituted a prime element in a great engineering headquarters for the whole country, should be elected to the presidency. He was made President for the year 1906-1907, and officiated in that capacity for the first time at the Indianapolis Meeting in 1907. At the end of his term he took for his presidential address the subject of the Mechanical Engineer and the Functions of the Engineering Society.

In 1908 he was elected Honorary Secretary, under the constitutional provisions which created such an office, a distinction which he held until his death.

With his varied and complex duties at Columbia University and in the secretary's office of the Society, it was impossible that he should enter largely into literary productions, but, nevertheless, he was the author of several books and several papers presented to the Society. The earliest of these was an elaborate monograph on Machine Tools for the Census of 1880. At that time technical books were few and engineering periodicals were fewer, and this treatise on machine tools stood out as one of the important documents of the time, and was used by engineering schools for the instruction of their students.

He wrote two textbooks, on Mechanical Engineering of Power Plants and on the Gas Engine. A distinctive and valuable feature of the former was the summarizing of the advantages and disadvantages of the various types and combinations of apparatus used in power plants. He was editor for encyclopedias and dictionaries, notably the Century, of 1911.

Fortunately for the Society, Professor Hutton was prevailed upon to write its history, which was issued by the Society in a handsome illustrated volume in 1915. While the volume is in no sense biographical of any one individual, and refers to Professor Hutton by name in only a few instances, it must, nevertheless, be regarded as largely a history of his own endeavors and accomplishments, and will long remain a valued and cherished volume to many of his friends and fellow-members. Special attention should be called to the chapter on Some Principles of Society Philosophy, which embodies a remarkably comprehensive statement of the stages of development of a great engineering society and the principles underlying them.

In 1911 Professor Hutton served as consulting engineer to the Department of Water, Gas and Electricity, New York City, and from 1905 to 1911 was vice-chairman of the Museum of Safety. He was consulting engineer to the Automobile Club of America and chairman of its Technical Committee from 1912, in which capacity he supervised the important testing work conducted by the club in its laboratory. He was one of the first engineers to use an automobile and to enter into a study of automobile construction.

In many ways since serving as President, Professor Hutton has been active in Society affairs, particularly as a member of the Committee on Constitution and By-Laws. In this work he endeavored to meet in a broad and progressive spirit the new conditions which were imposed upon the Society by its growth and expansion into various fields of activity and the establishment of its many Sections. He had, as always, a clear vision of the future and laid his plans accordingly. He was also a member of the John Fritz Medal Board of Award. His interest in young men was evidenced by his service on the Student Branch Committee of the Society. He has often presided at meetings and represented the Society on special occasions, which he always did with a distinction and grace of manner peculiarly his own. Here, as on all occasions, his felicity of expression and ready wit, his cordiality and withal his dignity, were strong characteristics.

In 1882 Columbia conferred upon him the degree of Ph.D. and in 1904 the degree of Sc.D., which is the highest distinction which the University places upon one for scientific and engineering training.

Professor Hutton is survived by Mrs. Hutton, who has so often been present with him at the Society's social functions; and two sons, Dr. Lefferts Hutton, now regimental surgeon in the army, with rank of Major, and Mancius S. Hutton.

The following are letters of appreciation received from friends of Professor Hutton, members of the Society.

LETTERS OF APPRECIATION

There was no one, in my estimation, who contributed more to the successful upbuilding of the Society than did Professor Hutton. He was absolutely untiring in his efforts, and even when he had gone to the mountains for his well-deserved summer rest, he kept the interests of the Society before him, and was of the greatest assistance in its work.

Professor Hutton's services as Chairman of the Committee on Constitution and By-Laws showed the greatest interest and devotion. These documents, under which we are at present acting, are evidences of his handiwork and wise judgment in almost every line.

There is much more I could say, but as there will be plenty of testimony from others I will only add that the Society showed its appreciation of his efforts in its behalf by conferring upon him all the honors within its gift. The history of its early struggles, which Professor Hutton wrote personally, remains as a monument to his memory; and indeed it would be hard to look into the archives of the Society without finding some evidence of his work.

WM. H. WILEY.

In the death of Frederick R. Hutton, we have lost one who has most worthily represented the Society in its ideals, traditions and active work.

During all of the years of service as Secretary, President, and Honorary Secretary, he was unremitting in his efforts to have the activities of the Society maintained on a high plane, both among its own membership and their relations to the public.

It was always he who was called upon to represent the Society on special occasions, which he did with such rare grace and wonderful expression.

He has always seemed to be an integral part of the Society. We shall all miss him, particularly those who have been associated with him these many years.

CHARLES T. MAIN.

The American Society of Mechanical Engineers in parting with Frederick Remsen Hutton loses one of its best beloved, highly respected and most valuable members.

No man has done more than he in guiding and keeping the

Society to its high ideals. In the earlier years he, with other high-minded engineers, set the standards of these ideals. He was ever watchful that they be not lost to view.

His devoted and willing services to the Society as Secretary, President, Member of Council, in many committees and notably in the Committee on Constitution and By-Laws, have left their indelible imprint on the history of the Society.

The Society will long remember and greatly miss his wise counsel, his genial manner and gentlemanly bearing, always fair and considerate.

May his influence still remain with us.

JESSE M. SMITH.

We who for years have been active in the A.S.M.E. heard with profound sorrow of the death of Dr. Hutton, for many years the efficient Secretary of our Society and then President and Honorary Secretary.

The Society owes a real debt of gratitude to Dr. Hutton for his services so effectively and tactfully rendered to the Society and the cause of engineering in general.

ALEX. C. HUMPHREYS.

All of us who knew him well can but deeply mourn the untimely death of our genial friend, Professor Hutton. Leaving to others an expression of appreciation of his work as a teacher, a research worker, a writer and one of the most successful of secretaries of a great engineering society, I will speak of his kindly spirit, his gracious manner and his attainments and accomplishments, in music, in oratory and in other lines of social and domestic life. His talk and his work, moreover, were spiced with a vein of humor which made him a delightful companion. All of this personal equipment doubtless tended toward the success of his earnest life work in connection with the many branches in which he was so ardently engaged.

OBERLIN SMITH.

Those of us who know something of the situation in 1883, when Professor Hutton became Secretary of The American Society of Mechanical Engineers, realize just what his work meant to us and what it will continue to mean so long as the Society exists.

Called to assume charge of its affairs at a time when its finances were inadequate to its expenses, when its publications were in arrears, when its membership was small and scarcely increasing, when its future lay in the balance, he gave to its recuperation an effective energy which never slackened for more than twenty years, and which, more than any other thing made the Society what it is today.

In those days Professor Hutton *was* the Society, for the able men who stood back of him could give but a small portion of their time to its affairs, while he stood before the membership as the one man who knew them all, greeted them all, welcomed them all, whose presence put life into otherwise dreary meetings, and whose judgment and untiring effort finally put the Society in a position where he could relinquish its guidance to others with a position so fully assured that failure had become impossible.

HENRY HARRISON SUPLEE.

The sudden death of our old-time friend and Honorary Secretary of the Society, Professor Hutton, is indeed sad news, and while I cannot at this moment do more than to express my sorrow and sympathy in this loss, to his family, to the Society and to his many personal friends, by so sudden a termination of his active life, and to state how greatly we shall all miss his ready and well-chosen words when voicing the feeling and sentiments of the members of the Society at meetings, as Secretary and as President, or at our many functions, abroad as in 1889, or in this country.

The results of the work he did in building up the prestige of the Society during its earlier years, and for many years since, while he was Secretary, are manifest in the position which the Society now holds in the broad field of engineering.

His uniform courtesy and cheerfulness under many trying conditions, will also be gratefully remembered by all whose good fortune it has been to know him personally. I certainly feel that in his death is the loss of a friend.

GEO. M. BOND.

I am confident that all the members of the A.S.M.E., from the time when Professor Hutton first became Secretary, have pleasant and delightful memories of him as our secretary and friend. His excellent and expert use of the English language was a continual example to those of us who made so many mistakes in our use of the mother tongue, and I believe we all use better language from having heard him speak. As an example, one item of his literary work is shown in the resolutions given by our Society to our British cousins following the acceptance of the invitation of the British Society in 1910.[2] Professor Hutton's keen sense of humor always kept us in good spirits. I remember on the occasion of our Annual Meeting in 1898 in the old society house on 31st Street, when I was sitting beside him, one of the largest members began to get up to discuss a subject then before the Society and I whispered to Professor Hutton, "He will now tell us what he did twenty-five years ago." The member began his remarks—"In 1872," and Professor Hutton instantly turned to me and said, "You're wrong, it's twenty-six."

The pleasant and delightful memories of Professor Hutton would fill a large volume and I wish those interesting episodes in his life which made us all happier were published. We all mourn his death and we all will cherish his memory.

WORCESTER R. WARNER.

Professor Hutton's sudden death is a great shock to me, particularly because when I saw him last, which was during the December, 1917, meeting of the Society, in New York, he appeared to be in splendid health, and full of his usual energy and spirit.

I know that the older members of the Society fully realize and thoroughly appreciate how much of the Society's present prosperity and high standard is due to Professor Hutton's devoted service during the long term of years which he served as its Secretary. I, as President of the Society, enjoyed greater opportunities of knowing, and thus appreciating, not only his work, but the loyal spirit and unselfish devotion to his duties, and also his wonderful tact and patience in meeting the many trying conditions which so constantly occurred.

The Society has passed through several strenuous periods, to emerge from each one stronger and more useful to its membership, and therefore to the whole engineering profession. One such period occurred during my presidency in 1891, when it became evident that its rapidly increasing growth, not only in membership, but also in the field of the Society's activities, and consequent usefulness, made a greater revenue imperative; therefore the question of lessening its activities and thus restricting the benefits to be derived from membership in it, or augmenting its income through increased dues, became a vital one. While the situation would seem to have been a plain one, the views of the membership were not at all alike—all earnest in their desire for the Society's good, but differing as to the proper ways and means. Secretary Hutton's position was a trying one, and only a man possessing his courage and certainty of being above just reproach, joined with never-ending patience and willingness to acknowledge the right of others to hold views differing widely from his own, could have met the situation in so successful a manner as he did.

ROBERT W. HUNT.

I have no doubt whatever that the entire Society shares with the Council a deep regret over Professor Hutton's death. His connection with the foundation of our Society and his long service to the Society and the individual members, have given us all a deep sense of gratitude for his effective work in putting the science of mechanical engineering upon a professional basis. I consider that his most important contribution. I feel a strong personal loss through a long acquaintance with him as a teacher at Columbia. He ought to stand to us all as the finest type of teacher, servant of the public, gentleman and scholar.

IRA N. HOLLIS.

Dr. Hutton's death removes a familiar and beloved personality from the activities of the Society. To those of us who had enjoyed the privilege of his friendship from the early days of the Society it counts as a personal bereavement.

For many years his work as Secretary made him the outstanding feature in the Society. Presidents and councillors had their day and passed on, often unknown personally to the majority of the members, but he remained, known to almost every member. He was admirably fitted for the work by his ability and engineering knowledge, but above all by his social qualities. His wonderful memory and sympathetic interest were a powerful aid in keeping up the membership in our days of adolescence and struggle. Nor

[2] Trans., vol. 32, 1910, p. 626.

did they lose their charm in more recent times when he had, with advancing years, reduced his activity but not his interest; his position as Honorary Secretary affording large opportunity for their exercise.

Other tributes will undoubtedly speak of his broad culture, his great felicity of expression, and his active detailed work for more than a score of years in caring for the interests of the Society and establishing the tone of the TRANSACTIONS at a high level. To those of us, however, who attach great importance to the human side, it will always seem that his greatest work was in the promotion of acquaintance and good feeling among the members, thereby assuring a steady growth in numbers and in *esprit de corps*. It is, perhaps, not going too far to say that the Society is his monument.

W. M. McFarland.

In the passing from earth of Professor Hutton I have lost a warm personal friend, The American Society of Mechanical Engineers has lost one of its devoted and untiring members, the engineering profession a distinguished representative and the country one of its best and most able citizens.

I have known Professor Hutton ever since the Cleveland Meeting in 1883, the first that he attended as Secretary. At that meeting he showed those qualities that have meant so much to the Society in the quarter of a century during which he was Secretary. Both in this country and in foreign countries we have always been proud of the part he has taken in representing the Society and the engineering profession, and in these later years as Honorary Secretary he has ever been ready to devote his time and thought to the problems of the Society. Among the many important services he rendered was the writing of the valuable history which we now possess, and in the great progress that has been made in recent years in coördinating the various branches of the engineering profession he has always been most helpful and sympathetic.

His life was one of service to his fellow men and in the highest sense he was a noble Christian gentleman.

Ambrose Swasey.

My acquaintance with Professor Hutton began with my membership in the Society. His efficiency as the Society's Secretary early made an impression upon me which the passage of years and the riper acquaintance incident thereto have not impaired. He was masterful in presenting the business of a meeting: in voice and manner, in skill and courtesy, he was altogether charming and his presence made significant proceedings which without him would have passed without notice. His theories concerning the conduct of Society affairs were based upon broad conceptions and generous procedures. Probably few of our younger members appreciate the extent to which in the early days Professor Hutton contributed to the Society's upbuilding.

W. F. M. Goss.

Through the death of Professor Hutton the Society has lost one of the grand Old Guard who founded and brought it to its present position and power. Always working with its welfare at heart, the Society will be forever a living monument to his endeavors. His cheerfulness and fair-mindedness overcame many an obstacle that might have led to disaster in less tactful hands. He will be remembered with honor by all and by his most intimate friends as a scientist who nurtured the flower of faith, a truly Christian gentleman.

D. S. Jacobus.

The following telegrams were received:

My belief, based on thirty-five years' membership in our Society, is that Professor Hutton, by his delightful personality, alert sympathy, remarkable memory of men's faces, and kindly greetings to all, no less than by his engineering knowledge, contributed tenfold more than any other one man to the success of our great Society in the formative period of its first twenty years. I deeply mourn his loss.

John R. Freeman.

Professor Hutton still lives. The prestige of the Society resulting from his twenty-five years of effort as Secretary was the foundation for the Society's further scope and usefulness. As an influential officer of one founder society and Secretary of the United Engineering Society during its formative period, Professor Hutton therefore contributed in a large way to the enhancement of the engineering profession in America.

Calvin W. Rice.

In the passing away of Professor Hutton The American Society of Mechanical Engineers has lost not only one of its honored members; not only one of the first authorities in the science of engineering; and not only one whose work and personal influence will undoubtedly be considered by future historians of the Society as most potent in molding the character of the Society toward these highest standards to which it will ever be faithful, but it has lost one of its most beloved and esteemed members, and one who was ever radiant with that cordiality and inspiration so essential in the building of a society. It leaves an example to the remaining members, especially the younger and more active members, of the noblesse and great value of Professor Hutton's characteristics to the success of the Society and the country that it represents and serves.

James Hartness.

One of the saddest messages received in many years was the announcement of the passing away of our past President and associate, Professor Hutton. I have been a guest at his fireside and always made welcome there. Our Society owes much of its high standing to our good friend who has gone from among us and his memory will always be cherished by its members.

John A. Brashear.

Classification of Trade Personnel

A work of almost incalculable value in classifying trades has been completed for the War Department by John J. Swan, Mem.Am.Soc.M.E., of the Trade Test Division of the Committee on Classification of Personnel in the Army. It is known as War Department Document aid in classifying skilled men who may be drafted or enlisted into the National Army, so that the right men can be selected for any required occupation in connection with the technical departments of the army.

There are 565 classifications, each of which is defined both as to the duties to be performed and the qualifications of a well-trained, high-grade man or journeyman (this is sometimes an expert or a foreman) who can do the work required. The classification also gives the nearest equivalent or substitute occupations which can be drawn from in case it is necessary to secure an additional supply of any particular kind of labor.

This is probably the first elaborate vocational analysis which has been published. The system has been taken up by the U. S. Department of Labor, and is being used first of all to cover the munitions industries, but later will be applied to all trades and industries. It has also been adopted by a large number of manufacturing firms. Only those who have attempted such a task can appreciate the amount of work involved in compiling so large a mass of material.

Submarine Engineer Officers Wanted

The Navy is in need of professional engineers for submarine duty, not over 35 years old and physically strong. The qualifications include citizenship in the United States, the degree of mechanical, electrical or mining engineer from a university of recognized technical standing, and at least two and one-half years' practical engineering experience. The candidates selected will be commissioned Ensign in the U. S. Naval Reserve Force, and will be sent to the Naval Academy and to the Submarine School in New London for a special technical course.

Engineers subject to the Selective Draft Law and those now in the Army are eligible. Letters from at least three responsible personal acquaintances must accompany each application. Address the American Engineering Service of the Engineering Council, Room 903, 29 West 39th St., New York City. Early responses are requested.

Tribute to John Porterfield Sparrow

At a recent meeting of the Committee on Flanges and Pipe Fittings of which the late John Porterfield Sparrow was chairman at the time of his death and whose obituary notice was published on page 328 of The Journal for April, the following tribute was paid to his memory:

John Porterfield Sparrow, Chief Engineer of the New York Edison Company, a member of the American Society of Mechanical Engineers and Chairman of its Committee on Flanges and Pipe Fittings, died March 18, 1918.

Mr. Sparrow was one of the best-known mechanical engineers in the United States, particularly in the modern power-station field.

His deep study into the intricate details of his work have brought forth improvements and economy in the power plant field of inestimable benefit to mankind.

His patience, courtesy, sterling honesty and ripened judgment were sources of pleasure to all who came in contact with him.

His death is a severe loss to this Committee, which can only be filled by the softening influence of time.

Great Canadian Reflecting Telescope

Every member of the Society feels a personal pride in the successive scientific attainments of "Uncle John" A. Brashear, who became endeared to so many during the year of his presidency. A few have known of the suspense under which he has been laboring in the difficult task of grinding and polishing the glass for the great Canadian Reflecting Telescope; and all should now know of his happiness and relief at the successful completion of this undertaking. Not only is the glass finished, but it has safely arrived at the Canadian observatory at Victoria, B. C. In a letter, Dr. Brashear writes: "The glass reached its destination in less than six days after I bid it good-bye on the car in Pittsburgh, a trip of 2200 miles. You bet Uncle John and his son-in-law and some others are happy over this 'news,' after three years and eight months." The following article from a Pittsburgh paper gives some interesting facts:

This precious glass, which took nearly four years in the grinding, polishing and correction of its accurate parabolic surface, required great care in packing and shipping, the glass disk alone weighing 2¼ tons, and in its iron cell nearly three tons; the packing case weighed not far from a ton.

The order for the big disk of glass was given to the St. Gobain glass works in France, but it was cast in their factories at Charleroi in Belgium, sent to Antwerp, placed on the ship, the *Vaterland*, and left Antwerp just a week before Germany declared war.

The first grinding of the glass required over two months. This was done to get it into shape for the finer grinding and polishing. About four hundred pounds of glass were removed from the upper and lower surfaces and the edges, leaving the dimensions as follows: Diameter, 73 in.; thickness, 12 in.; opening in center, 10⅛ in. in diameter; curvature, a radius of 60 ft.; the focal length of the telescope used in the Newtonian form, 30 ft.; in the Cassegrain form, about 108 ft.

After this preliminary work on the great glass, it was taken to the basement of the workshop, where the temperature conditions could be kept constant, and where the great tube with its double walls had been constructed on which all the final tests were made. Here Mr. McDowell took entire charge of the polishing and correction of the parabolic front surface, having as his right-hand assistant, Mr. Fred Hageman.

After polishing for a few hours with a large polisher, the glass had to be lifted into the testing tube, and an interval of at least 10 hours had to be allowed before the effect of the polishing could be studied, because of the disturbance of the surface by the heat produced in the polishing process.

As the surface came nearer and nearer to the true figure, smaller polishers were used over zones standing up, possibly one-hundred thousandth of an inch or less. This is what is called local polishing and is always done by handwork. Sometimes the local work lasted for only 15 to 20 minutes, then the huge glass had to be lifted into the testing tube to wait until the surface worked upon came to the normal temperature of the entire mass of glass. Patience as well as consummate skill is an imperative factor in this delicate work.

After over three years of delicate working, waiting and testing, by methods of marvelous accuracy, Dr. Plaskett, the astronomer of the Dominion of Canada, pronounced the parabolic curve almost twice as good as the specifications called for. The error allowed, which is practically beyond the limiting error that can be detected when used in the telescope, is one two hundred and fifty thousandth of an inch, while the greatest error that could be found in the surface was one four-hundred thousandth of an inch and in some parts of the surface not over one-millionth of an inch. In using some of the smaller polishers, not over one five millionth of an inch from any one part of the surface was removed.

Many people think only of the magnifying power of a telescope, but this is an erroneous idea. Its greatest value is as a collector of light from, let us say, some distant star cluster, and as this glass is over 4000 in. in area, it will gather and concentrate 100,000 times more light from the distant star than the human eye.

The mounting has been erected for some months at the Victorian Observatory and is a wonderful model of the highest efficiency in modern mechanism, made by the Warner and Swasey Company, Cleveland. The instrument complete weighs fifty-five tons, and the great reinforced cement piers supporting the axes weigh about 500 tons. The moving parts, with the great mirror, weigh about thirty-five tons, and these moving parts are all handled and controlled by electric current. Indeed, so delicately is the great telescope, with its massive parts, moved to follow a star or any heavenly body that the power required to light a 16-cp. electric lamp does the work.

The Victoria Observatory is situated about eight miles from the city, in one of the most beautiful sites on the Pacific coast. It was selected after many studies as to the best condition for astronomical research in Canada, the question of minimum change of temperature and minimum cloudiness being important factors in the selection of the site.

First American-Built "Tank"

The clipping which follows relates to the army tank *America*, of which papers throughout the country have published illustrations during the past month. It is one of the largest and heaviest tanks which has yet been constructed, weighing 45 tons. It is a steam, oil-burning tank, and the same size as those now used in Europe—35 ft. long and 11½ ft. wide.

Prof. E. F. Miller, Mem.Am.Soc.M.E., head of the Mechanical Engineering Department at the Massachusetts Institute of Technology, designed the huge war machine, in which it is said the *Brittania*, the British tank which recently visited Boston, could be stored without the least trouble. The construction work was done under the direction of Col. Francis R. Shunk, department engineer of the Northeastern Department. Major Henry Adams, Engineers Corps, N. A., assistant department engineer, was in executive charge of the work. Capt. Albert S. Smith, Superintendent of Buildings and Power at the Institute, was chief construction engineer. The construction work was done in the stockade in the rear of the Institute, where machine shops have been installed.

The American army engineers took full advantage of the experiences of the English engineers and improved upon the British type in many ways, eliminating features and designs which were proving impracticable in the big war engines of Europe and adding many distinctive American engineering improvements, so that the *America* stands out as a peer of all war engines and a monument to American ability and ingenuity.

The plans for the new American tank are now available for use in other factories where the Government is turning out tanks and engines, and the *America* is but premier of a great fleet.

The American "tank" service has started a drive in Boston for recruits between eighteen and forty-five, whether registrants under the selective service law or not. The tank corps, which has opened its office at 3 Tremont Row, is one of the newest and most attractive parts of Uncle Sam's fighting machine, and is one of the few open to men above the draft age. (*The Tech*, April 20, 1918.)

The John A. Stevens Trust Fund

It is fitting, now that the details of arrangement have been completed, that announcement should be made of the establishment of the John A. Stevens Trust Fund through the generosity of Mr. John A. Stevens, a member of the Council of the Society and Chairman of the Boiler Code Committee.

The fund consists of a $15,000 insurance policy which Mr. Stevens has taken out with the Connecticut Mutual Life Insurance Co., Hartford, Conn., and which will eventually be turned over to the Society. The net annual income accruing from this fund will then be allotted annually in equal shares to the person or persons who have that year invented or been responsible for an invention of noteworthy progress in the art of engineering having to do with the conservation of fuels in the generation of light, heat and power. If there should be no special processes evolved during any particular year, the net annual income is to revert to the person creating or being responsible for any engineering safeguard having to do with the protection of life and property.

Mr. Stevens has become widely known among our members and throughout the country as chairman of the A.S.M.E. Boiler Code Committee, a position which he has held since the inception of the committee in 1911. He had previously been a member of the Massachusetts Board of Boiler Rules, and this experience, combined with his varied practical experiences in the steam-engineering field, both marine and stationary, splendidly equipped him for the new standardization work, the most important by far which our Society has attempted.

Since 1909 Mr. Stevens has been in private consulting practice at Lowell, Mass., during which time he has superintended the construction of many power plants, made analyses of several large properties, and introduced a number of innovations in the line of power engineering. For 13 years previous he was chief engineer of the Merrimac Manufacturing Company, Lowell, Mass., where he practically rebuilt the entire steam installation, and also superintended the power work of the company's southern mills. This connection gave Mr. Stevens an intimate acquaintance with every phase of New England mill practice, and the large steam and power plants and distribution systems so important in this great industry.

The basic work of his life, however, was accomplished on shipboard, beginning when a young boy with the arduous duties of a fireman on a lake dredge, and closing in 1896 as a junior first assistant engineer on the transatlantic liner *St. Paul*. While engaged in marine work he served as engineer on several of the largest boats both on the Great Lakes and on the Atlantic Ocean, and it was characteristic of him that he lost no opportunity to acquire an intimate knowledge of marine practice, even though at a sacrifice in salary; for example, when first assistant engineer of the steamship *Illinois*, sailing between Philadelphia and Antwerp, he changed to the position of fifth engineer of the *New York* in order to become acquainted with the machinery of this larger and more modern vessel.

Besides serving as fireman on the lake dredge when a boy, he managed to complete a full machinist's apprenticeship in a shop doing a wide variety of construction and repair work, and later worked as journeyman. He recounts how, having reached this point, his mother prevailed upon him to complete his education, and how he took a full high-school course and a year at the University of Michigan. Finding, however, that mathematics was not his forte, he resolved that he would rather be a "first-class man in an engine room," where he had already met with success, than a "second-class man in a designing room." Therefore, securing a leave of absence from the university, he enlisted as second engineer on one of the lake steamers, a branch of the profession which he followed closely until he became connected with the Merrimac Company at Lowell. At the age of twenty-seven he secured an ocean steamship's unlimited license.

The trust fund which Mr. Stevens has established is in recognition of the opportunities for acquiring experience and for promoting the welfare of the engineer and his work which he has always found to exist in the engineering field; and as an incentive to the young engineer to develop further the field of light, heat and power with which he himself has been for so long identified.

John A. Stevens

Award of Medal by Cotton Manufacturers' Association

In 1898 the board of government of the New England Cotton Manufacturers' Association established the Association Medal, which was to be awarded to any person whose work would be of sufficient importance to the purposes for which the organization was devoted, including any papers read before the Association, the production of any mechanism or processes in the fabrication, design or finishing of cotton goods, comprising mill construction, the generation of power and its distribution, or any of the works tributary to cotton manufacture.

At the joint meeting of the American Cotton Manufacturers' Association and the National Association of Cotton Manufacturers held in New York, May 1 to 3, a medal was presented to Mr. Stevens for his paper on the Evolution of the Steam Turbine in the Textile Industry, which had been given at the annual meeting of the National Association of Cotton Manufacturers held in Boston, Mass., April 25 to 26, 1917. This paper was one of exceptional interest and value, in that it outlined with striking forcefulness the advantages of the steam turbine as it has been lately developed, for use in the power plants of textile mills. The author referred in detail in his analysis to the various economic developments in turbine design, embracing the low-pressure, mixed-pressure and extraction turbines, which features have undoubtedly been potent in

bringing this form of prime mover into more general use in mills where low-pressure steam is required in various processes. The paper also placed on record some most interesting and valuable information concerning the use of geared turbines for direct driving of mills, in the adaption of which the author and his associates have had much experience. It concluded with a description of a water-tube boiler of immense size which was developed by Mr. Stevens conjointly with Arthur D. Pratt, Mem.Am.Soc.M.E., which, it is predicted, would have effected a marked advance in large power-plant methods had it not been for the setback to industrial development resulting from the war. This boiler was described and illustrated in The Journal for July 1917.

In making the award, therefore, the Association states that it is "not only for contributing the most to the advantage of the cotton industry during the year, but for large conservation of coal and men made by the people using his services during the past years."

The obverse of the medal bears the names of the Association and the dates of its foundation and incorporation. In the middle is a loom of the pattern in general use at the time of its foundation, and this loom is surrounded by a garland of cotton bolls. The name of the Association in mural text is girted by a polygon of hanks of yarn knotted together.

The reverse side bears a chaplet of oak and laurel leaves, symbolizing strength and honor, and secured at the base by an American eagle with outstretched wings, the whole forming a frame for the tablet containing the inscription.

Cullom Medal for Dr. F. H. Newell

To Dr. Frederick H. Newell, Mem.Am.Soc.M.E., the American Geographical Society has awarded the Cullom Geographical Medal. This gold medal has been given from time to time to explorers, writers and men who have contributed in important ways to the advancement of geographical knowledge. The last recipient of the medal was General George W. Goethals, in recognition of his services in connection with the Panama Canal. Others who have been honored by the receipt of this medal are Admiral Robert E. Peary, Fritdjof Nansen, Sir John Murray, the Duke of the Abruzzi, Sven Hedin, and Sir Ernest H. Shackleton, every one of international and cosmopolitan reputation.

Professor Newell's accomplishment is perhaps best expressed by the inscription on the medal, which reads:

Frederick Haynes Newell

Organizer and Director
of the
United States Reclamation Service
1907-1914

He carried water
from a mountain wilderness
to turn the waste places
of the desert
into homes for freemen.

Pennsylvania can claim Professor Newell, but during his studies both at grade schools and the Massachusetts Institute of Technology, as well as at other times, he has been closely identified with Boston and its institutions. His work at the Institute was in mining engineering, with post-graduate studies, for his doctor's degree in geology and hydraulics. Three years after graduation he became an assistant in the U. S. Geological Survey and shortly afterward was given for his special work the study of the irrigation of arid lands. From a division of the U. S. Geological Survey the specialty was developed into a separate service, the Irrigation Service, of which Professor Newell was made director by President Roosevelt in 1902. Till 1914 he remained director of this service, the engineering works of which are of highest rank. He outlined and developed the splendid plans of the Reclamation Service with its great dams, basins and waterways. In May 1915 he was appointed by the University of Illinois head of the department of Civil Engineering.

Presentation of the Edison Medal to Col. John J. Carty

Dr. John J. Carty, colonel in the United States Army Signal Corps, chief engineer of the American Telephone and Telegraph Company and past-president of the American Institute of Electrical Engineers, has been awarded the Edison Medal in recognition of his services in developing the science and art of telephone engineering.

The medal was presented on Friday evening, May 17, at the annual meeting of the American Institute of Electrical Engineers in the Engineering Societies Building in West 39th Street, New York. After a statement of the history and significance of the medal by Dr. A. E. Kennelly, Chairman of the Institute's 1917 Edison Medal Committee, Dr. Michael I. Pupin, of Columbia University, told of the work of Colonel Carty which has made him preëminent in the field of telephone engineering. The medal was then presented by the President of the Institute, E. W. Rice, Jr., also president of the General Electric Company.

The Edison gold medal was founded in 1904 by the Edison Medal Association, an organization composed of old associates and friends of Thomas A. Edison. It has been awarded annually since 1905 by a committee of 24 members of the American Institute of Electrical Engineers, the recipients in order being Elihu Thomson, Frank J. Sprague, George Westinghouse, William Stanley, Charles F. Brush, Alexander Graham Bell and Nikola Tesla.

Colonel Carty is well known as the engineer of the great transcontinental telephone line, and as the engineer who made possible wireless telephoning over distances up to 5000 miles. Since 1916 he has coöperated with the Signal Corps of the Army and with the various departments of the Navy in making arrangements which would insure the readiness of the great telephone system of his company for military service in case the United States became involved in the world war. Last year saw these plans put into active use with a marvelous degree of success. He is now giving much of his time to the development of the nation's Signal Corps work in this country and abroad.

Library Service Bureau

As the knowledge of the facilities of the Engineering Societies Library to serve members of the engineering societies and the engineering profession outside of New York—and sometimes in New York—through its Library Service Bureau increases, the requests for such service correspondingly increase. From January 1 to March 31 of this year the Bureau conducted 135 searches; 32 of these were made in mechanical engineering, 29 in mining and metallurgy, 21 in civil engineering, 18 in chemical engineering, 10 in electrical engineering, and 25 miscellaneous. The Library also made 24 translations in the same period, and supplied 615 photostatic prints.

AMONG THE LOCAL SECTIONS

During the past month Mr. Calvin W. Rice, National Secretary of the Society, and Mr. Ernest Hartford, Secretary of the Committee on Sections of the Society, visited a number of the Sections where meetings were held. Many of these meetings were well attended and much enthusiasm was evoked. All presented a patriotic atmosphere, and everywhere the enormous part played by the engineers in winning the war was the dominant feature.

At Meriden, Conn., where a paper was presented on the Browning machine gun, over 175 were present; at Bridgeport over 200 attended and at Boston over 400 gathered. The Detroit meeting developed action regarding the development of intensive courses for training women at technical colleges and schools, so that they may serve as draftsmen and tracers, or as inspectors in munitions and industrial plants.

At New York the vital question of labor turnover was taken up in a way that emphasized the opportunity of the engineer to take a leading part in the solution of this vital problem. Engineers are the connecting link between labor and capital in the large majority of the industries of the country, and it is hoped other Sections will follow the lead of New York in arranging meetings on this subject.

In addition to attending Section meetings at Indianapolis, Cincinnati, New Orleans, Chicago and Toronto, and a joint meeting at Birmingham of the Atlanta and Birmingham Sections, Mr. Rice attended meetings of engineers at Toledo, Dayton and Duluth. He found everywhere throughout the West and South that the engineers and people generally were thoroughly alive to their responsibilities, and the consensus of opinion was that meetings of engineering organizations were of great value in maintaining a proper morale and in building up an *esprit de corps* in the profession.

The Providence Engineering Society and Its President

In The Journal for March 1918 was published a group of portraits of the chairmen of the Local Sections of the American Society of Mechanical Engineers for the year 1918, through whose leadership the full value of membership in a great national organization is being realized to a greater extent than ever before. In this connection it is appropriate to refer to the affiliated society of the A.S.M.E., the Providence Engineering Society, and to publish a portrait of its president.

This society was organized in 1894 under the name of the Rhode Island Association of Mechanicians. The next year the name was changed to the Providence Association of Mechanical Engineers, under which name it continued until 1915, when it was reorganized to include all branches of engineering and became the Providence Engineering Society.

In 1911, when the Providence Engineering Society became affiliated with our own organization, it was known as the Providence Association of Mechanical Engineers. Its activities then pertained almost exclusively to the field of mechanical engineering, which is so strongly represented in the industries of Providence. Although it has remained in every way an independent organization in distinction from that of the several Sections of our Society, which are integral parts of the parent body, the affiliation represents a mutual interest between the organizations of a real and vital character. One pleasant feature of the affiliation has been the joint dinners held with officers of the A.S.M.E. as guests of the Providence society.

It is expected that a large number of the members of the Providence Engineering Society will attend the Worcester meeting during the first week of June, and the Providence organization has generously contributed to the success of this meeting by arranging for three professional papers from its own membership.

Robert Winthrop Adams, the president of the Providence Engineering Society, is a graduate of Worcester Polytechnic Institute in the electrical engineering course, and has been connected with the B. F. Sturtevant Company, Hyde Park, Mass., the D & W Fuse Co., Providence, R. I., the Pittsfield Works of the General Electric Company, and is now manager of the Providence office of the General Electric Company. When with the D & W Fuse Co. he was engaged in research and development work on enclosed fuses for three years, and during this period was awarded the degree of Electrical Engineer by the Worcester Polytechnic Institute in recognition of original research work.

Mr. Adams is the inventor of the transmission-line calculator

R. W. Adams, President of the Providence Engineering Society

for the rapid calculation of line drop in alternating-current circuits, and has been a contributor to various technical journals. As a member of the Rhode Island Council of Defense since its formation, he has had charge of all engineering matters in connection with preparedness and war work, including a complete war census of Rhode Island engineers.

Section Meetings

Birmingham

April 25. After a business meeting an interesting address was given by James W. Moore, of the American Cast Iron Pipe Company, on The Producer-Gas Plant of The American Cast Iron Pipe Company, and it was pointed out how coke braize was used instead of coal. Comparisons were made between coke-braize gas and gas from Pocahontas coal in a double-zone producer, and operating conditions and costs were traced.

W. L. RouECHE,
Section Secretary.

Boston

April 30. A joint meeting of the Boston Society of Civil Engineers, The American Society of Mechanical Engineers, and the American Institute of Electrical Engineers was held at the City Club. Over 400 engineers sat down to supper.

Mr. W. H. Blood, Jr., of the American International Shipbuilding Corporation, delivered a very interesting illustrated address on Hog Island, the greatest shipyard in the world. By word and picture he described the wonderful progress which was made in six months in the transformation of a barren waste into a seething hive of industry, embodying an area of over 900 acres with a working force averaging over 26,000 persons.

Mr. Alfred D. Flinn, Secretary of the Engineering Council, gave a talk on the progress and aims of the Engineering Council.

Short addresses on subjects of the day were given by Major-General H. F. Hodges, in command of Camp Devens, at Ayer, Mass., and Mayor Andrew J. Peters of Boston. Motion pictures were shown illustrating the adaptability of a new rudder which has been perfected by Mr. H. O. Westendarp of the General Electric Company. By skilful manipulation the pilot can by means of this new type of rudder make a vessel go forward or backward, or circle right or left without changing the direction or speed of his engine. This should prove a wonderful aid in combating the U-boat.

W. C. Starkweather,
Section Secretary.

BUFFALO

April 24. An instructive lecture on Ball Bearings, Their Designs, Manufacture and Application, was given by S. W. Gurney, of the Gurney Ball Bearing Co., Jamestown, N. Y., who is a recognized authority on this subject.

May 1. The meeting was of a strictly business nature and included the reports of officers and committees and the election of officers for the Engineering Society of Buffalo for the coming year. The following were elected: George B. Bassett, president; H. P. Parrock, vice-president; E. B. Neil, secretary, and W. M. Dollar, treasurer. Messrs. F. A. Lidbury and David W. Sowers were elected directors.

E. B. Neil,
Section Secretary.

CHICAGO

April 22. At a joint meeting of the Chicago A.S.M.E. and A.I.E.E. Sections and the mechanical and electrical sections of the Western Society of Engineers, C. F. Kettering, Mem.Am.Soc.M.E., delivered a talk on The Automobile Power Plant.

May 24. Mr. John E. Ericson, Mem.Am.Soc.M.E., and City Engineer, delivered a lecture on The Mayfair Pumping Station.

Arthur L. Rice,
Section Secretary.

CONNECTICUT SECTION

Bridgeport Branch

April 24. Motion pictures, a good dinner and some fine speeches on matters of interest to engineers and factory men were the features of the spring meeting, held at the Stratfield Hotel. Members and friends from all parts of Connecticut were present at this meeting, 211 being the total number attending the evening gathering.

Committee and "get-acquainted" meetings were held during the afternoon. Ten reels of motion pictures, most of them being illustrative of factory work, were shown, and later dinner was served.

The opening address of the meeting was made by Henry B. Sargent. Secretary Rice, the second speaker, told of some of the work of the Society. Judge John S. Pullman gave a patriotic address, telling of the work of the draft and how men could best serve their country by their jobs. Clinton E. Woods, of the Woods-Keller Company, spoke on Factory Accounting as a Bill for Controlling Production. Harry E. Harris, Chairman of the Joint Gage Committee of the A.S.M.E. and S.A.E., discussed Facilitation of War Production by Practicable Manufacturing Allowances. He was followed by William R. Webster, vice-president of the Bridgeport Brass Company, whose subject was Intelligence, Specifications and Inspection as a Factor in Production Increases. Allen B. Lincoln, associate director of the U. S. Department of Labor of the Connecticut State Council of Defense, told of the work of his department.

E. L. Fletcher,
Branch Secretary.

Hartford Branch

May 13. After a brief business meeting, at which the following officers for the year 1918-19 were elected: Chas. S. Blake, chairman, Frank E. Howard, vice-chairman, and M. D. Church, secretary-treasurer, an interesting talk on submarines was given by P. B. Brill, general manager, Lake Torpedo Boat Company. He cited the progress of battleship design, giving a general idea of the various types of vessels and the arrangement of their guns, and described the various protective devices from torpedoes. A description of the different types of submarines from the earliest designs down to the most advanced stage of the art was given.

Private Wm. J. O'Neill, of the 101st Machine Gun Battalion, who has just returned from the fighting line in France, gave a short talk on the importance of the people at home supporting the soldier in the trenches. Some of his own experiences in the trenches were touched on.

S. F. Jeter,
Branch Secretary.

New Haven Branch

May 10. A business meeting preceded the regular meeting of the Branch at which the following officers were elected for the year 1918-19: E. H. Lockwood, J. Arnold Norcross, F. L. Mackintosh, Edwin Pugsley, A. C. Jewett and S. H. Barnum, 2d.

Professor Breckenridge then reported on the plan of the Fuel Administration to inspect all power plants of the country. In conformity with this plan a state fuel engineer will be appointed for Connecticut. It was then voted that the Executive Committee of the Connecticut Section coöperate with the proposed plan by nominating a suitable candidate for this position, reporting same to the Fuel Administrator.

An informal paper was given on the Development of the Repeating Rifle by Edwin Pugsley, Jun.Am.Soc.M.E. The talk was illustrated by a striking display of rifles showing the steps of the development leading up to the repeating rifle and including the Browning gun.

E. H. Lockwood,
Branch Secretary.

CINCINNATI

May 11. In a very inspiring address Secretary Rice presented the various activities of the A.S.M.E. He pointed out how the opportunity and ability of its members to serve in numerous ways has enabled the Society to be of substantial service to the Nation in solving problems such as those relating to the conservation of coal, wages of employees, the draft law, nitrate plants, and the activities of the Research Council. The policy of helping to win the war is exemplified in the appointing and organizing of committees, the presentation of papers and the use of the Society's rooms as recruiting offices. The Roll of Honor now constitutes 15 per cent of the membership. The whole sentiment expressed in the dedication of the Engineers' Club House at Dayton, Ohio, represents the spirit of the times in which engineers are realizing their duties toward the communities in which they live and are acquiring a feeling of civic responsibility. Such a sentiment, created through the Sections, will enhance the status and solidarity of the engineering profession. Mr. Rice suggested that the Sections organize committees on pavements, water, etc., and sub-committees of chemical, civil, electrical and other branches of engineering.

At present there is an opportunity to assist in the training of mechanics for the service. One million men are needed and at present there is provision for only ninety thousand by the first of September. Each member of the Section was then called upon to pledge his support in assisting in the war education work in Cincinnati.

Mr. Fred A. Geier, Assoc.Am.Soc.M.E., made a short address in which he emphasized the importance of the problems with which the Council is confronted at this time, and the policy in dealing with matters of national interest.

John T. Faig,
Section Secretary.

DETROIT

May 3. The Detroit A.S.M.E. Section held its Annual Meeting in conjunction with the Detroit Engineering Society at the Board of Commerce Building.

After the dinner, the election of the Executive Committee for 1918-19 was held and the following officers were elected: E. C. Fisher, E. J. Frost, F. H. Mason, E. J. Burdick and J. C. McCabe.

Mr. Robert H. Kuss, Mem.Am.Soc.M.E., and Consulting Engineer of Chicago, presented a very interesting paper on Coal Con-

servation, discussing that part of this broad subject embraced within the handling at the power house, furnace construction, firing methods and control.

Dean M. E. Cooley and Secretary F. H. Mason presented the following set of resolutions:

WHEREAS, The demands of the country for men and means to fight the war have resulted in a deficiency of skilled workers in the trades and professions; and

WHEREAS, The women of this country could with a short period of training fit themselves to fill these positions, as women have done in other countries at war; and

WHEREAS, Among the things which women could do advantageously are *drafting* and *tracing, inspection and testing of materials, both physically and chemically*; therefore, be it

RESOLVED, That the universities, colleges and technical schools throughout the land be asked to consider the question of meeting this demand by providing special courses of instruction open to women students qualified to pursue such courses; and further, be it

RESOLVED, That employers who could use such skilled help exert their influence with their universities, colleges and technical schools, and coöperate with them in developing and making available a great body of intelligent and adaptable women who are as eager and willing to serve their country as their brothers;

THEREBY bringing about not only increased effectiveness in fighting the war, but also a greater mutual respect and saner relationship of our men and women.

These resolutions were unanimously adopted, and it is hoped all members of the Society will give wide publicity to them in order that some definite results may be promptly obtained in the training of women to fill subordinate positions in the drafting room and inspection departments of the industries.

F. H. MASON,
Section Secretary.

INDIANAPOLIS

May 10. The officers elected for the ensuing year are as follows: L. W. Wallace, chairman; W. A. Hanley, vice-chairman; B. G. Mering, treasurer; F. C. Wagner and G. A. Young.

Secretary Rice gave an address on the relation of the National Society to the Section, the relation of the engineer to the war, and ways in which he can assist the National Fuel Administrator and his city or community.

The subject Heat Losses in Uncovered Steam Pipes was also discussed.

W. A. HANLEY,
Section Secretary.

MILWAUKEE

March 13. Under the auspices of the A.I.E.E. Section, Professor Cyril M. Jansky, of the University of Wisconsin, delivered an interesting lecture on Science in War, bringing out the part that science plays in the affairs of men. A very interesting film was shown entitled The King of the Rails, which pictured the electrical division of the C. M. & St. Paul R.R.

April 10. At a meeting held under the auspices of the American Society of Refrigerating Engineers, Mr. Charles L. Fortier, chief engineer of the Johnson Service Company, gave an illustrated talk on Automatic Control Apparatus for Temperature Control in general and also as applied to the refrigerating industry.

May 8. A lecture on The White Coals of Wisconsin, in which a very complete description of the Wissota Dam was given, was delivered by N. J. Whelan, industrial commissioner of the Wisconsin-Minnesota Light & Power Co., and V. S. Hillyer, construction engineer with the same company.

FRED H. DORNER,
Section Secretary.

NEW ORLEANS

May 13. Under the auspices of the Louisiana Engineering Society and the A.S.M.E. Section a meeting was held at which the Honorable T. F. Carlisle, British Consul, delivered a very interesting address on Britain and the War the Last Twelve Months.

Secretary Rice gave a talk on the War Activities of the A.S.M.E. and the Need of Coöperation Among Engineering Societies.

A business meeting followed at which the following officers were elected for 1918-19: H. L. Hutson, chairman; E. W. Carr, secretary; R. T. Burwell, W. B. Moses and J. S. Barelli.

H. L. HUTSON,
Section Secretary.

NEW YORK

May 21. Labor Turnover was the subject of the meeting and was discussed by the following speakers representing makers of ships, aeroplanes, ordnance and machine tools: L. D. Burlingame, industrial superintendent, Brown & Sharpe Mfg. Co., John Calder, Aeromarine Plane & Motor Co., Capt. Boyd Fisher, Ordnance Department, U. S. A., Dudley Kennedy, American International Shipbuilding Corp., H. E. Miles, Council National Defense, J. J. Pearson, British War Office, H. F. J. Porter, consulting industrial engineer, and Orrin W. Sanderson, director of labor, B. F. Goodrich Company.

Opportunity was given to participate in short three-minute speeches and among the discussers were the following: F. H. Colvin, Editor *American Machinist*; L. P. Alford, Editor *Industrial Management*, and Eric Oberg, Editor *Machinery*.

A more detailed account of the meeting will appear in the July JOURNAL.

W. HERMAN GREUL,
Section Secretary.

ONTARIO

April 18. A very interesting paper on the Heat Treatment of Low-Carbon Steels was presented by W. M. Wilkie of the Steel Department of the Imperial Munitions Board. The discussion that followed the paper bore principally on the troubles encountered by the producers and users of shell steel. Among the engineers present were a number of those connected with local munitions plants, and their remarks based on actual experiences and the solution of various troubles under war time conditions were very interesting.

CHESTER B. HAMILTON, JR.,
Section Secretary.

PHILADELPHIA

April 23. The Philadelphia Section entertained the Council of the National Society at a dinner meeting at the Adelphia Hotel at which over one hundred members of the Section were present.

During the preceding day, the Council had visited and inspected Cramp's Ship Yard, and also the Hog Island plant of The American International Shipbuilding Corporation.

Mr. Lewis F. Moody presided at the meeting. He introduced as toastmaster D. Robt. Yarnall, chairman of the National Committee on Sections. The Council was given a greeting from Philadelphia by W. S. Catell. President Chas. T. Main responded in behalf of the Council. Following President Main, Messrs. James Hartness, C. C. Thomas, S. M. Vauclain and W. C. L. Eglin each gave a short talk.

J. P. MUDD,
Section Secretary.

PROVIDENCE

April 24. Under the auspices of the Municipal Engineering Section an illustrated lecture was delivered by Frank E. Winsor, chief engineer of the Providence Water Supply Board on The Development of the New Providence Water Supply.

April 25. A business meeting of the Efficiency Section was held, at which new officers were elected.

April 30. At a joint meeting of the Rhode Island Section of the American Chemical Society and the Providence Engineering Society, Lieut.-Col. Allerton S. Cushman, Ord. Dept. U.S.N.A., delivered an illustrated lecture on The Manufacture of Military Primers. Mr. H. Anthony Dyer also delivered a short address in connection with the unfurling of the service flag of the society.

May 8. Prof. L. B. McMillan, of the H. W. Johns-Manville Co., gave an address on Thermal Insulation at the Power Section meeting.

May 14. At the Machine Shop Section meeting a discussion on Experimental Investigation of Machine Tools and Its Effect on Machine Tool Design was led by Professor James A. Hall, of Brown University, a number of representatives from various machine-tool companies contributing toward the discussion.

JAMES A. HALL,
Correspondent.

PERSONALS

In these columns are inserted items concerning members of the Society and their professional activities. Members are always interested in the doings of their fellow-members, and the Society welcomes notes from members and concerning members for insertion in this section. All communications of personal notes should be addressed to the Secretary, and items should be received by June 15 in order to appear in the July issue.

CHANGES OF POSITION

Albert H. Hudson, formerly general purchasing agent of the Wright-Martin Aircraft Corporation, New York, has assumed the duties of purchasing agent of the American International Steel Corporation, New York.

John D. Bowles has left the employ of the Springfield Gas and Electric Company and Springfield Traction Company, to become associated with the Douglas Company, of Cedar Rapids, Iowa, in the capacity of general mechanical superintendent.

William G. Edmondson has resigned from the Illinois Zinc Company, Peru, Ill., to reënter the service of the Interstate Commerce Commission, as mechanical engineer, with headquarters at Washington, D. C.

Francis L. Lindemuth, formerly affiliated with the H. Koppers Company, Pittsburgh, Pa., has become associated with Perin and Marshall, consulting engineers of New York.

Charles E. Burgoon has severed his connection with the Sandusky Cement Company, Cleveland, Ohio, and has accepted a position in the engineering department of the Air Nitrates Corporation, New York.

Jacob H. Wallace, formerly engineer with the Western Chemical Manufacturing Company, Denver, Colo., has become associated with the United Verde Copper Company, Clarkdale, Ariz.

A. E. Howard, formerly production engineer for Ingersoll-Rand Company, Phillipsburg, N. J., has accepted a similar position with Manning, Maxwell and Moore, and will be located at the Ashcroft plant, Bridgeport, Conn., for the next two months.

Charles D. Reeve has resigned his position as vice-president and factory manager of the Grand Rapids Brass Company, Grand Rapids, Mich. He has bought a controlling interest in the American Brass Novelty Company, of Grand Haven, Mich., and holds the position of president and general manager with the company.

John Chucan has left the employ of the International Harvester Corporation, Tractor Works, Chicago, Ill., to assume the position of mechanical engineer with the Goodwin Car and Manufacturing Company, Inc., of the same city.

Jonathan A. Wilson, until recently traveling engineer for the Babcock and Wilcox Company, Bayonne, N. J., has accepted the position of purchasing agent for the Todd Shipyards Corporation, of New York.

E. R. Kenner, formerly with the Westinghouse Electric and Manufacturing Company, Pittsburgh, Pa., is now with the Air Nitrates Corporation, Muscle Shoals, Ala.

A. C. V. Malm, formerly president and general manager of the Malm Machine Company, Dayton, Ohio, has assumed similar duties with the Malm Engineering Company, of Philadelphia, Pa., a newly formed company. In addition to consulting engineering, the new company has leased the rights to manufacture the Malm rotary punch presses for rubber and metal punching, now patented, belonging to the Malm Machine Company.

John J. Eason has accepted the position of works manager with the United States and Cuban Allied Works Engineering Corporation, operating the Havana Iron Works and the Havana Dry Dock Company, in Cuba. Mr. Eason was formerly connected with the Havana Marine Railways, Inc., Havana, Cuba, in the capacity of general superintendent.

George E. Barrett, until recently affiliated with the Sprague Electric Works, Bloomfield, N. J., has assumed the duties of inspector of naval construction, Bureau of Construction and Repair, Washington, D. C.

Otto G. Jenner has severed his connection as industrial engineer with the Inland Steel Company, Chicago Heights, Ill., and has accepted the position of superintendent with the Wilson and Bennett Manufacturing Company, Chicago, Ill.

John H. Nelson has resigned from the Bureau of Standards, Washington, D. C., to become research engineer with the Wyman-Gordon Company, Worcester, Mass.

Frederick G. Kenyon, formerly with the engineering department of Remington Arms Union Metallic Cartridge Company, Bridgeport, Conn., has become associated with the American Can Company, Liberty Ordnance Plant, of the same city, as chief draftsman.

Robert W. Ellingham has resigned from The Bilton Machine Tool Company, Bridgeport, Conn., to enter the employ of the Heald Machine Company, as works manager.

Harry G. Baldwin has resigned his position with the S K F Bearing Company, Hartford, Conn., to accept the position of assistant general manager with the Henry G. Thompson and Son Company.

ANNOUNCEMENTS

George F. Swain, of the Massachusetts Institute of Technology staff, has returned to the Institute from the western part of the country after having been honored twice by the University of California on the occasion of its semi-centennial, which conferred on him the degree of LL.D. and also accorded him the distinction of being the first engineer to deliver before the University one of the Hitchcock lectures, which are supported by an endowment of $10,000. For his subject, Professor Swain selected Some General Principles and Disputed Points in the Valuation of Public Utility Corporations.

James A. Beaubien has assumed the duties of general manager and mechanical engineer with the Weber Subterranean Pump Company, of New York.

Ernest B. Bishop has been transferred from the Ilion Works to the Smith Premier Works of the Remington Typewriter Company, Syracuse, N. Y.

William R. Wilson, until recently secretary of the Alberger Pump and Condenser Company, New York, has been elected vice-president, and Richard C. Williams has been elected secretary of the company.

Schuyler S. Wheeler, of Ampere, N. J., is in France and later will go to Great Britain to explain the system that he has successfully used in his factories by means of which persons physically handicapped may become self-supporting workers. He was invited by Eugene Brieux, who is in charge of this sort of work done by the French Government.

Warren E. Murray, consulting engineer, announces the establishment of general engineering offices at San Francisco, Cal. He was, until recently, with the Western Sugar Refining Company, of the same city, as refinery manager.

Hal R. Stafford, mechanical engineer of the Economy Devices Corporation, New York, is now chief engineer of the Franklin Railway Supply Company, Inc., a consolidation of the Economy Devices Corporation and the Franklin Railway Supply Company.

Ralph G. Macy, formerly in the Army, and with the Air Reduction Company prior to that, has resigned his commission and is now with the New York Steam Company, New York.

The honorary degree of doctor of engineering has been conferred upon **Alexander C. Humphreys**, president of Stevens Institute of Technology, by the Rensselaer Polytechnic Institute.

Russell G. Clark, general draftsman of the American Thread Company, formerly at Willimantic, Conn., is now located at the head office of the company, in New York.

Hubert C. Verhey, who joined the technical department of the Emergency Fleet Corporation at Washington, D. C., in the capacity of chief draftsman is now at the head of the marine Diesel engine department.

R. S. Brunner has become identified with the Hamilton-Otto Coke Company, of Hamilton, Ohio.

F. G. Pease has become associated with the National Research Council, Washington, D. C., as chief draftsman of the Engineering Section.

Dugald C. Jackson, in charge of the Department of Electrical Engineering at Massachusetts Institute of Technology, Cambridge, Mass., has been called into active service. Last December Professor Jackson took the formal oath and now has been ordered "over there." His commission is that of Major in the Engineer Reserve Corps.

John T. Faig, for 12 years professor of mechanical engineering, University of Cincinnati, has been appointed president of the Ohio Mechanics Institute. Professor Faig will give special attention to training students in the operation and construction of internal-combustion engines.

Marcus T. Lothrop has been appointed assistant factory manager of the Timken Roller Bearing Company, Canton, Ohio. He has been metallurgist and has had charge of the steel and tube department of the company for the past seven years.

Captain Frederick H. Moody, who upon being wounded in France was evacuated to England, was temporarily loaned to the Ministry of Munitions for inspectional and expediting work on mechanical plants for the Air Board, is still acting as an Air Board officer.

APPOINTMENTS

Allen E. Ostrander has been appointed general mechanical engineer of the American Car and Foundry Company, New York. He was previously connected with the company in the capacity of mechanical engineer.

O. S. Maple, formerly purchasing assistant of the U. S. Shipping Board, Emergency Fleet Corporation, at Washington, D. C., has recently been appointed assistant purchasing officer.

Harold G. Kniese has accepted an appointment as mechanical draftsman and designer in the Nitrate Division, War Ordnance Department, Washington, D. C.

William D. Halsey has been appointed mechanical engineer with the National Advisory Committee for Aeronautics at Washington, D. C. He will continue his late afternoon and evening classes at the George Washington University, Washington, D. C., as assistant professor of mechanical engineering.

AUTHORS OF PAPERS, ETC.

Sterling H. Bunnell has contributed a brief article on Commercial Relations of Allies with Russia, to the May 16 issue of *The Iron Age*.

Harrison R. Cady is the author of an article entitled Electrification of Pumping Stations Saves Coal and Money which appears in the May 9 number of *Engineering News-Record*.

NECROLOGY

REAR ADMIRAL JOHN D. FORD

John D. Ford, Rear Admiral (retired) in the United States Navy, died at his home in Baltimore on April 8, 1918.

Admiral Ford was born on May 19, 1840, in Maryland and was educated in the public schools of Baltimore. He was graduated from the Maryland Institute School of Design in June 1861, receiving the Peabody Prize. The following year he was graduated from the Potts School of Mechanical Engineering and immediately entered the United States Navy as third assistant engineer. Early in 1864 he was made second assistant engineer and two years

John D. Ford

later became first assistant engineer. On December 27, 1890, he was made chief engineer.

During the Civil War Admiral Ford took part in the recapture of Baton Rouge, La., in March 1863, and in the Battle of Mobile Bay, 1864, and was on the *Arizona* when it was destroyed by fire off Poverty Point in the Mississippi River in 1865. He was wrecked in the *Sacramento* on the Coromandel coast of India in 1867.

In 1884 he was put on detached service for the purpose of establishing the Baltimore Manual Training School. From 1894 to 1896 he was connected with the Maryland Agricultural and Mechanical College. He was next assigned to the U. S. S. *Brooklyn*, with the relative rank of commodore, and in 1898 to the U. S. S. *Baltimore* (flagship), later becoming fleet engineer of the Pacific Station. He joined the Asiatic fleet and took part in actions of April 30, May 1 and August 13, 1898, and in the destruction of the Spanish fleet off Cavite, the destruction of the batteries at Cavite and at Sangley Point, the capture of the forts at Corregidor and the capture of Manila. On May 19, 1905, he retired from the service as Rear Admiral.

Admiral Ford was a member of the Associated Veterans of Farragut's Fleet, the Loyal Legion, the Society of Manila Bay, and of the American Society of Naval Engineers. He became a member of our Society in 1884.

HENRY ARTHUR BAYFIELD

Henry A. Bayfield was born in Charlottetown, Prince Edward Island, Canada, on June 19, 1873. He was graduated from McGill University, Montreal, in 1896, with the degree of Bachelor of Applied Science, having taken the mechanical-engineering course.

The first two years after his graduation he spent at the shops of the Intercolonial Railway, Moncton, N. B., as machinist and junior mechanical draftsman, and in testing locomotives on the road. He was also a year in the Great Northern Railway shops at St. Paul, Minn., where he was draftsman in charge of the office; later he was made superintendent of the company's shops at West Superior, Wis. For a short period he was with the Dar-

danelle Mining Company, Sa[illegible] B. C., overhauling and operating their plant. From 1899 to 1900 he was connected with the Albion Iron Works and Victoria Machinery Depot, Victoria, B. C., as a designer of small marine engines, boilers, etc., leaving this firm to become senior designer on dredging and hoisting machinery, air compressors, shop appliances, etc., with the James Cooper Mfg. Co., Montreal. In 1901 Mr. Bayfield was appointed mechanical superintendent in charge of dredging fleet, shops and shipyard for the Harbor Commissioners of Montreal. About three years later he entered on private practice in Vancouver, B. C., and with the exception of an interval with the British Columbia General Contract Company, continued in private practice until 1909, when he entered the service of the Department of Public Works of Canada, being appointed superintendent of dredging for British Columbia. In December 1912 Mr. Bayfield was made chief engineer in charge of all estimating and designing of the Vancouver Machinery Depot Company, where he remained until 1913, when he was again called upon by the Dominion Government to design a self-propelling hydraulic dredge. In 1914 he returned to private practice at Vancouver, B. C., engaging principally in consulting work in connection with dredging and marine matters, but was called in 1915 to the Department of Railways and Canals of Canada to take the position of mechanical engineer in charge of all mechanical and marine work at Port Nelson, Manitoba. Late in the same year Mr. Bayfield became chief engineer with Norton, Griffiths & Co., Ltd., St. John, N. B., in connection with the harbor-improvement contract. In 1916 he was called on by the British Ministry of Munitions of War to take charge of the Enfield rifle production at the Winchester Repeating Arms Company, New Haven, Conn., where he remained until the summer of 1917, when he was appointed engineer in charge of the Ogden Point assembly plant of the Imperial Munitions Board, Victoria, B. C. He held this position at the time of his death, February 12, 1918.

Mr. Bayfield was a member of the Institution of Mechanical Engineers (Great Britain) and an associate member of the Canadian Society of Civil Engineers. He became a member of our Society in 1913.

ROBERT ELLSWORTH JACKSON

Robert E. Jackson was born in Matteawan, N. Y., on August 24, 1888. He was educated in the public schools of Garfield, N. J.

He served his apprenticeship with the Dutchess Tool Works, Fishkill Landing, N. Y., and there learned the machinist's trade. The year of 1910 he spent with the Coldwell Wilcox Company, Newburgh, N. Y., as machinist. He then worked in the same capacity for about six months with the Fiat Automobile Company, Poughkeepsie, N. Y. Upon leaving this company he became associated with P. H. Gill & Sons, Brooklyn, N. Y., as machinist. In April 1911 he entered the employ of the Edison Laboratory, West Orange, N. J., as foreman of the machine department. He was later made superintendent and held this position at the time of his death.

Mr. Jackson became a junior member of the Society in 1917. He died at West Orange, N. J., on April 5, 1918.

ERNEST AINSWORTH MOORE

Ernest A. Moore was born in Victoria, Australia, on October 11, 1879. He was educated in Melbourne, Australia, and later received special instruction in work of a mechanical nature from tutors.

While in Australia he was employed by Knox, Schlapp & Co., who represented the Allis-Chalmers Company, in the capacity of private secretary to Mr. William Knox. In 1904 Mr. Moore decided to come to the United States and in August of that year became draftsman with the Filer & Stowell Co., Milwaukee. Two years later he became connected with the Allis-Chalmers Company, working first in the gas-engine department, and later as assistant engineer. In 1908 he became chief engineer of the Bates Machine Company, Joliet, Ill., having full charge of all technical and later all commercial engineering work; he designed, built and supervised a great amount of special machinery and while with this company obtained his experience in work of a consulting and legal technical nature.

Mr. Moore left the Bates Machine Company in 1913 to take the position of resident manager in Chicago for the A. M. Byers Company, Pittsburgh, manufacturers of wrought-iron pipe. About May 1914 he left Chicago for Detroit, planning to develop there a new business for the production of a new machine making paper containers. This machine was first designed by him in 1911 and was gradually perfected, until in 1914 the Moore Container Company was organized in Detroit with Mr. Moore as president. Plans were practically completed for the manufacture of the machine when his health failed and he was forced to give up his work completely and leave for the West in an effort to regain his strength. He died very suddenly in Phoenix, Ariz., on February 15, 1918.

Mr. Moore became a member of the Society in 1913.

WILLIAM PRESCOTT SARGENT

William P. Sargent was born in Stoneham, Mass., on September 9, 1878, and received his early education in the public schools of that city.

He was first employed in 1896 by Prentice Brothers, Worcester, Mass., manufacturers of machine tools, where he had charge of the stock room. His spare time he devoted to learning machine operation and machine fitting. His next position was with the Draper Machine Tool Company as draftsman. For a short while thereafter he was connected with the Lodge & Shipley Machine Tool Company, Cincinnati, as a designer of special machinery. In 1903 he was made special engineer for the Niles Tool Works, Hamilton, Ohio, where his work dealt with chemical and metallurgical research problems. He returned to the Pratt & Whitney Co. as assistant construction engineer in the design of the machine shop, foundry and power plant which were being erected. He was next made engineer in direct charge of the design and construction of the machine and forge shop of the Niles Tool Works. About 1907 Mr. Sargent became associated with the Barber-Colman Company, Rockford, Ill., as engineer to design and develop automatic textile machinery. From 1909 to 1915 he was engaged in the design and development of automatic machinery for handling periodicals, papers and paste, and in the design and construction for the Bureau of Chemistry of several graphic machines for recording impacts and stresses. He was associated also with the Curtis Publishing Company, Philadelphia, where he was interested in the reduction of labor costs in the mechanical processes involved in the publication of 5,000,000 magazine copies a month. During the years of 1915 and 1916 Mr. Sargent devoted his time to coördinating the facilities of more than twelve small shops whose production singly of gages, tools and ordnance parts would not have been appreciable. Recently Mr. Sargent was engaged in the construction of gages and interested in other work for the Frankford Arsenal.

Mr. Sargent became a member of the Society in 1909. He died on April 10, 1918.

WILLIAM WARREN SMITH

William W. Smith was born in Toronto, Canada, on September 9, 1876. He was educated in the public schools of Michigan and in Michigan Agricultural College, taking the mechanical-engineering course. Later he attended Purdue University, where he took special work in mechanics.

He obtained his shop experience with the Welded Steel Barrel Company, Detroit, Mich., where for about a year and a half he was draftsman and inspector. He spent two years with the American Car and Foundry Company, Detroit and St. Louis, as draftsman, estimator and finally as chief draftsman. His next position was with the Standard Steel Car Company, Pittsburgh, as assistant construction engineer, where he remained for about a year, leaving to become assistant manager with the Mexican Car and Foundry Company, Mexico City. He remained in Mexico, transferring his business connections to the National Iron and Steel Works as superintendent and mechanical engineer in charge of design for miscellaneous machine and structural-steel work. About 1916 Mr. Smith became associated with Dodwell & Co., New York, as foreign representative with Behn Brothers, San Juan, Porto Rico. In February of this year he joined the sales force of the Allis-Chalmers Manufacturing Company, expecting later to be transferred to sales work in South America, with which country he was especially familiar.

Mr. Smith became a member of the Society in 1909. He died in Milwaukee, Wis., on April 1, 1918.

ROLL OF HONOR

ALEXANDER, LUDWELL B., First Lieutenant, Aero Section, Signal Officers' Reserve Corps, School of Military Aeronautics, Massachusetts Institute of Technology.

ANTOSCH, WALTER, Ensign, United States Naval Auxiliary Reserve.

BALLOU, J. LADD, Sergeant, Co. C, 342d Inf., Camp Grant, Ill.

BARKER, EARNEST S., First Lieutenant, Headquarters Co., 48th Infantry, Camp Stuart, Newport News, Va.

BARRON, ALEXANDER F., Private, Co. F, 305th Engineers, Camp Lee, Va.

BARRY, JOHN L., JR., Ensign, Engineering, U. S. Naval Auxiliary Reserve.

BECHTEL, JOHN A., Captain, Co. F, 108th Supply Train, 33d Division, U. S. Expeditionary Forces, France.

BOYER, GEORGE H., First Lieutenant, Ordnance Training Camp, Camp Hancock, Augusta, Ga.

BRIGGS, LESTER G., U. S. Navy Aviation.

BUCK, J. E., Ensign, U. S. Naval Reserve Force.

CARPENTER, F. S., First Lieutenant, Signal Corps, U. S. Army.

CLARKE, LEON L., Captain, Engineer Officers' Reserve Corps, American Expeditionary Forces, France.

DAYTON, BIRGE S., Private, Co. C, 6th Regiment, U. S. Engineers, American Expeditionary Forces, France.

DICKSON, CHARLES H., First Lieutenant, Ordnance Officers' Reserve Corps.

DOUGLAS, MORRIS D., First Lieutenant, Ordnance Officers' Reserve Corps, Inspection Division, Ordnance Dept.

EKSTRAND, CHARLES E., Lieutenant (Junior Grade), U. S. Naval Reserve Force.

GIANELLONI, VIVIAN J., Lieutenant, Coast Artillery Reserve Corps, Co. B, 53d, A. T. C. A. C., Oakland, Cal.

GOLDSMITH, CLARENCE, Major, Construction Division, Quartermaster's Corps, U. S. Army.

HAMILTON, W. B., Captain, Ordnance Officers' Reserve Corps, Division of American Ordnance Base Depot in France.

HOSMER, FRED E., Lieutenant, Assistant Engineer Officer, Headquarters Staff, Aviation Section, Ebberts Field, Lonoke, Ark.

JACKSON, DUGALD C., Major, Engineer Officers' Reserve Corps, American Expeditionary Forces, France.

JACKSON, E. R., First Lieutenant, Ordnance Officers' Reserve Corps, Inspection Division, Ordnance Dept., U. S. A.

JACKSON, WILLIAM B., Major, Quartermaster's Corps, U. S. A., Officer in Charge of Utilities, Camp Merritt, N. J.

LYNE, L. F., First Lieutenant, Ordnance Officers' Reserve Corps, Inspection Division, Ordnance Department, U. S. Army.

McKAIG, W. W., Ensign, Bureau of Construction and Repair (Aviation), Navy Dept.

McNALLY, EDWIN M., Ensign, U. S. Naval Reserve Force, Bureau of Steam Engineering, Navy Department.

MARROW, GEORGE P., Major, United States Army.

MERRILL, S. CLIFFORD, Second Lieutenant, Ordnance Officers' Reserve Corps, Inspection Division, Ordnance Department, U. S. Army.

MORSE, WALTER R., Captain, N. A., 301st Engineers, Camp Devens, Mass.

MUNYAN, EARL A., Lieutenant (Junior Grade), U. S. Naval Reserve Force, Navy Department, Bureau of Ordnance.

NORTHCROFT, JAMES F. S., Officers' Training Camp, British Army, England.

PLANK, WILLIAM J., Cadet, Aviation Section, Signal Enlisted Reserve Corps, School of Military Aeronautics, Austin, Tex.

ROBECHEK, B., 21st Co., Coast Artillery Corps, Ft. Preble, Me.

ROBERTS, CHAPIN, Ensign, U. S. Naval Reserve Force, U. S. S. *Hawk*.

ROSE, DAVID, Private, Co. C, Second Provisional Ordnance Bureau, American Expeditionary Forces, France.

SAWYER, WILFRED D., Private, Camp Funston, Tex.

SCHALLER, ALWIN L., Captain, Ordnance Department, N. A., Aberdeen Proving Ground, Md.

SEATON, EDWARD W., Private, Ordnance Corps, Detachment A, Gunpowder Reservation, Barracks 2, Edgewood, Md.

SEWARD, HERBERT L., Lieutenant (Senior Grade), U. S. Naval Reserve Force, Navy Steam Engineering School, N. Y.

SMOCK, HAROLD E., U. S. Naval Reserve Force, stationed at Dayton, Ohio.

SMITH, FURMAN, JR., Lieutenant, Ordnance Officers' Reserve Corps, Ordnance Department, U. S. Army.

TAYLOR, PAUL H., First Lieutenant, Ordnance Officers' Reserve Corps, 26th Division, Ordnance Mobile Repair Shops, American Expeditionary Forces, France.

TAYLOR, STEVENSON, Lieutenant-Colonel, U. S. Naval Reserve Force.

THURSTON, EDWARD D., JR., Lieutenant (Junior Grade), U. S. Naval Reserve Force, U. S. Navy Gas-Engine School, Columbia University, N. Y.

WALSH, EDWARD T., Major, Ordnance Officers' Reserve Corps, Inspection Division, Ordnance Department.

WELLING, LINDSAY H., Sergeant, 117 Mobile Ordnance Repair Shop, American Expeditionary Forces, France.

WETHERILL, WILLIAM C., Ensign, U. S. Naval Reserve Force.

WOODWORTH, C. B., Captain, 49th Engineers, Fort Meyer, Va.

CANDIDATES FOR MEMBERSHIP

TO BE VOTED ON AFTER JULY 10

BELOW is the list of candidates who have filed applications since the date of the last issue of THE JOURNAL. These are classified according to the grades for which their ages qualify them, and not with regard to professional qualifications, i.e., the ages of those under the first heading place them under either Member, Associate or Associate-Member, those in the next class under Associate or Associate-Member, those in the third class under Associate-Member or Junior, and those in the fourth under Junior grade only. Applications for change of grading are also posted. Total number of new applications, 79.

The Membership Committee, and in turn the Council, urge the members to scrutinize this list with care and advise the Secretary promptly of any objections to the candidates posted. All correspondence in this regard is strictly confidential. Unless objection is made to any of the candidates by July 10, and provided satisfactory replies have been received from the required number of references, they will be balloted upon by the Council. Those elected will be notified about July 15.

NOTE. The Council desires to impress upon applicants for membership that under the present national conditions the procedure of election of members may be slower than under normal conditions.

NEW APPLICATIONS

FOR CONSIDERATION AS MEMBER, ASSOCIATE OR ASSOCIATE-MEMBER

Connecticut

BALDWIN, CHARLES A., Assistant General Sales Manager, Bridgeport Brass Co., Bridgeport

LUDEMAN, OSCAR H., Engineer and Salesman, The Spencer Tubine Cleaner Co., Hartford

SHAW, STILLMAN, Mechanical Engineering—Lorenz & Lorenz, Hartford

Delaware

CRAIG, WILLIAM D., Engineer, Atlas Powder Co., Wilmington

District of Columbia

DOYLE, EDMUND A., 1st Lieutenant, Engr. R. C., U. S. Army, Washington

FISCHER, LOUIS A., Major, Ordnance Reserve Corps, Bureau of Standards, Washington

Georgia

PERRY, HIRAM W., General Superintendent, Yaryan Rosin & Turpentine Co., Brunswick

Illinois

McWETHY, FRANK H., Secretary, Stephens-Adamson Mfg. Co., Aurora

OLSON, CARL G., Chief Engineer, Illinois Tool Works, Chicago

Maryland

SYMINGTON, THOMAS H., President of the several Symington Companies, Baltimore

Massachusetts

GRADE, OSCAR W., Mechanical Engineer, Worthington Pump & Machy. Corp., Blake & Knowles Works, Cambridge

HARVEY, John C., with C. M. Allen, Engineer, also owner and manager Haynes automobile business, Worcester
INGRAM, Edward H., Mechanical Engineer, Greenfield Tap & Die Corp., Greenfield
JONES, Evan F., Treasurer and General Manager, Morgan Spring Company, Worcester
LINCOLN, Frank S., Machine Purchase & Tool Designer, Construction Department, Watertown Arsenal, Watertown
REID, Alexander, Manager of Water Wheel Dept., Holyoke Machine Companies, Worcester

New Jersey
FRENCH, Charles M., 1st Lieutenant Engineers R. C., 34th Engineers, Camp Dix
GIBBONS, Archer, Manager of General Office Service Departments of Thomas A. Edison, Inc., Orange
PARRISH, Samuel M., Power Supervisor, The Celluloid Co., Newark

New York
LATTER, Edward D., Industrial Engineer, with Federal Accounting Corp., New York
MOREAU, L., Engineer, with M. M. Schneider & Co., New York
POLLARD, Wright, Supervisor, Remington Arms & U. M. C. Co., Inc., Ilion
POTTER, Joseph S., General Superintendent, Gas Engine & Powder Co., & Charles L. Seabury & Co., Consol., Morris Heights
VAN BOMEL, Leroy A., President, Sheffield Condensed Milk Co., Inc., Asst. General Manager, Sheffield Farms Co., Inc., President, High Bridge Garage, Inc., New York
WILDER, Robert H., General Inspector, American Metal Products Corp., New York
WAINRIGHT, Walter S., Engineer, Walter Kidde & Company, Inc., New York

North Carolina
MACEWAN, Thomas A., Mechanical Construction Engineer in Private Practice, Greensboro

Ohio
LEAHY, Francis W., Inspector of Machinery, U.S.S.B. Emergency Fleet Corp., care of Hooven, Owens, Rentschler Co., Hamilton
McCONKEY, Walter N., Shop Engineer, Lima Locomotive Works, Inc., Lima
RUCK, Edward H., Chief Engineer, The Cleveland Tractor Co., Cleveland

Pennsylvania
BUCK, Charles A., Vice President, Bethlehem Steel Co., Bethlehem
ENZIAN, Charles, Mining Engineer, Philadelphia and Reading Coal and Iron Co., Pottsville
GUTHRIE, Bayard, Superintendent of Crucible Works, Crucible Steel Co. of America, Pittsburgh
HOFAMMANN, Karl E., Assistant Foreman, Pennsylvania Railroad Company, Altoona
SCHLATTER, Louis H., Assistant Foreman, Pennsylvania R. R. Co., Test Dept., Altoona

Tennessee
SEWELL, Charles B., Saw Mill Designer and Builder, Newport

Virginia
VANDEGRIFT, Wayne A., Supt. of Const., J. W. Danforth Co., Naval Base Station, Norfolk

Wisconsin
ERBACH, William L., Vice-President & Manager, Riethrock Land & Lumber Co., Athens

Canada
COSLER, Arthur S., Adviser on Pulp-Mill Construction, Fraser Companies, Ltd., Edmundston, N. B.
FRASER, Duncan W., General Manager, Montreal Locomotive Works, Ltd., Montreal

Canal Zone
HEDGES, Selby E., Plant Draftsman, Mechanical Division, Panama Canal.

South America
BARKER, Edgar E., Superintendent of Mines, Cerro de Pasco Copper Corp., Cerro de Pasco, Peru

FOR CONSIDERATION AS ASSOCIATE OR ASSOCIATE-MEMBER

Alabama
DREXELIUS, George W., Local Manager, The Fairbanks, Birmingham

Illinois
REDFIELD, Edmund R., Mechanical Engineer, Russell, Burdsall & Ward, Bolt & Nut Co., Rock Falls

Iowa
NICHOLSON, James M., Fuel Supervisor, care of A. T. & S. F. Ry. Co., Fort Madison

Michigan
LANGILL, Ross E., Chief Engineer, Sawmill Dept., The Prescott Co., Menominee

Missouri
HILL, William S., Superintendent, Light & Power Dept., Springfield Gas & Electric Co., Springfield

New Jersey
PONSEN, Lyas, Power-plant Engineer, Babcock & Wilcox Co., Bayonne

New York
GRAHAM, Warren W., Mechanical Engineer, Ford, Bacon & Davis, New York

Pennsylvania
BENNETT, Leland W., Instructor, Dept. Mechanical Engineering, University of Pennsylvania, Philadelphia

FOR CONSIDERATION AS ASSOCIATE-MEMBER OR JUNIOR

District of Columbia
COLLINS, Lester W., Investigator in Marketing Fruits and Vegetables, Bureau of Markets, Washington

Massachusetts
STRUCK, Henry W., Mechanical Designer, Stone & Webster, Boston
TUCKER, Harold B., Asst. Supt. Const., Merrimac Chemical Co., No. Woburn

Minnesota
KOPPER, Edward, Jr., Chief Engineer, Minnesota Manufacturers' Assn., North St. Paul

Nebraska
BIRD, Frank S., Superintendent of Construction, Phoenix Construction Co., Omaha

New Jersey
BELDING, Lewis A., Assistant Professor of Mechanical Engineering, Stevens Institute of Technology, Hoboken.
RILEY, Arthur B., Sergeant, 1st Class, in charge of road construction, Utilities Dept., Quartermaster Corps., U. S. Army, Camp Merritt
SCOTT, Walter C., Manager and member of firm—Walter Scott & Co., Plainfield

New York
ANDRESEN, John H., Jr., Mechanical Superintendent, New York American Journal, New York
BROOKS, John, Assistant to General Manager, Russell Motor Car Co., Inc., Buffalo
SANBORN, Arthur P., Engineering Ensign, U.S.N.R.F., Section Base, No. 8, Tompkinsville, Staten Island

Ohio
BOHANNON, George L., Chief Engineer, The Youngstown Steel Car Co., Youngstown
DRUMMOND, John H., President, The Drummond-Miller Co., Cleveland

Pennsylvania
BAGLEY, Glen D., Engineer for Mellon Institute of Industrial Research, Pittsburgh
PRUDDEN, Theodore M., 1st Lieutenant, Ordnance Dept., R. C., Frankford Arsenal, Philadelphia
SMITH, Victor J., 1st Lieutenant, Ordnance R. C., U.S.A., Frankford Arsenal, Philadelphia

Virginia
McCLAVE, Bernard D., Captain, Sanitary Corps, N.A., Assigned to A. S., S. C., Hampton

West Virginia
KAUFMAN, Morris L., Engineer in Cotton Purification Dept., Staff of Lt. Col. Arthur Wass, Nitro

FOR CONSIDERATION AS JUNIORS

California
BEATTIE, Joseph A., Assistant Engineer, Board of Public Utilities, Los Angeles

Connecticut
STURTEVANT, Henry S., Mechanical Engineer, S.K.F. Ball Bearing Co., Hartford

Indiana
DAVIDSON, John L., Chief Inspector for the Ordnance Department, U. S. Army, care of The Illinois Steel Co., Gary

Maryland
BELL, Walter M., Engineer, U. S. Filling Plant, Co. B., Gunpowder Reservation, Edgewood

Michigan
MEHARD, Hugh R., Time Study Chief and Efficiency Engineer, The Aluminum Castings Co., Detroit

New Jersey
GOTTLIEB, Solomon, Departmental Manager, American Lead Pencil Co., Hoboken

New York
LEGGE, Elmer E., Mechanical Engineer and Metallographist, Watervliet Arsenal, Watervliet
WATKINS, Roy A., Ensign, Instructor, Columbia University, New York

Pennsylvania
MARQUARDT, William C., Asst. Superintendent, Nelson Valve Co., Philadelphia
McCABE, P. Charles, Heating Engineer, The Austin Company, Philadelphia

Canada
GUSTAFSON, Alfred O., Checker, Engineering Dept., Willys-Overland, Ltd., West Toronto

APPLICATIONS FOR CHANGE OF GRADING

PROMOTION FROM ASSOCIATE-MEMBER

Connecticut

PIGOTT, REGINALD J. S., Superintendent, Raw Material Depts., Bridgeport Brass Co., Bridgeport

New York

HATCH, EDWIN G., Consulting Engineer and Manufacturer, New York

Pennsylvania

BRYANS, HENRY B., Engineer, Counties Gas & Electric Co., Norristown

PROMOTION FROM JUNIOR

District of Columbia

HALSEY, WILLIAM D., Asst. Professor, Mechanical Eng., Geo. Washington University, and Mechanical Engineer with National Advisory Committee for Aeronautics, Washington

Massachusetts

HAYES, J. HOWARD, Member of firm, E. H. Hayes Machinery Co., Boston

New Jersey

ABRAMS, FRANK W., Asst. Superintendent, Standard Oil Company, Jersey City

SMITH, WILLIAM E., Traveling Engineer, Babcock & Wilcox Co., Bayonne

STROUSE, SIDNEY B., General Engineering Practice and District Manager for Warren Webster & Co., Atlantic City

New York

GATES, JOHN G., Production Superintendent, Sperry Gyroscope Company, Manhattan Bridge Plaza (Reinstatement), Brooklyn

Ohio

RENTSCHLER, GORDAN S., Vice-President and Works Manager, The Hamilton Foundry & Machine Co., Hamilton

Pennsylvania

BICKLEY, JOHN H., Designing Hydraulic Engineer, W. H. Wood, Media

LEWIS, GEORGE C., Chief Engineer, Hersh & Brother, Allentown

MANN, HARVEY B., Department Manager and Director, Dravo-Doyle Company, Pittsburgh

SUMMARY

New applications	79
Applications for change of grading	
Promotion from Associate-Member	3
Promotion from Junior	10
Total	92

SUMMARY SHOWING AVERAGE AGE AND POSITIONS OF APPLICANTS ON BALLOT OF MAY 29, 1918

AVERAGE AGE OF APPLICANTS

Members	39
Associates	42
Associate-Members	[illegible]
Juniors	[illegible]

POSITIONS OF APPLICANTS

Chief Engineer	24
Chief Engineer (Asst.)	3
Chief Draftsman	11
Chief Draftsman (Asst.)	2
Construction Engineer	5
Construction Engineer (Asst.)	1
Consulting Engineer	16
Consulting Engineer (Asst.)	1
Cost Accountant	1
Designers	17
Draftsmen	17
Editor	1
Estimator	1
Executive (Pres., V.P., Treas., Secy., Manager)	51
Factory Manager	2
Field Engineer	1
Foremen	4
Foremen (Asst.)	12
Fuel Engineer	2
Gas Engineer	1
Industrial Engineer	5
Inspectors	17
Inspectors (Chief)	4
Inspectors (Asst.)	1
Junior Engineers	2
Machinist	1
Manufacturer	1
Master Mechanic	[illegible]
Mechanical Engineers	[illegible]
Mechanical Engineers (Asst.)	17
Operating Engineer	1
Operating Engineer (Asst.)	1
Power Engineer	1
Production Engineer	4
Professors	[illegible]
Professors (Assoc.)	2
Professors (Asst.)	6
Purchasing Engineers	1
Purchasing Engineer (Asst.)	1
Representative	2
Resident Engineer	[illegible]
Resident Engineer (Asst.)	1
Salesman (Engineers)	8
Sales Manager	1
Shop Engineer	1
Standardization	1
Superintendents	18
Superintendents (Asst.)	9
Testing Engineers	4
Works Managers	5
Works Managers (Asst.)	4
Miscellaneous	28

UNITED STATES GOVERNMENT SERVICE

Captains	2
Lieutenants	2
First Lieutenants	3
Second Lieutenants	1
Aeroplane Designer	1
Electrical Gunner, U.S.N.R.F.	1
Naval Inspector of Mach.	1
Naval Inspector, Ord.	1
Sig. Corps—Aerological Wk.	1

EMPLOYMENT BULLETIN

THE SECRETARY considers it a special obligation and pleasant duty to make the office of the Society the medium for assisting members to secure positions, by putting them in touch with special opportunities for which their training and experience qualify them, and for helping any one desiring engineering services. The Society acts only as a clearing house in these matters.

GOVERNMENT POSITIONS

Stamps should be inclosed for transmittal of applications to advertisers; non-members should accompany applications with a letter of reference or introduction from a member; such reference letter will be filed with the Society records.

Members applying in person for Government positions at such places as Navy Yards should invariably make appointments beforehand by letter, telephone or telegraph, and arrange to have passes or the equivalents so that they can gain entrance. In this way they will avoid disappointment.

TECHNICALLY TRAINED MEN AS INSTRUCTORS in Government schools for automobile mechanics and military aeronautics. Men within the draft age can be used for this work, provided they have not already been called by their Local Draft Board. 2611.

ASSISTANT RESIDENT INSPECTORS. Several recent graduates of technical schools to supervise the construction work on hulls and installation of the machinery. Salaries from $1200 to $1500. Location, New York. 2612-A

SEVERAL ENGINEERS of mature experience and with some acquaintance with the principal parts of steamships to be in office to help in directing work. Salaries range from $1500 to $3000. Location, New York. 2612-B.

DIESEL ENGINEER. Technical department of Emergency Fleet Corporation requires the service of experienced Diesel engineer who should also have knowledge of shop practice. 2613.

NUMBER OF HIGH-GRADE TECHNICAL MEN wanted for positions in industrial establishments by the United States Army Ordnance through the Civil Service, as follows:

SUPERINTENDENTS for plants engaged in chemical manufacturing processes; salaries range from $2400 to $6000. Assistant superintendents of nitrate and chemical plants, $1600 to $2400.

CHEMICAL ENGINEERS to have complete supervision over one or more chemical manufacturing processes incidental to the war. Salaries from $2400 to $6000. Some with less experience as chemical engineers to receive from $1600 to $2400.

GAS-MANUFACTURING EXPERT to receive $1600 to $2400 a year.

MECHANICAL ENGINEERS experienced in operation and control of high-pressure hydraulic and gas machinery. Salaries for junior mechanical engineers from $1600 to $2400.

POWER-HOUSE ENGINEERS for supervision of operation. Salaries from $1800 to $2400.

MACHINE SHOP FOREMEN. Salaries $1,800 to $2400 a year.

Education and experience of men will qualify them without necessity of Civil Service Examinations.

Persons of military age accepting appointment will not avoid the obligations of the Selective Service Law. No application will be accepted from employees of firms or corporations engaged in contracts for the Government or its Allies unless written assent to such application is given by the head of the establishment that might be seriously handicapped in its war work by the loss of the man.

Many positions are open. The needs of the service, the Ordnance Department announces, are so imperative that applications will be received indefinitely. Further information regarding the Army Ordnance positions that must be filled is obtainable from the Civilian Personnel Section, United States Army Ordnance, 1330 F Street, Washington, D. C.

CIVILIAN POSITIONS

EXPERIENCED COPY WRITER to handle building construction and equipment accounts; exceptional opportunity with New England agency for man who knows the contracting field and can show satisfactory evidence of ability through copy and catalogue matter already written. 0267-F.

MECHANICAL DRAFTSMAN, preferably draft-exempt, for machinery and building layouts, mill specifications, design of experimental and new machinery. Permanent position. Attractive surroundings. Location, New Hampshire. 0268-F.

YOUNG MEN for sales, productive and experimental engineering work in large electrical manufacturing firm in Middle West. Applicants must have complete high-school training and the equivalent of at least two years' technical training; preferably be technical graduates from a university of good standing. In reply state training and experience in detail, salary desired, draft classification and references. 0269-F.

POWER SUPERINTENDENT to take charge of a large power plant near New York City. In reply state nationality, age, education, experience in full, and salary expected. Location, New Jersey. 0275-F.

SUPERINTENDENT of textile machine-shop, employing 50 men; preferably a graduate of Mass. Inst. Technology. Location, New Jersey. 0276-F.

COST CLERK AND ACCOUNTANT for concern manufacturing structural steel materials and hardware specialties; familiar with modern methods of accounting, statistical work and cost keeping. Familiarity with stenography of advantage. Location, New York City. 0277-F.

DRAFTSMAN experienced in machinery, pipe layouts, etc. Salary, $40. Headquarters, New York. 0278-F.

MECHANICAL ENGINEER to increase production and development of goods. Location, Middle West. 0279-F.

ASSISTANT TO HEAD OF BALLOON DEPARTMENT. Must speak French. Competent to develop production and improvements in design. Location, Middle West. 0280-F.

EXECUTIVE, of college professor type, with personality to meet and gain confidence of customers and direct the activities of a large physical laboratory. Location, Middle West. 0281-F.

DIRECTOR OF WELFARE WORK and general plant cooperation with heads of departments and employees. Location, Middle West. 0282-F.

ASSISTANT SUPERINTENDENT in large paper-box manufacturing plant. Man with technical education preferred. Experience in manufacturing desirable. Position requires man with tact and ability to handle large amount of detail. Location, Indiana. 0284-F.

MECHANICAL ENGINEER to oversee the testing of fabrics, glue, dope, varnish, structural tests, sand-load panels, etc. Location, Buffalo. 0285-F.

MASTER MECHANIC to take entire charge of maintenance work, including machinist, millwright, carpenter, electrical and pipe-fitting work. Salary about $150 per month to start; good chance for advancement. Locality, Brooklyn. 0286-F.

STATISTICIAN to compile engineering data. Recent college graduate preferred. Salary, $25 per week. Locality, New Jersey. 0287-F.

ASSISTANT EMPLOYMENT MANAGER. Man of some mechanical training wanted. Location, Connecticut. 0288-F.

DRAFTSMEN for Connecticut plant. Men of recognized ability desired. 0289-F.

TIME-STUDY WORK for men of ability. Location, Connecticut. 0290-F.

DRAFTSMAN, designer of hoisting engines and hoisting machinery generally. American citizen. Salary $150 to $200 a month. Must be experienced and capable designer. 0291-F.

DRAFTSMAN, of good education; experienced in steam-piping work, ventilating, etc. Salary $100. 0292-F.

ASSISTANT TO GENERAL SUPERINTENDENT of Canadian plant. Chemical graduate. Previous experience in the manufacture of smokeless powder very much desired, though not absolutely necessary, or previous experience in the manufacture of powder for high explosives. Salary, $3000 to $3500. 0293-F.

MECHANICAL DRAFTSMAN of not less than two years' experience to work in engineering department of well-established and growing business, doing light structural and mechanical work. State age, nationality, education and experience, also references, accompanying reply with sample of lettering. Location, New York City. 0294-F.

DRAFTSMEN for plant layouts of machinery and equipment. Location, New York. 0296-F.

ASSISTANT ENGINEER, graduate of ability and initiative. Experience in structural steel work and supervision of construction desirable. Location, Illinois. 0295-F.

CHIEF ENGINEER for cement corporation plant aggregating 3000 hp., and comprising Corliss engines, a. c. generators, motors, etc.; plant in excellent condition. 0297-F.

FACTORY SUPERINTENDENT, 31 years of age or over, to take charge of works for factory employing about 200 men. One who has had an all-round experience and capable of handling employees. Salary at start, between $4000 and $5000. Location, New York. 0298-F.

MACHINE DESIGNER with some experience in electrical apparatus, and familiar with automatic-machine design and electrical appliances. Salary from $1800 to $2400. Location, New York State. 0299-F.

DESIGNING DRAFTSMEN, with some experience on printing-press work and shop experience. 0300-F.

DRAFTSMEN, experienced in boiler and power-plant equipment, able to check drawings. Salary depends on man. Location, New York City. 0303-F.

YOUNG TECHNICAL GRADUATE to develop as superintendent. Must be draft-exempt or above draft age and have personality to handle men. Salary $2000 to $2600. Location, New Jersey. 0304-F.

MAINTENANCE MECHANICAL ENGINEER, for plant employing 5000 men. Experience in belt transmission, electric, steam, air and gas service, plumbing, etc., and as millwright, tinsmith, electrician, etc. Salary depends on man. Location, New Jersey. 0305-F.

MECHANICAL DRAFTSMEN, conveying machinery. Young technical graduates preferred. Salary, $125. Location, New York. 0306-F.

ENGINEERS and ASSISTANT ENGINEERS in forest products. Work embraces principally investigations of mechanical and physical properties of wood in airplane construction, methods of artificial drying, etc. Salaries range from $1800 to $2400 for engineers, and from $1200 to $1500 for assistant engineers. Location, Wisconsin. 0307-F.

ASSISTANT, to take charge of design and construction of motors, etc., in shop. Personality essential factor. Technical graduate preferred. Salary, $2500. Location, New York. 0308-F.

OPERATING ENGINEER, high-grade man for light, heat and power. Location, New Jersey. Salary depends upon man. 0311-F.

SALES ENGINEER for large corporation; experience in sale of semi-Diesel fuel-oil engines. Only high-class salesman with successful record considered. 0313-F.

DRAFTSMEN, mechanical, electrical, structural, reinforced concrete. Location, Pennsylvania. 0314-F.

OFFICE ENGINEER to take charge of complete design of blast furnaces, steel plants, power plants, etc. Location, Ohio. 0315-F.

YOUNG ENGINEER, over draft age, single, to go to head office in Chile, S. A., of company operating several plants in nitrate district; should have some experience in industrial cost analysis and efficiency work, in addition to general engineering experience. Salary, $3000 a year to start. 0316-F.

PLANT ENGINEERS or HIGH-GRADE DRAFTSMEN for plant engineering work. Location, New Jersey. 0317-F.

ASSISTANT EMPLOYMENT SUPERVISOR to secure men for Government work. Salary depends on man. Must be American citizen. Location, Brooklyn. 0318-F.

ENGINEERS to travel throughout the country and get in touch with employers and

with men not engaged in war work, and to secure competent men for concerns doing Government work. Location, New York. 0319-F.

PRODUCTION ENGINEER, man with good executive ability. Location, Michigan. 0320-F.

MAN WITH MECHANICAL AND BUSINESS ABILITY, who understands sheet-iron work, capable of taking charge of a small plant. Permanent position. Location, New York. 0321-F.

DRAFTSMAN wanted for mechanical department of smelter plant producing spelter and sulphuric acid. Locality, Pennsylvania. 0323-F.

HIGH-GRADE SHOP EXECUTIVES FOR IMPORTANT WAR WORK, shop superintendents, shop foremen, master mechanic, construction engineer. 0326-F.

SALES MANAGER to organize sales force for concern manufacturing metal-sawing products. Salary, $5000. 0327-F.

EXECUTIVE FOR ENGINEERING DEPARTMENT to take charge of technical end of steam and power-pump line. Locality, Kentucky. 0328-F.

MECHANICAL DRAFTSMEN with technical education, experienced in vacuum-heating systems and high-pressure steam-piping. Location, New York City. 0329-F.

ORGANIZATION MAN to handle placing of orders and correspondence relative thereto for forgings. Position would be one of considerable importance and would require accuracy, a good knowledge of correspondence, planning, scheduling, etc. Salary, $3000. Location, Washington, D. C. 0330-F.

DRAFTSMEN in architectural lines for work on factory buildings. Location, New York. 0334-F.

YOUNG MAN, DRAFT EXEMPT, for sales department at general office of large corporation. With mechanical education, sales-department experience, preferably familiar with semi-Diesel fuel-oil engines. State education, age, experience, etc. Applications strictly confidential. Location, Michigan. 0335-F.

DRAFTSMEN with experience in conveying machinery and general engineering. Salary, $175 to $200. Location, New Jersey. 0336-F.

YOUNG ENGINEER with executive ability, and some experience, to serve as master mechanic in charge steam and electric plants and kilns, and general maintenance. Location, Michigan. 0337-F.

ENGINEERS, DESIGNERS and DRAFTSMEN wanted for work of research, development, and design related to problems of telephonic, telegraphic and radio communication which are matters of public importandce. Both temporary and permanent positions are open. Location, New York. 0338-F.

YOUNG ENGINEER to start with growing concern in drafting and miscellaneous work, estimating, superintending construction work, etc. Salary not over $1200 to start. Headquarters, New York. 0339-F.

PRODUCTION MANAGER with estimating experience in machine shop and on machine tools. Men of 30 to 40 years of age preferred. Salary, $2500 to $3000. Location, New York City. 0340-F.

TOOL MAKERS, DESIGNERS or MACHINISTS for manufacture of dies, gages, jigs and fixtures. Location, New Jersey. 0341-F.

DRAFTSMAN, on vertical triple-expansion marine engines for shop in western New York. Permanent position and excellent opportunity for the right man. 0342-F.

ENGINEER to head section interested in fuel problems connected with Government power plants, also carrying on laboratory investigations of boiler-room instruments, devices and house-heating apparatus. Man is needed to head section who has leaning toward investigation work rather than the commercial phase of engineering. Salary, $2500. 0343-F.

INVESTIGATOR in powdered-fuel work, for Government laboratories, one not interested in any commercial organization of powdered fuel industry; must be well posted and able to follow the needs of this field by laboratory investigations. Salary, $2500. 0344-F.

ENGINEERING CHEMIST, specially proficient in tests of city gas plants and the production of retort coke. Salary, $2500. Location, Illinois. 0345-F.

DRAFTSMEN. Some experience in chemical plants. Location, New York. 0346-F.

MECHANICAL DRAFTSMEN, experienced in power-transmission and machinery layouts. Work in question will probably be over two months' duration and good salaries will be paid competent men with traveling expenses from New York to West Virginia and return, and living quarters. 0347-F.

FACTORY SUPERINTENDENT. Prominent corporation, manufacturing light product of large variety, part stock, part special to order, requires aggressive, energetic factory superintendent, thoroughly experienced in machine-shop practice and modern centralized planning control methods, capable of securing large production efficiently and economically. To be considered, replies must fully state experience and qualifications. 0348-F.

MAINTENANCE ENGINEER for machine shops and foundry of growing plant in Providence. Technical graduate preferred. 0349-F.

YOUNG CONSULTING ENGINEER, to act as personal understudy to consulting engineer. Man who has mechanical-engineering ability combined with all the knowledge of economics and statistics possible. Prefer men three years out of college, exempt from draft. Unusual opportunity through the educational features of the work. 0351-F.

MECHANICAL DRAFTSMEN. Men familiar with large power-station work. Immediate work in hand is the installation of a 20 000 kw. turbo-generator with the necessary condensing apparatus, boilers, stokers, coal and ash-handling apparatus, etc. Salary $150 per month. 0352-F.

MACHINE DESIGNERS on fixtures, jigs, etc. Flat salary of $35 and opportunities at high rates by the hour. Location, Connecticut. 0363-F.

LABORATORY INSTRUCTOR for large New York City University, one capable of taking charge. Work covers the entire range, with the exception of materials testing, and includes hydraulics. 0354-F.

SALES ENGINEER, one energetic and willing to work. Must be a thinker. Engineering college degree with some experience in shop work and machine design, or a high-school education with two or three years' shop work and machine design. Must be between 25 and 32 and draft exempt, or in class 4. Salary, $1500 to $1800. Location, New Jersey as headquarters. 0355-F.

MEN AVAILABLE

Only members of the Society are listed in the published notices in this section. Copy for notices should be in hand by the 12th of the month, and the form of notice should be such that the initial words indicate the classification. Notices are not repeated in consecutive issues.

MECHANICAL AND EFFICIENCY ENGINEER, Member, age 37, married; 16 years' wide experience in mechanical and electrical engineering, seven years of which was as directing engineer with large professional efficiency engineering company. Reason for changing is that present position does not permit of future advancement. Desires position of executive nature with progressive concern where ability will be recognized and responsibilities increased proportionally. Only permanent connection will be considered. F-146

GENERAL MANAGER of light and power company, for past seven years in responsible position in steam-driven electric and ice-making plant, desires similar position with company having larger field. American born, 39 years of age; high-class reference; well versed in plant upkeep and operation. F-147.

MECHANICAL-ELECTRICAL ENGINEER, technical graduate 1904, now employed as mechanical engineer and superintendent of two modern turbine steam plants and gas plant, desires to make connection with progressive public utiity or industrial plant where ability, integrity, and reliability will be appreciated. Experienced in handling men, in design, construction and maintenance of high and low-voltage stations, steam plants, piping, machinery, buildings and various kinds of steam and electrical equipments. Unusual business and technical training. Speaks French fluently. Best references. Location preferred, Eastern States. Salary, $3000 per year. F-148.

MECHANICAL ENGINEER, M. E. graduate, age 32, not in draft, married; eight years' experience in design and manufacture of automobiles, motor trucks, spark plugs, production tools, small punch and die work, inspection gages, and a large variety of small and medium sized special and semi-automatic machinery. Two years in executive position. Thorough and systematic. General knowledge of accounting principles and efficiency work. Salary secondary to opportunities and surroundings. At present employed. F-149.

SALES ENGINEER, electrical-mechanical, technically trained, age 35; speaks Spanish and Portuguese fluently, and has good knowledge of Italian and French. At present employed, but desires to change to larger possibilities. F-150.

GENERAL SUPERINTENDENT, mechanically and technically trained, thoroughly conversant with modern methods of produc-

[illegible] company [illegible] Has [illegible] of typewriter, adding [illegible] speedometer [illegible] installation [illegible] control of large scale pro[illegible] Salary, $5000. F-151.

METALLURGICAL ENGINEER. Junior member and technical graduate, age 27, single, draft-exempt, desires position as assistant executive in production or control work. Has had broad experience covering foundry, machine shop, cost, drafting, efficiency and construction work. Has specialized in metallography, electrometallurgy and pyrometry. Salary will depend on future possibilities. F-152.

GENERAL SUPERINTENDENT OR SUPERINTENDENT. Associate-member, diplomatic and forceful executive, accustomed to supervising from one hundred to one thousand employees. Fifteen years' general mechanical experience. F-153.

MECHANICAL ENGINEER, age 35, technical graduate with thirteen years' experience in the design and manufacture of railway supplies, and as factory engineer designing and supervising the installation of mechanical equipment of all kinds in modern manufacturing plant, desires position as works engineer or assistant in manufacturing plant or as mechanical engineer, with engineering firm designing and installing industrial plants. Salary, $2700 to $3000. Location, Chicago or vicinity preferred. F-154.

ELECTRICAL AND MECHANICAL ENGINEER, married, nine years' experience on power-station operation and construction work. Has been in charge of large hydroelectric stations, high-voltage transmission system and sub-stations. Desires executive position with large power or holding company. F-155.

ASSISTANT ENGINEER. Junior member, technical graduate 1914, age 25, married, in Class IV of draft in present position since graduation, thorough drafting and engineering experience, desires position of responsibility in small to medium-sized industrial plant preferably in New England, manufacturing standardized product. F-156.

MECHANICAL ENGINEER desires to associate with consultant or industrial firm as expert on tools and production methods. Available for two or three days a week only, as balance of time is being devoted to development and manufacture of standard shop appliances for munitions plants. Location, Philadelphia. F-157.

EXECUTIVE. Junior member, graduate of Massachusetts Institute of Technology, 35 years of age, ten years' continuous service with present concern, advancing from draftsman to superintendent, desires opportunity for larger service. Experienced in shop management, embracing tool and machine design, stock and toolroom organization, planning and routing work, handling men and producing, shop accounting, and modern methods of payment. A student of, and believer in, scientific management, and anxious to develop along such lines. Minimum salary, $4500. Available after two weeks' notice. F-158.

PRODUCTION MANAGER OR WORKS MANAGER. Member graduate mechanical engineer, several years' experience in the manufacture of transmission and special machinery, and especially familiar with the planning and organizing of plants for intensive production of duplicate parts. Now doing Government work but will be available about June 15. Best of references. F-159.

MECHANICAL ENGINEER with executive ability. Technical graduate, 13 years' experience in the design, construction and operation of power plants and general manufacturing machinery. Well experienced in the production and application of electricity in manufacturing plants. Specializes in operation of plants and manufacturing equipment including the economical combustion of fuel. F-160.

EXPERIMENTAL ENGINEER, technical graduate, five years' designing experience; at present experimental engineer with large manufacturing concern. Munition work preferred. F-161.

SUPERINTENDENT OR PRODUCTION MANAGER. Member, technical graduate, age 36, strong disciplinarian and successful handler of men; well up on efficiency, rate setting, cost accounting and modern shop management, desires new connections with company operating a foundry or machine shop or both. Present salary, $4000 per year. F-162.

WORKS MANAGER, at present employed by large concern in charge of factory. Experienced in manufacture of machinery and details of factory management, also power-plant operation. Energetic, good personality and best of reference covering more than 15 years with present employers. Technical education. Age 47. Desires change to increase possibilities. Prefers location near New York. F-163.

MECHANICAL ENGINEER. Member, American, age 36, technical education, married. Expert designer of complex appliances and special machinery; 16 years' practical experience in modern drafting-room methods, shop practices, manufacture, erection and tests. Desires position as engineer, head of drafting department or similar position of responsibility. Detailed information on request. F-164.

MECHANICAL ENGINEER AND EXECUTIVE with 12 years' experience in drafting, elevator and power-plant construction, manufacturing and sales work, desires new connections with a growing concern requiring the services of an executive with initiative and aggressiveness. Location no object. Minimum salary, $2300. F-165.

EXECUTIVE. Graduate mechanical engineer, American, with unusually broad business and engineering experience in this country and in Europe. Can handle men and coordinate work of different departments. Particularly successful in adjusting contract disputes in matters involving expert technical knowledge. Acquainted with modern production methods, and understands principles of accounting. Writes clear, forcible English. Can fill acceptably any responsible position in a manufacturing establishment. Would make exceptionally good assistant to chief executive of very large and complicated business. Worth an interview at least. F-166.

MECHANICAL ENGINEER, married, specialized in power-plant equipment, design and testing of marine apparatus; also condensers and spray-cooling systems. Had charge of sales office. F-167.

ASSISTANT TO EXECUTIVE. Age 33, technical graduate of Yale. Eleven years' experience along several lines of manufacture. Has held positions of draftsman, assistant engineer, surveyor, engineer in charge of improvements and reconstruction, plant manager and assistant to president. Good knowledge of industrial equipment and purchasing; competent to assume responsibility and handle detail work as well as correspondence as an executive. Interested worker. Desires to locate with growing company offering executive future and permanent position. At present engaged. East or Middle West. F-168.

MECHANICAL ENGINEER. Industrial and power-plant experience. Desires responsible position. F-169.

MECHANICAL ENGINEER. Member, American, age 48, experienced in mill designing and operating, hydraulic power development and water storage, now employed, desires change. Capable manager and executive officer. F-170.

MECHANICAL ELECTRICAL ENGINEER, Columbia graduate, sales manager or superintendent. At present employed as manager of a very large concern. Experience in internal-combustion engines, gas producers, power installations, foundry and machine-shop practice and marine power plants. Unusual business and technical training. Fully conversant with French, Italian and Spanish. Minimum salary to start, $4,000. F-171.

MECHANICAL ENGINEER, member, graduate, experienced in small parts manufacture and now engaged as production engineer on Government work, desires executive position in similar lines. Available in 30 days. F-172.

EXECUTIVE, MECHANICAL, and CHEMICAL ENGINEER, 39 years of age, married. Technical graduate, two years' experience abroad and 12 years in U. S. Designing, erecting and operating, cement plants, chemical plants and glass work with labor-saving machinery. Can control analytical work on raw materials and finished products such as cement and glass. Able to handle tactfully executives and employees. Employed but desires responsible permanent position in a northern state. Minimum salary $3,000. F-173.

MECHANICAL ENGINEER. American, with experience on Diesel and steam engines, also boilers, tanks and stacks. At present assistant chief draftsman with a company building oil engines. Desires executive position with a company who could use man with above experience. F-174.

MECHANICAL ENGINEER, member, age 34, technical graduate with 12 years' experience covering steam-power plant design, heating and ventilation, general test and efficiency work, machine design, construction, estimating. Can work into several lines on account of broad knowledge and thorough technical ability to develop new lines of work. At present employed in capacity of consulting engineer for large oil refinery nearing completion. F-175.

CHIEF INSPECTOR, thoroughly familiar with airplane engine manufacture and testing. Technical graduate, age 38, member S.A.E. and junior member A.S.M.E. since 1906. Experienced in shop, office and sales methods gained in the engineering departments of shipyards, as assistant superintendent of a manufacturing plant, and sales manager of a machinery house in New York. Location, Middle West or Pacific Coast. Available at once. F-176.

ENGINEERING SURVEY

A Review of Engineering Progress and Attainment in Mechanical Engineering and Related Fields, Including a Digest of Current Technical Periodicals and Selected Titles of Engineering Articles

National Foreign Trade Convention

THE fifth convention of the National Foreign Trade Council was held in Cincinnati, Ohio, on April 18, 19 and 20. Delegates to the number of about twelve hundred gathered there, representing a large number of manufacturers, exporters, shippers, banks, the Government, chambers of commerce, and various organizations. Mr. E. A. Muller, of Cincinnati, was appointed by President Main to represent The American Society of Mechanical Engineers.

Possibilities of the Webb-Pomerene Bill

In an address during the meeting Edwin M. Herr, Mem. Am. Soc. M. E., president of the Westinghouse Electric & Mfg. Co., spoke of the importance of coöperation in export trade. He said that we are facing as serious and critical a situation in our foreign trade, especially our foreign trade in manufactured products, as the nation faced at the sinking of the *Lusitania*, and are doing almost as little toward real preparation for the proper development of this trade as did we as a nation in preparation for the terrible war in which we are now engaged. A step of great importance to exporters is the passage of the long-delayed Webb-Pomerene bill, which legalizes combinations for export trade and permits manufacturers of a given district to organize and to work in coöperation in order to meet the far-reaching plans of our competitors in foreign fields.

Treating this same subject was a paper by George H. Charls, of the American Rolling Mill Co., presenting a plan for coöperation under the provisions of the Webb-Pomerene bill. This involved the organization of a company with a business management that would exert every effort to secure the coöperation of schools and colleges in introducing practical export trade studies, and in teaching the languages most useful in the fields of American foreign-trade enterprise. This company would adopt well-established selling methods for its organization, which would comprise the compilation of addresses of American representatives in foreign fields, lists of foreign houses, the securing of data and price quotations from the various manufacturers, the establishment of individual departments to handle the sale of different products and organizations, of a clearing house on credits, shipping rates, etc.

Magnitude of the Country's Industries

E. A. S. Clarke, of the Lackawanna Steel Company, quoted figures showing the remarkable increase in iron and steel output in 1916 over 1915, over $33\frac{1}{3}$ per cent. The plate-making capacity of the country has been nearly doubled, standing now at about 6,000,000 tons per year, the equivalent of 18,000,000 dead-weight tons of ships, with approximately 1,000,000 tons of additional capacity under construction which, it is thought, will be in operation before the end of the year.

Other speakers referred to marked increase in production in other fields.

The production of the American potash industry has increased from an annual output of 970 tons to 42,000 tons a year in the short space of two years.

The amount of both the crude and refined oil produced has been enormously increased during the last year. The extent of the war demand for these supplies is indicated by the fact that in 1913 exports of gasoline to our allies totaled 29,000,000 gal. and in 1917 they amounted to 300,000,000 gal. Lubricating oil shows similar increase of export, the total of 103,000,000 gal. in 1913 mounting to 200,000,000 gal. in 1917. Naphtha and gasoline export records show the total of 1913 to have been 188,000,000 against some 400,000,000 gal. in 1917.

It is estimated that there are 300,000 automobiles in use by the armies on all fronts. Of these our allies have bought 45,308 from America during the last three years compared with only 410 in the two years preceding the war. Last year American export trade in automobiles exceeded \$88,000,000 for 65,792 passenger cars and 14,347 trucks—most of the latter going to the countries at war. The United States Army has bought and ordered some thirty thousand motor trucks, and requirements are in sight for from ten to fifteen thousand more.

In a paper on The Influence of the Demobilization of War Industries upon World Commerce by Charles M. Muchnic, vice-president of the American Locomotive Sales Corporation, some indication of the magnitude of our war industries is obtained:

On April 6, 1918, our ordnance program included the purchase of 23,000,000 hand grenades, 725,000 automatic pistols, 250,000 revolvers, 23,000,000 projectiles for heavy artillery, 427,246,000 lb. of explosives, 240,000 machine guns and 2,484,000 rifles.

When war was declared, 123 naval vessels were building or authorized; contracts have been placed since for 949 vessels.

In February the Director-General of Military Railways placed orders for supplies valued at \$142,000,000 and with an aggregate weight of 754,000 long tons; the General Engineer Depot to February 1 issued 9500 orders for material valued at \$202,000,000.

Emphasizing more particularly the need for educational preparation for foreign service, Glen L. Swiggett, of the United States Bureau of Education, presented an extremely valuable paper in which he not only outlined the requirements of preparatory courses for service in foreign trade and suggested a curriculum, but summarized the courses which are now offered by schools and colleges throughout the country according to cities and states.

Cotton Convention and Exposition

An important happening during the first week in May in New York City was the convention of the National Association of Cotton Manufacturers and the American Cotton Manufacturers' Association. At the same time an exposition was held at the Grand Central Palace.

The subjects discussed covered an unusually wide range, being devoted to matters in the field of finance, economics,

home and [illegible] trade as well as technical matters in the broad meaning of the word.

One of the most interesting meetings was devoted to a group discussion of research as an aid to industrial efficiency.

Dr. George E. Hale spoke of the work of the National Research Council, Dr. Edward R. Wardlem, of the Mellon Institute of Pittsburgh, on Science and Industry, while Dr. C. E. K. Mees presented a paper on Planning the Research Laboratory for an Industry.

The dye exhibits at the Sixth National Show were a striking proof of the adaptability of American industry to new conditions. Less than four years ago this country relied practically exclusively on importations from Germany for its dyes. Now, domestic needs are not only fully covered but a comfortable export trade in dyes is being built up.

Probably the most difficult problem which has confronted American dye makers has been the development of a supply of intermediates. The coal-tar industry was in such a crude state in this country that when war cut off foreign supplies the country lacked not only the dyes themselves but also the materials from which they are directly produced.

Now practically all of the principal dye makers are also producing intermediates, some on a very large scale. This growth of the production of intermediates has been materially assisted by direct war demands, as several of these intermediates are first by-products or produced from by-products of munitions manufacture. On the other hand, however, war demands have absorbed some of the raw materials of dye manufacture to such an extent as to cripple the production of the dyes. This is especially true of the toluine group of colors, hampered by the fact that the entire production of toluol is absorbed by the more important high-explosives production.

The greatest lesson of the show was, however, in indicating the great possibilities of peace production in America under conditions which may be expected after the termination of the war, provided, of course, the industry is not then hampered by outside interferences.

United States Railroad Equipment Standardization

The United States Railroad Administration has announced the placing of orders for 100,000 freight cars to be built to its standard specifications, and 1025 locomotives, also of its standard types.

The statement issued regarding the locomotives is as follows: "The six standard types of locomotives, two sizes of each class, are expected eventually to supersede the many miscellaneous types and varieties of locomotives now in service, embracing engines built according to five hundred or more varying specifications. This is the first time that any real forward step has been taken looking to the wide standardization of locomotive engines."

A somewhat similar announcement was made with respect to the car orders, saying, among other things, that "the adoption of these standard types, it is believed, will eventually substitute a few scientifically worked-out designs for the numerous miscellaneous varieties of the cars representing probably more than a thousand different old styles and specifications now in use, the accumulation of the past."

The policy has been received not without criticism on the part of the technical press. Thus, the *Railway Age* (May 10, 1918) points out that the adoption of these standards has not been made for the purpose of saving time, but indicates definite tendencies to standardize thoroughly the entire motive power and car equipment of the railroads.

The tentative specifications of the standard locomotive were published in the *Railway Age Gazette* for April 19, 1918.

In the main, it appears to have been the desire of the committee designing the locomotives to provide types which will best meet average conditions.

The locomotives are all designed to traverse 19-deg. curves and grades of 2 per cent. The clearance limitations are practically alike, the overall height being 15 ft., with the exception of the heavy Santa Fe and the 2-8-8-2 Mallet, which have height clearance of 15 ft. 9 in. The width of cylinders is also the same for all designs, with the same exceptions as above.

The freight locomotives of the Mikado, Santa Fe and Mallet types cover fairly well the range of tractive efforts for that kind of service, comprising six types from 54,600 lb. to 106,000 lb., and, in addition, the boiler factors of the heavy Mikado and two Santa Fe-type locomotives are sufficiently high to permit increased tractive effort by increasing the boiler pressure.

Fear has been expressed that there may be difficulties, particularly around terminals at low bridges, also on some tunnels. Thus the Hoosac tunnel of the Boston & Maine has a height clearance of 14 ft. 8 in., which will prevent any of the standard locomotives passing through the tunnel.

The tentative specifications for the standard steel-sheathed box car have been published in *Railway Age* for April 12, 1918. In its basic features it is the same as other standard box cars, and is to be carried on the standard 50-ton truck.

The most interesting details refer, of course, to the superstructure. In this respect the designs called for an 1/8-in. steel sheathing with a 13/16-in. lining at the sides and ends, and a steel roof of 3/32-in. plates. As regards the side framing, it comprises six pressed-steel posts on each side of the car made from 1/4-in. plates. These are 18-in. wide and 3 1/2-in. deep. In addition to these there are eight 3-in. x 3 1/2-in. wooden side posts to which is nailed the inside lining. The end posts for the plain end construction are pressed from 1/4-in. plate and are 7 3/4 in. wide by 3 3/4 in. deep. The corner posts are of wood. The side plates are 4-in., 10.3-lb. Z-bars, to which are riveted the side sheathing and the roof sheets.

Two designs of roof are permitted.

The tentative specifications for the general type of United States standard cars are published in the *Railway Age* for March 29 and April 5. These cover seven types of bodies for box, hopper and gondola cars and three types of trucks. They are quite extensive and cannot be reproduced here because of lack of space.

War Department Bureau Created to Pass Upon Plans of Inventors

The following statement is authorized by the War Department:

In order to secure prompt and thorough investigation of inventions submitted to the War Department, an "Inventions Section" has been created as an agency within the General Staff. All inventions of a mechanical, electrical, or chemical nature submitted to the War Department for inspection, test, or sale are now considered by this section.

Inventions may be sent by mail or may be submitted in person, accompanied by written descriptions or drawings. They go first to an examining board having technical knowledge of the classes of inventions they handle, whose investigations determine whether the inventions have merit. Those with merit are referred to the Advisory Board, which determines in

each case whether it should be put in the hands of some of the numerous testing and developing agencies, or if it should go to one of the staff or supply departments for test and consideration of its adoption, and final acquirement of title if such action is desirable.

When completed the board will have twelve to fifteen members to cover fully all of the various technical problems which may come before it.

Any persons desiring to submit an invention for consideration, test, sale, or development should do so by letter, giving in order the following information: Name and object of the invention; any claim for superiority or novelty; any results obtained by actual experiment; whether the invention is patented; whether remuneration is expected; whether the invention has been before any other agency; whether the writer is owner or agent; the number of inclosures with the letter. A written description and sketches or drawings of sufficient detail to afford a full understanding of the cases should also be submitted. Should the invention be an explosive or other chemical combination, the ingredients and processes of mixture should be stated.

The Inventions Section will not bear the expense of preparation of drawings and descriptions, nor advance funds for personal or traveling expenses of inventors.

Any matter submitted will be treated as confidential. The inventor will be notified of each step taken during the investigation of his invention. All communications should be addressed: Inventions Section, General Staff, Army War College, Washington, D. C. (*Official Bulletin*, May 13, 1918, p. 3)

Testing the Relative Strengths of Riveted and Welded Parts of a Ship's Hull

The purposes and possible benefits of the ship-welding test being conducted by the Emergency Fleet Corporation at the Central Shipbuilding plant, at Newark, N. J., under the direction of Arthur J. Mason, are outlined in a report made to Charles Piez, vice-president of the corporation, by Mr. Mason. The report follows:

The committee of which Prof. C. A. Adams is chairman has been enlarged, as instructed, and is active in bringing to bear all the knowledge and apparatus available, about which, no doubt, reports will come to you directly from time to time. I am a member of that committee and continue in active touch with it and rely on it for technical knowledge.

Electric welding in its various phases has for years been employed in shipyards and in the arts generally, but for a number of reasons the work has been confined to odd jobs and repairs. The proposal to extend its use to the major part of ship construction has met with gratifying approval from the shipbuilder. It remains for us through this large test to demonstrate its economy in time and money and its adequacy to build a stanch ship.

The purpose of this test is to demonstrate these advantages, to do it in such a way that all may see and contribute, and finally to test the structure itself so completely that there will follow a heart-whole and unanimous belief in the method.

The test itself will take the form of building part of a hull at the Federal Shipbuilding plant, Newark, N. J.

It has been necessary to design a ship to suit the material available, without encroaching on that needed for the regular ship construction at the plant. This has been done. The hull will have the outline, dimensions and strength conforming to the ships the Federal company is building.

It has been thought best to conduct the work at a site apart from the shipways, so as not to interfere with that program.

A 10,000-ton ship, costing $2,000,000, now costs but $70,000 to rivet. It must be plain that if electric welding only promises to modify this amount, no very substantial gain offers.

Splendid benefits we all feel do offer themselves in the possible change in the whole régime of shipbuilding. Our test has in view abolishing, or greatly diminishing—

1 The railroad journey from rolling mill to fabricating plant, when the latter is not at the shipyard
2 The template-makers' work
3 The markers' work
4 The punching
5 Much of the work of the fitters and bolters, who flog and pull the pieces to fit on the ways.

There lies in the above items an excellent likelihood to save a month's time in construction and a saving of no less than $40 a ton in the cost of steel structure, at least $100,000 a hull on a 10,000-ton vessel.

Briefly the program is to assemble a hull rapidly by spot welding, tacking the ship together much as a tailor bastes his work in assembling a suit of clothes. The structure then becomes a house favorable for work in all weather and at night in which the completion of the ship may go on.

After the material is thus assembled and fastened with spot welds so that it is sufficiently strong to hold its shape, the work is completed by arc-welding all seams to insure strength and render the work watertight. Roughly we expect the spot welds to be about ten inches apart.

The severe tests of strength contemplated needed about 300 piles.

One-quarter of the structure will be riveted; the other three-fourths welded so that the tests of strength will afford a basis of comparison.

Electric welding offers a great field for lightening a ship. In this design various views of this opportunity will be tried out. The field here is very great—ultimately ten per cent of the steel may be eliminated.

Only a fifth of the men on a hull are riveters. The spot-weld yoke will forthwith pull the parts to place with much more vigorous agency than flogging and pulling to place by numerous bolts, now done by the other four-fifths.

The problems of fitting in place the parts of a hull are almost wholly problems arising out of the necessity to make a number of little holes in a plate made by one man at one time and place fit a number of little holes made by another man at another time and another place.

Once all holes are left out of the material, all parts fit. The creeping and kindred problems so perplexing to the shipbuilder disappear. Every plate becomes a closer. Every plate justifies itself.

An adequate system of testing the work when done is under consideration.

The primary test will consist of filling the hull with water and shifting the points of support under continual and close scrutiny, as one-quarter of the whole will be riveted in the normal manner. There will be always a gage of comparison with that portion which is welded. Likewise there will be a chance for comparison of the two forms when subjected to abuse, by bumping with rams and in various other ways. (*Emergency Fleet News*, April 29, 1918, p. 11)

Interest in Use of Steam Meters in England

Shortly after the inauguration of the Government department of scientific and industrial research (about 18 months ago) it was decided to form a society, to be called The Brad-

[illegible] Research to [illegible] mechanical and electrical engineers in the [illegible] largely became subscribers. A committee of representatives of these firms was formed, with Mr. Frank Wigglesworth, of Messrs. Frank Wigglesworth & Co. (Ltd.), engineers, [illegible] Wood, Shipley, as honorable secretary. From a number of subjects submitted for inquiry the first one selected was Flow of Steam in Pipes, with Special Reference to Steam Meters. The Government advisory council was approached with a request for assistance in the form of a grant, and several interviews have taken place with the authorities in London, whose sanction to the project has been given on the understanding that half of the cost of the research will be subscribed locally.

The need for a reliable steam meter is very great, especially where steam is used for heating and boiling, as in dye works, bleaching works, chemical works, soap works, paper mills, etc. It is well known that a large proportion of the steam is wasted in ways which cannot easily be detected, and which have come to be regarded as inevitable. A reasonably accurate steam meter would help materially to reduce these losses. During the last ten years several forms of meter have been brought out, and have met with more or less success. They are all, however, of American or German origin, and hitherto nothing has been done in Great Britain either in the way of research or in the manufacture of an instrument of British origin. The foregoing is from the *Yorkshire Observer* of April 5, 1918, in regard to a report to be issued by the Bradford Association for Engineering Research, on the Flow of Steam in Pipes, with Special Reference to Steam Meters. (*Commercial Reports*, no. 100, April 29, 1918, p. 389)

Pitch as a Steam-Boiler Fuel

Pitch is composed chiefly of free carbon and of hydrocarbons which become volatile on heating above 400 deg. cent. Under correct conditions it can be burned completely to carbon dioxide and water vapor. The elementary analysis of pitch shows it to contain from 90 to 94 per cent of carbon and from 4 to 4½ per cent of hydrogen. The "approximate" analysis, however, gives a better indication of its composition and of difficulties that may be expected when burning it upon a commercial scale, for when it is raised to a red heat in a platinum crucible two-thirds of it passes off as volatile matter, and only one third remains behind in the crucible in the form of pitch coke. When tested in the bomb type of calorimeter pitch shows a calorific value of 15,600 B.t.u. gross or 15,000 B.t.u. net; that is, it possesses a heat value equal to that of the best Welsh steam coal. If supplied with sufficient oxygen and raised to a temperature sufficiently high to secure complete combustion it is therefore a valuable fuel, and the problem of its efficient utilization under steam boilers resolves itself into one of providing the necessary conditions inside the boiler furnace.

Two difficulties are met with when burning pitch under industrial conditions in ordinary grates and furnaces, both due to certain physical characteristics of the fuel. In the first place, it softens at a comparatively low temperature and passes into the semi-fluid state by almost imperceptible stages. In the second, the hydrocarbon gases which form two-thirds of the weight of the fuel when heated come off with great rapidity when once the molten pitch has attained the temperature necessary for gasification. At a moment, therefore, when a great increase in the air supply is necessary, the molten pitch is flowing into the air spaces between the firebars of the furnace, and is closing these, with disastrous results for the proper combustion of the evolved gases.

As regards trials of pitch for steam-raising purposes carried out in London, the fuel expert of the London Coke Committee, Mr. E. W. L. Nicol, soon after the outbreak of the war began to experiment with this use of pitch, since it was seen that if a mixture of coke and pitch could be burned with a fair measure of efficiency under boilers, a better market would be created for these two by-products of the gas-making and tar-distilling industries, and incidentally the demand for ordinary coal would be reduced. A special type of firebar was designed by Mr. Nicol for the purpose, its chief feature being that it contained a channeled passage leading to a spoon-shaped trough, in which the molten pitch collected and remained while the volatile gases were distilled. Steam jets were employed with this bar in order to supply the heated air necessary to mix with and consume the large volumes of hydrocarbon gas produced as the solid pitch fed on the flat and cooler end of the bar melted and flowed down into the cavity at the center, where the heat of the surrounding incandescent fuel gasified it. These "pitch bars" could be sandwiched, in any number required, between the ordinary bars of the furnace grate, the latter being removed to make place for them. The pitch coke that collected in the center trough of the bars, after the gases were distilled, was cleared out from time to time and burned at the rear of the furnace on ordinary firebars. The trials of these special pitch bars were suspended in 1917 owing to the increase in the price of pitch in London, but so far as they went they proved that pitch can be burned with coke in this way without excessive nuisance from smoke.

Among new forms of "atomizer" for very thick and viscous liquid fuels, patent No. 101444 of 1916, granted to H. Bolling, of Christiania, describes a method of melting the pitch by aid of superheated steam, while German patent No. 300301 of 1916, granted to H. Sieger, describes a more complicated form of gas-heated vaporizer for liquid fuels, in which the principle of flameless combustion is employed to gasify the fuel before it is injected into the combustion chamber of the furnace or boiler. Another German patent, No. 299864 of 1915, makes use of an electric resistance coil for preheating, and of a pilot jet of light oil for ignition purposes. All these devices, of course with some modification, might be applied to the atomization of pitch, and lest it be thought that only foreign engineers are devoting their attention to the problem, it may be stated that English inventors are already at work upon it, and that very shortly an English design of liquid fuel burner for use with pitch will be placed upon the market. (*The Times Engineering Supplement*, no. 522, April 26, 1918, p. 84)

Products Derived From Corn Cobs

In a paper read before the New York section of the American Chemical Association at its regular meeting last Friday night, Dr. F. B. LaForge of the Bureau of Chemistry said that with the American corn crop estimated at 3,000,000,000 bu., which means probably about the same amount of corn cobs now going to waste, the United States Bureau of Chemistry has discovered practical and probably commercial methods whereby 37½ per cent of their substance can be converted into glucose, 30 per cent into usable mucilage, and 5 per cent into xylose, in addition to much new baking-powder material and a large quantity of acetic acid, with probably other valuable by-products yet to be discovered.

According to Dr. LaForge, there are four principal materials which may be prepared successfully from corn cobs;

about 30 per cent of a gum resembling dextrine but composed largely of polymerized xylose, instead of glucose, as in the case of dextrine. This material should be useful as an adhesive in the paper-box industry, for bill posting, wall papering, labeling, etc. It would be extremely cheap, and as far as its sticking qualities are concerned, it is probably about the equal of the dextrine preparations now commonly used. Its use would make possible an enormous saving of the foodstuffs now used in making dextrine and other starch preparations.

From 5 to 6 per cent of the pentose sugar xylose is another product. This sugar has been up to now a comparatively rare substance, but one and possibly two uses for it have been tried out or are being worked out and will be described later.

Acetic acid is obtained in the preparation of xylose in amounts which, at its present price, would be a very great source of profit in working up large amounts of cobs and at all times would be an important by-product. (*Journal of Commerce*, May 13, 1918, pp. 15 and 17)

Rochester Plan for Supplying Shipyard Labor

As the result of a conference between the Merchants' Association and representatives of the New York shipyards, the idea underlying the "Rochester Plan" for supplying shipyard labor may be adopted in New York. The essential feature of this plan is a central employment bureau created and operated by all the important Rochester, N. Y., industries, through which they secure all their labor. The central bureau becomes a labor-recruiting organization for all Rochester factories and endeavors to prevent other cities from inducing Rochester workmen to leave Rochester. It guarantees that the most essential Rochester plants will be furnished with the necessary skilled workmen even if that necessitates a voluntary draft on other factories, and it seeks to make labor conditions in Rochester plants such that the workmen will be properly treated, satisfied and efficient. In other words, Rochester has endeavored to place the entire community squarely behind the plants working on war orders.

It was the opinion of most of those present at the conference that the "Rochester Plan" is essentially a community plan which could not be adopted successfully in a large and complex metropolitan district, but that the underlying idea of the plan, namely, that of centralized effort to increase the shipyard labor force and to adapt mechanics to shipyard work, is possible and desirable.

In essence the "Rochester Plan" consists of a coöperative employment bureau organized, financed and operated by the important industrial plants of the city, and in charge of a very high-grade man having extensive experience in industrial-employment problems. The chief function of this employment agency of the manufacturers is to obtain a sufficient number of workmen to meet the requirements of all factories of the city. All additional workmen of plants operating under this agency are secured through it. In obtaining labor, the principle is followed that the demands of plants working on Government war supplies must be met first, even if this means taking skilled men from those less-essential plants supporting the Central Employment Bureau. In fact, there has already been a voluntary industrial draft to obtain certain skilled workmen needed by the plants operated for the Government.

The Central Employment Bureau has not displaced the regular employment agencies, but works through them as much as possible. It also seeks to bring workmen to Rochester from communities where a supply of skilled labor is available. In doing this it represents industrial Rochester rather than individual plants. It does not stop at merely bringing the workmen to the city, but it distributes them to the various plants according to their needs and to the type of workmen, aids in getting the workmen properly housed in a district near the plants, and in general endeavors to make the workmen contented and satisfied with Rochester.

So called "stealing the labor" is eliminated. However, it is realized that much of the additional labor needed by the war industries of Rochester is already there and must be shifted from less-essential plants. The Central Employment Bureau has proved to be a valuable agency for transferring labor from industry to industry. The industry which must lose its labor to some extent to more essential plants is aided in diluting its remaining labor and thus in continuing efficient production, while at the same time it is protected from losing a proportion of its labor force so large that it becomes impossible to dilute the remainder successfully. On the other hand, through the Central Employment Bureau the essential plants are constantly studying the problems of training inexperienced workmen and diluting their own skilled force so as to expand production with the least possible harm to the other industries of the city. (*Journal of Commerce*, May 3, 1918, p. 3)

Pig-Iron Interests Form Association

The production of pig iron is so far short of the heavy demand for it that preference has had to be given in making allotments to certain concerns holding urgent Government contracts. There has also been some controversy as to what constitutes the base price for determining the differentials, and there has also been considerable controversy between the trade and the War Industries Board on the subject of the right of sellers to collect commissions from consumers.

To enable these differences to be brought to the attention of the Washington authorities in a representative and official way, and to arrive at a settlement of all such questions as may arise between the Government and the trade, an organization known as the Merchant Pig Iron Distributers' Association has been organized at a conference held in Philadelphia.

The president of the new association is W. S. Pilling, of Philadelphia, and the secretary is W. W. Hearne, of the same city. The membership is not yet complete, but it will include all representatives of all the leading distributers of pig iron in the United States. It has been felt by members of the industry that they should be entitled to greater consideration when matters of vital importance to the trade were decided at Washington. (*Journal of Commerce*, April 23, 1918, p. 3)

The spring meeting of the National Machine Tool Builders' Association was held at Atlantic City, May 16 and 17. The meeting was devoted mainly to subjects relating to the war, the leading feature being an address by Isaac F. Marcosson, war correspondent of the *Saturday Evening Post*, on the Business of War. Addresses more technical in nature were given by H. W. Dunbar, of the Norton Grinding Company, on Safety Devices on Machine Tools, by H. E. Miles, on Women in Industry, and one by George Merryweather, relating to work of the Machine Tool Section of the War Industries Board.

Of the business transacted, the most important dealt with the production of heavy machine tools such as required for the work of the Ordnance Department, both with regard to the design of the machines and the apportionment of the tools in a way to secure the maximum production necessary to meet the present emergency of the Government.

U. S. BUREAU OF STANDARDS

COMPARATIVE TESTS OF CHEMICAL GLASSWARE, Percy H. Walker and F. W. Smither. Beakers of Kavalier glass, and beakers and flasks of Macbeth Evans Glass Co., Pyrex, Jena, Nonsol, Fry and Libbey glasses were tested for chemical composition, coefficient of expansion, refractive index, strain, behavior on repeated evaporation, resistance to heat and mechanical shock, and to solution in a variety of chemical reagents.

No conclusions as to the relative values of the different wares can be drawn from the chemical analyses, though these analyses may be useful by enabling the chemist to choose a glass which will yield no objectionable ingredient to the solutions used in any particular piece of work. The coefficient of expansion of all the glasses is low and is unusually so in the Pyrex ware. All the ware shows more or less strain, but it was disappointing to find that no information as to liability to break under sudden changes in temperature or mechanical shock could be obtained by an examination for strain. All the ware tested showed good resistance to repeated evaporation of a salt solution. While the heat and mechanical shock tests were performed on too small a number of pieces to justify positive conclusions, they indicated that the Kavalier and M. E. G. Co. ware are less resistant than Jena, Nonsol, and Fry wares, the Libbey somewhat more resistant and the Pyrex ware distinctly more resistant. The Kavalier ware is unsatisfactory as regards solubility in water; all the other wares appear satisfactory in this respect. All the ware is resistant to acids. Kavalier is least resistant to carbonated alkalies, Pyrex more resistant than Kavalier but less resistant than the others. Kavalier and M. E. G. Co. wares are more resistant to boiling caustic alkaline solutions than the others but the differences are not great. All the glasses are much attacked by evaporating caustic alkalies. Ammonia water has about the same effect as mixtures of ammonium chloride and sulphide. The authors are of the opinion that considering all the tests each of the American wares is superior to the Kavalier and equal or superior to the Jena ware. (*Technologic Papers of the Bureau of Standards*, no. 107)

EFFECT OF THE SIZE OF GROG IN FIRECLAY BODIES, F. A. Kirkpatrick, Assistant Physicist. In those industries which use crushed and ground raw materials in forming bodies by means of a cementing action of some sort the size of the particles plays a most important rôle. This may be in many instances the main factor controlling the desired properties in the body. This is nowhere more true than in the ceramic industries, where in compounding bodies the manufacturer is compelled to use materials from the size of pebbles down to the dispersoid and emulsoid (colloidal) states. All present evidence tends to show that in disperse systems the size of particles which we can not now measure has as much effect upon the properties of certain materials as have the larger sizes which we are able to measure. In no other way is it possible to account for the great differences in cementing power exhibited by fine-grained bond clays and other fine-grained materials. In practice the cementing action takes place at temperatures from zero to that of the electric arc, depending upon the nature of the process, and is due to many different chemical reactions. In the present work the bonding power of mixtures composed of raw clay and calcined clay is determined after these bodies have been heated to 110 deg. cent. and to 1250 deg. and 1300 deg. cent.

The control of the strength of raw fireclay bodies is a difficult matter into which enter a number of factors. Those which are directly connected with the size of grog are size of the body, cracks formed in drying, density or porosity, and size of grain of the clay.

If the grog is too large for the size of body used, the conditions of bond are different than for smaller grog. Small cracks may or may not form in drying. The general rule in ceramic bodies is that strength increases with decrease of porosity, but this factor may be overruled by others. In series 4 of the tests carried out, however, the rule holds. As shown in connection with series 5 and 7 the size of grain of the bond clay also affects the strength of the body. In regard to the grog, aside from other considerations, the following condition is necessary for highest strength. The mixture of sizes must be such that the smaller particles fill the voids between the larger, giving maximum density. The proper proportions may be predicted qualitatively from the ratio of sizes, but can be determined accurately only by experiment.

The strongest raw bodies were those in series 4 and 7. In series 4 these had the following limits of grog composition: 25 to $66\frac{2}{3}$ per cent, 20 to 40 grog; 0 to 25 per cent, 40 to 80 grog; and $33\frac{1}{3}$ to $66\frac{2}{3}$ per cent, 80 to dust grog. In series 7 the strongest bodies were those containing the greatest percentage of 80 to dust grog.

The control of strength in the burned state proved to be not at all difficult. For all bodies used the modulus of rupture was found to increase with increase of surface factor. The relation was represented by means of straight lines except that the lower portions of some of the curves representing large-sized grog were of parabolic form. The rate of increase of strength increased with the temperature of burning, due to the more rapid rate of solution of the finer particles at the higher temperatures. The porosity at cone 12 varied much the same as in the raw bodies and had little relation to strength. The strongest bodies were those in series 4 (20 to dust grog). No relation was found between strength in the raw state and in the burned state.

In the quenching tests from 600 deg. cent. and 1000 deg. cent., mixtures of the larger sizes of grog gave the more resistant bodies. (*Technologic Papers of the Bureau of Standards*, no. 104)

National Research Council as a Permanent Body

The National Research Council was organized in 1916 at the request of the President by the National Academy of Sciences, under its congressional charter, as a measure of national preparedness. The work accomplished by the council has demonstrated its capacity for larger service, and the National Academy is now requested by executive order of President Wilson to perpetuate the National Research Council, the main duties of which shall be as follows:

1 In general, to stimulate research in the mathematical, physical, and biological sciences, and in the application of these sciences to engineering, agriculture, medicine, and other useful arts, with the object of increasing knowledge, of strengthening the national defense, and of contributing in other ways to the public welfare;

2 To survey the larger possibilities of science, to formulate comprehensive projects of research, and to develop effective means of utilizing the scientific and technical resources of the country for dealing with these projects. (*Official Bulletin*, May 14, 1918, p. 1)

REVIEW OF ENGINEERING PERIODICALS

SUBJECTS OF THIS MONTH'S ABSTRACTS

For Articles on Subjects Relating to the War, see Aeronautics, Engineering Materials, Machine Tools, Munitions, Varia

Aeronautics

Aviation and the War, C. F. Lee. *Journal of the Washington Academy of Sciences*, vol. 8, no. 8, April 19, 1918, pp. 225-232. Discussion of the training of aviators, with special reference to "stunt" and formation flying; also some remarks on the classification of machines.

The Sopwith Triplane. *Flight*, no. 484 (vol. 10, no. 14), April 4, 1918, pp. 361-365, illustrated.

The Effect of an Airplane Rudder in Flight, Karl H. White. *Aviation and Aeronautical Engineering*, vol. 4, no. 7, May 1, 1918, pp. 448-449, 4 figs. Describes methods for finding the moments about the center of gravity of airplanes of different length due to rudders of different aspect ratios under varying angles of deviation. The results are expressed in the form of tables and curves.

The Gallaudet Airscrew Propulsion Described. *Aviation and Aeronautical Engineering*, vol. 4, no. 7, May 1, 1918, pp. 454-456, 4 figs. Description of the construction of an airplane fitted with a pusher propeller without using an attachment of the tail planes by means of outriggers or tail booms, the presence of which generates a certain amount of parasite resistance: taken mainly from a United States patent.

Engineering Materials (See also Measurements)

Defects in Steel Ingots and Forgings, S. W. Werner and Gordon Spencer. *Iron and Steel of Canada*, vol. 1, no. 3, April 1918, pp. 110-116, 13 figs.

La Fabrication des Briques de Silice, H. LeChatelier and B. Bogitch. *Bulletin et Comptes Rendus Mensuels de la Société de l'Industrie Minérale,* Tome 12, 3rd issue of 1917, pp. 49-97, 14 figs. Data on the manufacture of silica bricks.

Les Alliages d'Aluminium et de Magnesium, Jean Escard. *Revue Scientifique, Industrielle & Commerciale des Métaux et Alliages,* no. 11, November-December 1917, pp. 1-3. Discussion of various aluminum-magnesium alloys giving, among other things, tables of their melting points and indicating their physical and chemical characteristics and methods of preparation..

L'Emploi de la Pression Plastique du Plomb, M. Lünet. *Le Génie Civil,* tome 72, no. 14, April 6, 1918, pp. 236-238, 11 figs. Description of methods of manufacture of stamped metal articles under lead pressure. An abstract of this article may appear in an early issue of The Journal.

Cooling Rate Affects Steel Casting Design, J. G. Fletcher. *The Foundry*, vol. 46, no. 309, May 1918, pp. 201-204, 2 tables.

The Penetration of Carbon, Howard Ensaw. Discussion of various methods of case-hardening and of the penetration of carbon. Among other things a chart showing penetration of carbon is given, with percentages of carbon as ordinates and degrees of hardness as abscissæ.

The selection of suitable boxes for carburizing is discussed, the writer recommending, as a most suitable material in most cases, steel boiler plate 3/8 or 1/2 in. thick, which can be made with welded joints and will last well.

The sizes of the boxes employed depend to a great extent on the nature of the work being done, but care should be exercised to avoid putting too much in one box, as smaller ones permit the heat to penetrate more quickly, and one test piece is sufficient to give a good indication of what has taken place. If it should be necessary to use larger boxes it is advisable to put in three or four test pieces in different positions to ascertain if the penetration of carbon has been satisfactory in all parts of the box, as it is quite possible that the temperature of the muffle is not the same at all points, and a record shown by one test piece would not then be applicable to all the parts contained in the box. It has been found that the rate of carbon penetration increases with the gas pressure around the articles being carburized, and it is therefore necessary to be careful in sealing up the boxes after packing. When the articles are placed within and each entirely surrounded by compound so that the compound reaches to within 1 in. of the top of the box, the lid, which should be a good fit in the box, is then to be pressed on top of this, and another layer of clay run just below the rim of the box on top of the cover.

A mixture of fireclay and sand will be found very satisfactory for closing up the boxes, and by observing the appearance of the work when taken out we can gage the suitability of the methods employed, for unless the boxes are carefully sealed the work is generally covered with dark scales, while if the sealing is properly done the articles will be of a light gray.

By observing the above recommendations reliable results can be obtained and we can expect uniform results after quenching. (*American Machinist*, vol. 48, no. 18, May 2, 1918, pp. 755-756, 1 fig., 1 chart)

Acid Open Hearth Steel Investigation, T. D. Morgans and F. Rogers. *The Blast Furnace and Steel Plant*, vol. 6, no. 5, May 1918, pp. 216-217.

[illegible] Cold-Worked [illegible] Carbon Steels, F. Cloup. In studying the heat changes brought about in annealing cold worked or heat-treated steel the writer has observed a complete parallelism between these two phenomena. The experiments were carried out in accordance with the differential method of Sir Roberts-Austen and with photographic recording by the double galvanometer of Saladin and LeChatelier.

The following results were obtained:

1 The curve of the rise of temperature in steels which have previously undergone cold-working or heat-treating has in all cases at about 400 deg. cent., a singular point characterized by an evolution of heat.

2 The change of state which takes place at this temperature reaches completion only quite slowly, both in the case of heat-treated steel and in the case of cold-worked steel. Thus, two samples of the same steel, 0.12 per cent carbon, of which one has been tempered from 1000 deg. by immersion in water at 15 deg. and the other cold-worked, then both heated to 640 deg. for a period of 25 min., still show, during the second reheating, the singular point at 400 deg. cent. After a heating for twelve hours at 600 deg. cent. the transformation is completed and a new curve of heating does not show any irregularities.

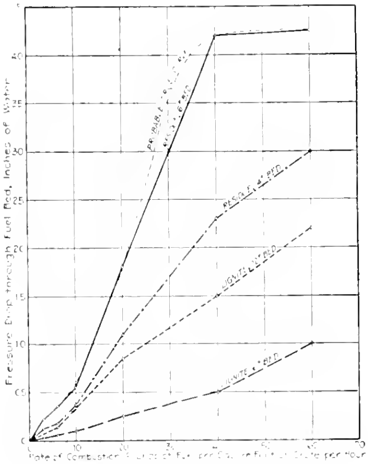


Fig. 1 Draft Required for Lignite

3 This change of state is irreversible. The curves of cooling of both heat-treated and cold-worked steel have the perfectly regular appearance. This transformation must be accompanied by a sudden change of volume. Since the metal is not malleable at 400 deg. cent., it becomes subject to internal stresses which produce a breakdown of equilibrium. If, then, by external work, such as hammering, these internal stresses are still more intensified the most favorable conditions are created to cause rupture of material, which is actually quite frequent when cold-worked steel is heated and subjected to mechanical working at about 400 deg. cent. (*Trempe et Ecrouissage des Aciers au Carbone*, F. Cloup, presented by Henry LeChatelier. *Comptes Rendus hebdomadaires des Séances de l'Académie des Sciences*, tome 166, no. 10 (March 11, 1918), pp. 415-416)

Junk Pile Transformed into Gold, George H. Manlove. *The Iron Trade Review*, vol. 62, no. 19, May 9, 1918, pp. 1173-1176, 3 figs., 1 chart. Discussion of the changes which the present scarcity of raw materials produced in the handling of metal scrap.

Bibliography of the Physical Properties of Copper, Paul D. Merica. *Metallurgical and Chemical Engineering*, vol. 18, no. 8, April 15, 1918, pp. 409-415.

Foundry

How Gun Lathe Castings Are Made, H. Cole Estep. *The Iron Trade Review*, vol. 62, no. 17, April 25, 1918, pp. 1045-1051, 15 figs.

Estimating the Weights of Castings Rapidly, Warner Hathaway. *The Foundry*, vol. 46, no. 309, May 1918, pp. 210-212, 4 tables.

Fuel and Firing

Combustion of North Dakota Lignites, with Suggestions for Design of Furnaces, Henry Kreisinger, Mem.Am. Soc.M.E. An article published by special permission of Dr. H. Van Manning, Director of the United States Bureau of Mines.

In the ordinary furnace with horizontal grate the lignite of North Dakota is very difficult to ignite, and even after combustion has been started troubles are apt to occur.

A special furnace was designed and constructed to satisfy the basic requirement of burning lignite and its carbonized residue. The essential features of this furnace, designed with particular regard to house-heating purposes, are shown in Fig. 3.

In this furnace rapid ignition is obtained by the rear arch, which turns the hot gases and flames back over the fuel bed. Thus, the incoming fresh fuel is heated not only by conduction through the fuel and radiation from the arch, but mainly by convection when coming in contact with the hot gases and flames from the already burning fuel.

Further, to heat lignite having 35 per cent moisture to ignition temperature takes more than twice as much heat as is required to heat bituminous coal containing 10 per cent of moisture. It is therefore difficult, if not impossible, to supply enough heat by radiation from the ordinary front arch to ignite the lignite, and another factor of heat supply must be brought into action—in this case heat transmission of hot gases by convection. The grate is inclined and has wide horizontal air spaces, which can be easily kept open, permitting free flow of air through the grate. Additional air is admitted through the door for removing clinker at the lower end of the grate. As this air passes up between the arch and the fuel it scrubs against the surface of the fuel bed, and a large part of it is consumed in burning or gasifying the solid fuel, thus making it unnecessary to force all the air needed for gasification of the fuel through the fuel bed.

Experiments showed that the scrubbing action of additional air caused a rapid and rather complete oxidation at the surface of the fuel bed, indicated by the bright red heat, which was practically absent on the tests made in an ordinary furnace with horizontal grate. Thus there were two oxidation zones, one next to the grate and one at the surface of the fuel bed, probably with a small reducing zone between them. Because the air which enters through the cleaning door against a low resistance burns or gasifies solid fuel, higher rates of

combustion can be obtained than with ordinary or natural draft.

The air spaces in the grate are horizontal, and the inclination of the grate is such that the fuel is fed from the magazine down the grate by gravity, besides which the rate of feeding can be increased by a slight agitation or rocking of the grate bars. The gravity feeding can be used better with lignite than with most bituminous coals, because the fuel does not cake. The thickness of the fuel bed and, to some extent, the rate of feeding are controlled by the opening of the gate of the fuel magazine.

In the tests made with a draft of 0.1 to 0.15 in. of water, the lignite made a bright, red-hot fire, although the arch never was visible red-hot. When the lignite was broken to pieces not exceeding about two inches, the feeding of the fuel was nearly automatic, though with larger pieces the fuel had to be occasionally moved down by shaking the grate bars and by poking the large pieces through the magazine gate.

Slack, though present in considerable amount, did not seem to cause any particular trouble.

The principles embodied in the design of the furnace for house-heating purposes shown in Fig. 2 can be applied also to boiler furnaces as shown in Fig. 3. There diagram A suggests the design of an inclined step-grate boiler furnace. The fuel can be fed by gravity aided by hand regulation, or it can be pushed out of the magazine mechanically by a pusher plate. There should be as little air as possible entering through the coal magazine or through the plate in front of the coal magazine where the fuel is merely being dried and does not burn.

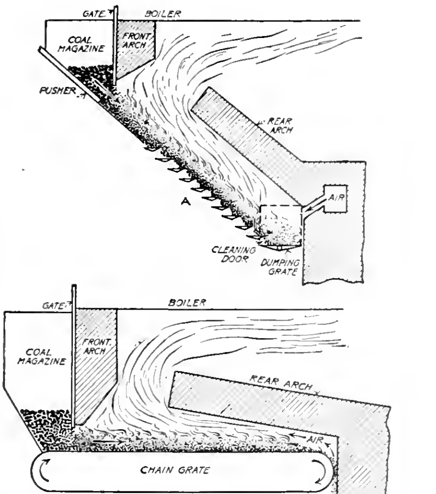


Fig. 2 Experimental House-Heating Furnace for Lignite

The completeness of combustion should be controlled by regulating the air admitted to the lower end of the grate and not by regulating the admission of air through the magazine.

Diagram B shows the application of the same principles to a chain-grate furnace. The diagram shows the grate in horizontal position, and it is believed that better results could be obtained if the top of the grate were inclined about 20 deg. to the horizontal. (*Power*, vol. 47, no. 18, April 30, pp. 608-612, 5 figs. *tpA*)

Entropy Diagram for Gasoline, Jean Rey. The utilization of gasoline in various apparatus as a vapor makes it desirable to have precise knowledge of the physical laws of its vaporization, preferably expressed as an entropy diagram.

The diagram presented here and plotted for ordinary gasoline of density 0.800 to 0.820 (for water = 1.000) has been developed from an investigation extending over many years.

The writer has found that the specific heat can be ex-

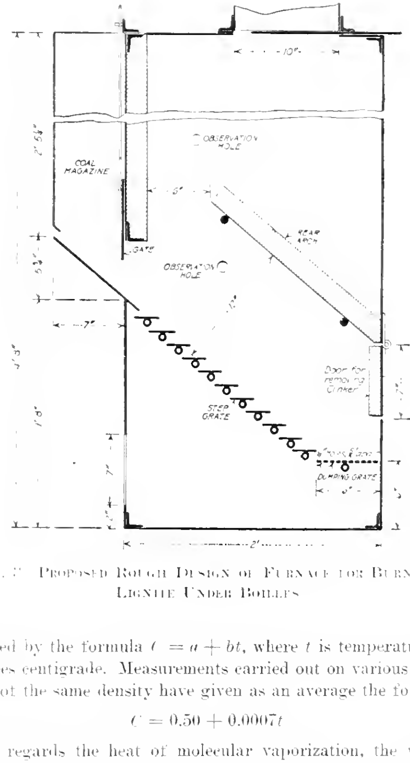


Fig. 3 Proposed Rough Design of Furnace for Burning Lignite Under Boilers

pressed by the formula $C = a + bt$, where t is temperature in degrees centigrade. Measurements carried out on various gasolines of the same density have given as an average the formula

$$C = 0.50 + 0.0007t$$

As regards the heat of molecular vaporization, the writer has determined the value of L/T by comparison with various known organic liquids, namely, chloroform, acetone, sulphur and chloride of carbon.

In plotting the curves, giving L/T as a function of the absolute pressure, one finds that the average curve represents with sufficient approximation the value of the function for ordinary gasoline. This function has the form

$$L/T = a\,T - b$$

where a and b are constants.

For the numerous series of organic liquids, the Bingham formula

$$L/T = 17 + 0.011T_0$$

expresses the heat of molecular vaporization at the temperature T_0, which is the temperature of boiling at atmospheric pressure. It may, therefore, be used as a check for one point on the curve.

On the other hand, the writer has determined the curve of pressures of vapor of ordinary gasoline, which permitted him to plot the values of L/T for gasoline as a function of the

...temperature. Expressing these values as absolute pressures. In this way he obtained the following relation:

$$L/T = 15{,}160/T - 12.42$$

By dividing this expression by μ, the molecular weight of ordinary gasoline, one obtains the heat of vaporization per unit of weight in large calories r, or

$$r/T = 82.4/T - 0.0675$$

or

$$r = 82.4 - 0.0675T$$

The value 184 is a fairly close expression of the molecular weight for the various samples of gasoline tested. It is known that American gasolines are essentially expressed by the formula C_nH_m, where $m = 2n + 2$, while Russian gasolines correspond to formula C_nH_{2n}. Ordinary gasoline, which is nothing but a mixture, is expressed with sufficient exactness by $C\,H$.

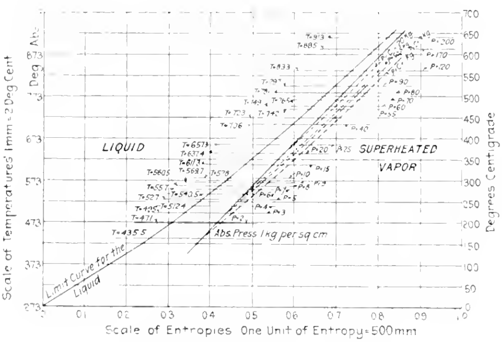


FIG. 4 ENTROPY DIAGRAM FOR GASOLINE

With these magnitudes established, one finds that the entropy of the liquid is given by the expression

$$S_{liq} = \int_0^T \frac{dq}{T} = \int_0^T \left[0.50dT + 0.0007(T - 273)\frac{dT}{T}\right]$$

$$= 0.3089 l\left(\frac{T}{273}\right) + 0.0007(T - 273)$$

It is only necessary to add to this expression r/T in order to obtain the entropy of the saturated vapor, which is

$$S_{vap} = 0.3089 L_n\left(\frac{T}{273}\right) + 0.0007T + \frac{82.4}{T} - 0.2586$$

It is by means of these formulæ that the diagram, Fig. 4, has been plotted. In order to verify the heat of vaporization, the writer used a special tubular boiler so designed as to make it possible to obtain pressure rapidly. After vaporization, gasoline condenses in a nest of pipes cooled by water from the outside. With this arrangement all that is necessary is to measure the amounts and the inlet and outlet temperatures of water and gasoline. The same apparatus was used for measuring the vapor pressures.

Certain precautions were necessary due to the fact that gasoline cannot be kept above a certain temperature without undergoing polymerization.

From the curve of vapor pressures one may deduce the following expression where T is the absolute temperature of boiling of gasoline expressed as a function of T_w, which is the absolute temperature of boiling of water at the same pressure:

$$T = 1.167T_w - 0.641(T_w - 273)$$

The various points in the entropy diagram reproduced here have been checked up to a pressure of 40 kg. (569 lb. per sq. in.). These checks have shown possible errors of from 1 to 2 per cent. The inspection of the diagram shows at once—

1 That the saturated vapor of ordinary gasoline is superheated through fall of pressure, and
2 That the heat of the liquid is always considerably higher than the heat of vaporization.

From these two properties, which are directly opposite to those of water vapor, it follows that when saturated vapor of gasoline is allowed to expand it is simultaneously superheated and produces mechanical work. If liquid gasoline under pressure is allowed to have part of its pressure removed it is partially vaporized, and if this lower pressure is maintained for a sufficiently long time, its vapor is superheated.

These properties are probably common to all the principal hydrocarbons. (*Comptes Rendus Hebdomadaires des Séances de L'Académie des Sciences*, vol. 166, no. 9, March 4, 1918, pp. 387-390, 1 fig., *teA*)

CONSERVING FUEL BY COAL BRIQUETING, F. Denk. *The Coal Industry*, vol. 1, no. 4, April 1918, pp. 129-131.

ECONOMY IN THE USE OF FUEL IN POWER STATIONS, Charles H. Parker. *Journal of the Boston Society of Civil Engineers*, vol. 5, no. 4, April 1918, pp. 163-185, 10 figs. An extensive paper devoted to the various features of power-plant operation having a bearing on fuel economy.

COMBUSTION OF COAL AND DESIGN OF FURNACES. *Power*, vol. 47, no. 17, April 23, 1918, pp. 596-600.

CARBOCOAL, Charles T. Malcolmson. Description of a series of experiments which are said to have resulted in the development of a process for the manufacture of a smokeless fuel from volatile coals and for the recovery and refinement of the coal-tar products derived therefrom. The process described is the invention of Charles H. Smith.

The essential features of this process are two distillations carried on at different temperatures; first of the raw coal and second of the raw briquets. The raw coal, after being crushed, is distilled at a relatively low temperature, 850 to 900 deg. fahr., and the volatile contents are thereby reduced to the desired point. The result of this first distillation is a large yield of gas and tar, and a product rich in carbon, termed semi-carbocoal. The semi-carbocoal is next mixed with a certain proportion of pitch obtained from the tar produced in the process, and this mixture is briquetted. The briquets are then subjected to an additional distillation at a higher temperature, approximately 1800 deg. fahr., resulting in the production of carbocoal, the recovery of additional tar and gas, and a substantial yield of ammonium sulphate.

The characteristic feature of the primary distillation is that it is continuous and that the coal is constantly agitated and mixed during the entire operation. This is accomplished by a twin set of paddles, which also advance the charge through the retort. By this means all portions of the charge are uniformly distilled, and by controlling the speed at which the charge moves through the retort, the distillation may be arrested at any desired stage. As only a partial carbonization is permitted in the primary distillation, the hard metallic cells characteristic of coke are avoided. The period of distillation is one to two hours, and the continuous retort has a carbonizing capacity of one ton of coal per hour.

In the subsequent distillation of the briquets all evidence of the pitch as a separate ingredient disappears. There is a

marked shrinkage in the volume of the briquet, with a corresponding increase in density, but no distortion of its shape. This distillation requires four to five hours, and is performed in an inclined, self-charging and self-discharging bench.

The carbocoal represents more than 72 per cent of the weight of the raw coal, the exact percentage depending upon the volatile content of the latter.

Carbocoal is dense, uniform in size and quality, grayish-black in color and is manufactured in briquet form in any size from 1 oz. to 5 oz. It is stated that it has been tested by the Long Island R. R., by the Pennsylvania R. R. at Altoona, the Carolina, Clinchfield & Ohio R. R. and by the U. S. Navy, and that it requires no greater draft than bituminous coal.

The analysis of carbocoal indicates from 1 to 3 per cent of moisture, from 0.75 to 3.50 per cent volatile matter, 82 to 90 per cent of fixed carbon and 7 to 12 per cent ash.

The article also describes in brief the recovery of tar and other by-products. (*Bulletin of the American Institute of Mining Engineers,* no. 137, May 1918, pp. 971-977, 3 tables)

The Burning of Pitch and Creosote Mixtures. Furnace and burner makers had not considered the burning of pitch mixtures until the subject was taken up by the Ministry of Munitions. The apparatus used was crude and of an elementary design. The use of creosote oil as fuel by the British Navy is likewise of comparatively recent origin.

Now, in order to increase the available supplies of creosote for naval purposes, steps were recently taken in Great Britain to limit its use in other directions by a system of licenses.

Admiralty supplies were increased to a point at which it appeared that further supplies could be drawn only from oil now consumed in the land furnaces. This is why the question of burning pitch, or rather pitch and creosote mixtures, was taken up in earnest, the successful use of such mixtures becoming a matter of great national importance.

The coöperation of furnace makers was first obtained, primary attention being given to those making use of oil for steam raising. Extensive trials were carried out with pitch and creosote mixtures, using modern pressure-jet systems. During these tests two companies successfully handled mixtures containing 60 per cent and 75 per cent of pitch and obtained boiler efficiencies of over 80 per cent working under natural-draft conditions. The fuel in the supply tank was kept at a temperature of about 130 deg. fahr. and was raised to 290 deg. fahr. at the burners, the fuel pressure being maintained at about 75 lb. per sq. in. Another company who used the White system for steam raising obtained a boiler efficiency of 82 per cent under forced draft from a mixture consisting of 70 per cent creosote and 30 per cent pitch, and are now using commercially in all their furnaces a mixture of 66.6 per cent creosote and 33.3 per cent pitch with satisfactory results.

Manufacturers of reheating, smelting and other furnaces were likewise induced to carry out experiments and have obtained promising results.

The chief difficulties in burning pitch and creosote mixtures lie in the handling and transport of the mixture and the presence of certain bodies in the pitch which necessitate increased attention to the burners. As regards transhipment of fuel, little difficulty has been experienced when the consumer has a railway siding available to take delivery and the tank wagons are equipped with steam coils.

The trouble experienced in burning certain mixtures is a very real one, and is due to the presence of free carbon, resinous matters or other foreign bodies contained in the pitch blocking up the burners and strainers. In practice it has been found that the pitch and any other liquid fuel which is rich in free carbon usually present difficulties in burning. It is recommended that consumers of pitch fuels should have their systems fitted with alternative strainers, so that when one strainer becomes choked up another may be operated while the first is being cleaned. (*The Engineer*, vol. 125, no. 3251, April 19, 1918, pp. 332-333, 1 fig.)

Hydraulics

Vertical-Shaft Water-Wheel Alternator, H. D. Stephens. Description of the general construction of such alternators, the Kingsbury thrust bearing, methods of lubrication, and various schemes employed to drive the exciter. The informations refers mainly to the type built by the Westinghouse Electric and Manufacturing Company. (*Power*, vol. 47, no. 17, April 23, 1918, pp. 572-575, 7 figs., *d*)

Internal-Combustion Engineering (See also Fuel and Firing)

Heavy-Fuel Engine with Detonating Igniter. Description of a heavy-fuel igniter working on the principle of detonation. The description is very incomplete because of legal formalities in connection with patent rights.

It is stated generally that the suction in the engine cylinder as the piston descends on the induction stroke is transmitted through a narrow passage in the foot of the detonator to its interior. Arrived at this point the suction opens a non-return valve inside the detonator and thence exerts its influence in the pipe connecting the detonator with the supplementary carburetor.

As regards the carburetion, it is stated that kerosene is merely broken up at the jet, the effective aperture of which is rendered rather smaller than usual by the insertion of a larger jet needle.

In addition to this there is a small auxiliary carburetor mounted above the cylinders and provided with two float chambers, one for gasoline and the other for a heavy fuel. Leading from this supplementary carburetor is a pipe with branches passing to a small receptacle known as a detonator screwed into each spark-plug hole.

On every induction stroke of the piston fuel is drawn both from the main carburetor into the combustion chamber and cylinder of the engine and from the supplementary carburetor along the appropriate branch pipe into the interior of the detonator mounted in the spark-plug hole of the same cylinder of the engine.

At the end of the induction stroke the suction ceases and the non-return valve in the top of the detonator closes under the influence of a light spring, so that the mixture in the detonator cannot escape back to the supplementary carburetor on the compression stroke of the engine piston. As this stroke proceeds, the main charge is compressed in the combustion chamber and a small proportion is forced up through the narrow opening in the foot of the detonator into the body of the detonator itself.

In the upper part of the detonator, however, the mixture from the supplementary carburetor is stated to lie compressed practically as a stratum on the top of that portion of the main charge which has been forced up into the lower part of the detonator. Into the side of the detonator is inserted a spark plug of ordinary design, the spark occuring on the completion of the compression stroke. It is said that the spark fires first of all the stratum of mixture drawn from the supplementary carburetor which ignites the heavier fuel in the detonator, and

tion, the flame rushes downward through the foot of the detonator into the engine combustion chamber. The heat intensity and area of the flame from the burning of the detonator charge are stated to be such that the temperature of the main charge instantly rises to a very high point, which makes its combustion practically perfect.

It is stated that the fuel drawn from the supplementary carburetor (gasoline) is only two per cent of the whole. (*The Autocar*, vol. 40, no. 1172, pp. 338-340, 1 fig., *d*)

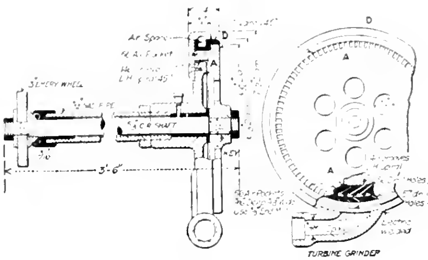


Fig. 5 Air-Turbine-Driven Grinding Wheel

Use of Tar Oil in Internal Combustion Engines, A. W. H. Griepe. *The Gas Age*, vol. 41, no. 8, April 15, 1918, pp. 348-350, 7 figs.

Notes on the Gas Turbine, E. Boudot. *Aeronautics*, vol. 14, no. 232 (New Series), March 27, 1918, pp. 270-272, 3 figs.

Exhaust Pits for Low-Compression Oil Engines, L. H. Morrison. *Power*, vol. 47, no. 17, April 23, 1918, pp. 586-587, 3 figs.

Kerosene Carburetors and Vaporizers, George F. Crouch. *Motor Boat*, vol. 15, no. 7, April 10, 1918, pp. 30-34, 11 figs. Brief semi-technical description of kerosene carburetors and vaporizers on the American market, with special regard to their application to motor-boat engines. No data of actual tests are cited.

Machine Shop

Travail du Laiton a Froid, Henri Bertin. *Le Génie Civil*, tome 72, no. 14, April 6, 1918, pp. 233-236, 6 figs. An interesting discussion of the cold-working of brass. An abstract will appear in an early issue of The Journal.

Drill Grinding, Edward K. Hammond. *Machinery*, vol. 24, no. 9, May 1918, pp. 825-830, 8 figs. An extensive practical discussion of the subject of drill grinding of interest to machine-shop men.

Electric Furnaces for Heat Treatment, T. F. Baily. *The Iron Age*, vol. 101, no. 19, May 9, 1918, pp. 1199-1201, 2 figs.

Machine Tools

Air-Turbine-Driven Grinding Wheel, W. J. Nene. Description of a machine designed especially for grinding welds. One of the greatest difficulties associated with electric welding of cast iron in the small shop is a tendency to leave the weld so hard as to be practically unworkable except by an abrasive wheel. The operator therefore has to have some quick and efficient means of working down these hard spots.

The machine described is simply an air turbine of special design, carrying an abrasive wheel on the end of its rotor shaft. The writer vouches for the efficiency of the machine and states that the turbine at 90 to 100 lb. pressure furnishes ample power to drive a 3-in. wheel at 3500 r.p.m., which is approximately correct for a wheel of this size.

The parts are made of mild-steel forgings, except the ring *D* and the bearings, which are of hard brass, and the ball races, which are of tool steel hardened and ground.

The compressed air enters the annular chamber marked "air space," Fig. 5; thence it flows through the air ports, that is, the fifty-seven 3/64-in. drilled holes, and impinges at high velocity on the air pockets in the rotor *A*, imparting to it the first rotary impulse. At this point the air divides, part flowing through the 1/16-in. holes in the rotor and thence toward the center, where it exhausts through the six ⅞-in. holes, while the larger portion of the air flows through the 1/64-in. opening between *A* and *D*, where it comes in contact with the vanes

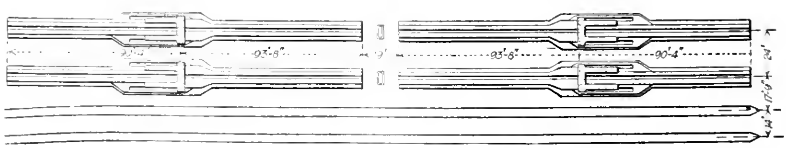


Fig. 6 Shop Layout for Four 90-Ft. Planing Machines

or wings which form part of the rotor and are set at an angle of 45 deg. with the axis of the rotor.

As the combined area of the fifty-seven air ports is approximately 0.098 sq. in., a ⅜-in. air hose would furnish an ample supply of air; but the usual standard connection for small hose is ½ in., and for this reason the air intake of the machine is made of this size.

It is stated that when this turbine runs at full speed it seems to use very little air. (*American Machinist*, vol. 48, no. 16, April 18, 1918, p. 658, 1 fig., *d*)

Salvaging Tools in War Time, Edward K. Hammond. *Machinery*, vol. 24, no. 9, May 1918, pp. 771-779, 20 figs. A

Adaptation of Carbureters to Low Volatile Fuels, J. H. V. Finney. *The Gas Engine*, vol. 20, no. 5, May 1918, pp. 220-227, 2 figs. Brief discussion of the subject indicated in the title, with the larger part of the article devoted to the description of a special device.

Machine Parts

Standardization of Gearing, B. F. Waterman. *Automotive Industries*, vol. 38, no. 17, April 25, 1918, pp. 827-829.

Thickness of Involute Gear Teeth on Addendum Circle, Reginald Trautschold. *Machinery*, vol. 24, no. 9, May 1918, pp. 800-802, 1 fig.

practical discussion of methods of economizing on tools under the present conditions, when the high prices make it especially essential to salvage tools.

CRANE FOR GUN JACKET SHRINKING SHOP. *The Iron Age*, vol. 101, no. 18, May 2, 1918, pp. 1133, 1 fig.

IMPROVEMENTS IN WATER WHEEL EFFICIENCY, E. C. Hutchinson. *Journal of Electricity*, vol. 40, no. 8, April 15, 1918, pp. 404-406, 2 figs. A discussion of recent developments in the design of water wheels, with examples taken from actual installations.

directions by a man stationed on top of the housings. Four 24-in. handwheels are conveniently located for the operation at this place and the shaft carrying each handwheel also carries an index finger, which, in conjunction with the graduated dial, forms the means of gaging the rate of feed.

Work on the machines was begun December 24, 1917, and in spite of the unusually difficult conditions and unavoidable delays the first machine was ready to run the last week of February 1918, which establishes a record speed for the completion of a machine tool of this size. (*American Machinist*, vol. 48, no. 15, April 11, 1918, pp. 603-608, 15 figs., *d*

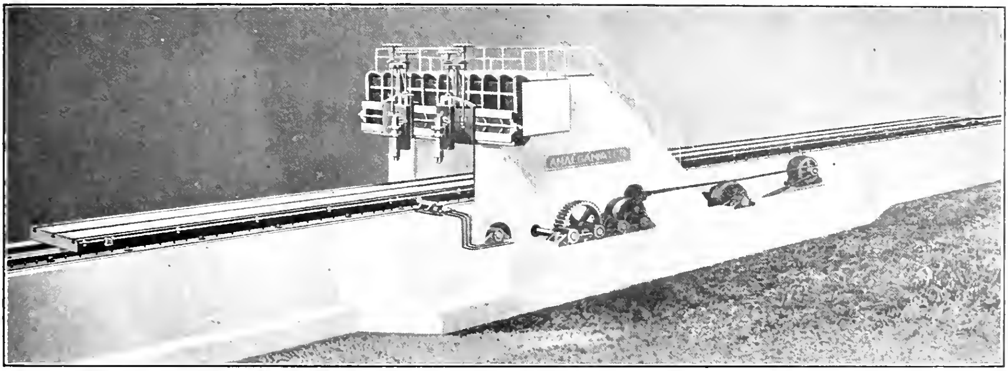


FIG. 7 REINFORCED-CONCRETE PLANING MACHINE WITH 80-FT. BED FOR WORK ON GUN-BORING MACHINES

CONCRETE METAL-PLANING MACHINES, Ethan Viall, Mem. Am.Soc.M.E. Description of a machine tool which represents a radical departure from common practice and may offer important possibilities for the future.

The machines here described were built by the Amalgamated Machinery Corporation, Chicago, primarily for the purpose of planing the beds of large gun-boring machines for the Government. The striking features of their construction and execution are first the use of reinforced concrete for the bed of the machine and next the speed with which the machine was built.

The original construction plan for these machines comprises a battery of four planers, each with a bed 184 ft. long, 17 ft. at its widest place and 18 ft. from the bottom of the bed to the top of the housing. There are approximately 212,000 lb. of iron and steel castings in each machine and about 13,500 cu. ft. of concrete reinforced with 34,000 lb. of steel bars. See Fig. 6.

A view of one of these machines is given in Fig. 7 and details in Figs. 8, 9 and 10.

The bed was designed like a huge concrete girder intended to support a load, which accounts for the high percentage of steel reinforcement. This was done to avoid any possibility of the bed settling at any point and destroying the alignment of the ways.

The bed ways are made with one flat guide and one V-guide. The ways are made in sections 12 ft. long, 4 ft. 10 in. wide and 13 in. through the thickest point. The V is cut with a 50-deg. slope angle and is 10 in. wide at the top of the flare. The flat guide is 10 in. wide at the top. After the table sections have been fastened together concrete is poured into the box-like sections, making the table one long, solid monolith of concrete and iron.

The method of feeding the cutting tools is quite unusual, no automatic means of feeding being supplied. Each cutter head is controlled independently in both horizontal and vertical

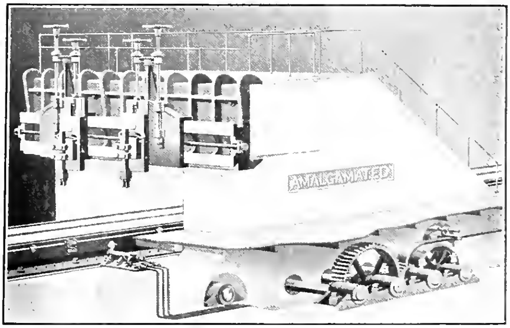


FIG. 8 CONTROL PLATFORM FOR PLANING MACHINE

Measurements

INNOVATIONS WITH RESPECT TO MICROMANOMETERS, M. Berlowitz. (*Zeits. Vereines Deutsch. Ing.* 61, pp. 969-973, Dec 8, 1917.) Interest in air measurements has been aroused during recent years to an unusual degree, particularly as regards ventilators and compressors; in consequence, a large number of manometric improvements have been forthcoming. The author here presents a summary of the various innovations which have been proposed. The differential manometer of G. Recknagel, which itself was a development of Péclet's earlier apparatus, and which for a number of years was the only instrument for measuring very low pressures, is first described in detail. Owing to serious inconvenience involved in the use of this instrument, a new construction was proposed by Krell, to which he gave the name micromanometer. A full de-

... apparatus is ... the paper. Further ... experiments by Berlowitz and Schultz are then discussed, the ... details being illustrated by eight diagrams. The paper concludes with a mathematical discussion of the mechanism ... manometric measurement, accompanied by two tables of results. (*Science Abstracts*, Section A Physics, vol. 21, part 3, no. 243, March 31, 1918, pp. 90-91.)

ROLLER FULCRUM VERSUS KNIFE EDGE TRACK SCALES, A. Bousfield. *Scale Journal*, vol. 4, no. 7, April 1918, pp. 12-16. 24 figs.

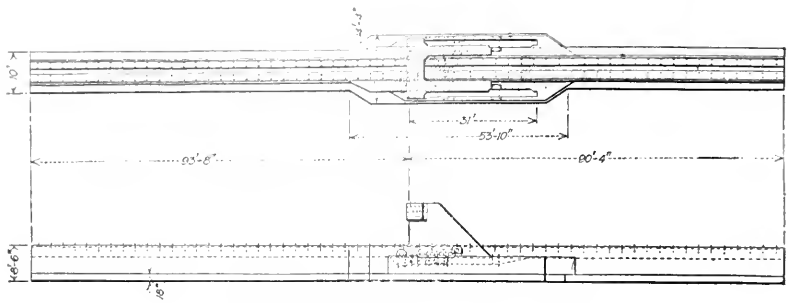


FIG. 9 PLAN AND SIDE ELEVATION OF PLANING MACHINE

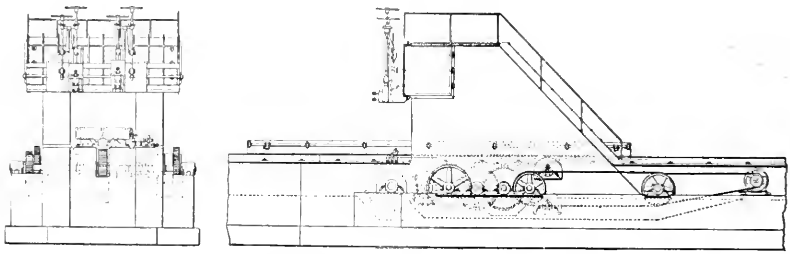


FIG. 10 DETAILS OF REINFORCED-CONCRETE PLANING MACHINE

PERFORMANCE TESTS BY ACCELEROMETER, H. C. Skinner. *Automotive Industries*, vol. 38, no. 17, April 25, 1918, pp. 816-817, 5 figs. Description of the use of an instrument for determining acceleration and deceleration of motor cars in road tests.

PROPERTIES OF MANGANESE BRONZE TEST COUPONS. *The Foundry*, vol. 46, no. 309, May 1918, pp. 218-219, 6 figs., 3 tables. A practical article giving test data of various manganese-bronze test coupons, of interest because of the fact that the method of testing of manganese-bronze castings is still a somewhat mooted subject.

MINNESOTA TRACK SCALE SPECIFICATIONS AND TOLERANCES. *Railway Age*, vol. 64, no. 18, May 3, 1918, pp. 1113-1115, 4 figs.

ENGINE TEST LABORATORY. *Automotive Industries*, vol. 38, no. 18, May 2, 1918, pp. 868-869. Description of a mechanical testing laboratory recently completed by the Minneapolis (Minn.) Steel and Machinery Co., mainly for testing engines of their tractors.

RECORDING THERMOMETER, C. V. Boys. *Proceedings of the Physical Society of London*, vol. 30, pt. 2, February 15, 1918, pp. 94-99, 5 figs. Description of a laboratory recording thermometer of comparatively simple construction.

APPARATUS AND MACHINES FOR TESTING OF AEROPLANE MATERIALS. *Canadian Machinery*, vol. 19, no. 18, pp. 465-468, 8 figs.

ERICHSEN TESTS ON ALUMINUM SHEETS, Robt. J. Anderson. Results of tests made with the Erichsen ductility testing apparatus on annealed 18-gage aluminum sheets. The Erichsen apparatus consists essentially of a die and holder for holding the sample to be tested and an internal tool actuated by a hand wheel which moves gradually forward until the sample is ruptured. The progress of the internal tool and the ultimate fracture are observed in a mirror and the depth of indentation is read directly from a micrometer graduated screw.

One of the features of this test is the evidence of approximate grain size of the metal tested, which fractured domes of the test pieces indicate. This makes this test valuable as a guide to drawing operations on an annealed metal, since underannealed metal will rupture by deep draws owing to its hardness and lack of ductility, while overannealed metal will also rupture because of the weakened condition of the metal resulting from large grain size.

The Erichsen test indicates how a given metal may be expected to behave in the draw press; in fact, the apparatus itself is nothing but a miniature draw press. The ductility control of metal going into draw-press work may be expected to reduce the percentage of scrap largely and to provide a rational basis of control for the annealing operations.

In this instance are described tests on 18-gage aluminum sheets, preliminary tests being made on a lot which had worked badly in the draw press. Then a number of tests were made upon 18-gage cold-rolled aluminum sheets reduced in the cold from a 0.25-in. slab to 18 gage. The metal employed

TABLE 1 EFFECT OF ANNEALING 18-GAGE ALUMINUM SHEETS: TEMPERATURE VARIABLE, AND TIME CONSTANT AT TWO HOURS

Sample	Temperature in deg. cent.	Thickness in millimeters	Indentation in millimeters	Scleroscope hardness	Appearance of domes
1	As rolled	1.08	6.83	14.0	
2	100	1.08	6.96	13.5	
3	200	1.09	8.39	10.0	
4	300	1.07	10.17	4.5	Smooth
5	400	1.07	10.10	4.5	Medium
6	500	1.09	9.73	4.0	Coarse

Note—(a) Time constant at 120 min.; (b) Values given represent the mean of two closely agreeing determinations.

TABLE 2 EFFECT OF ANNEALING 18-GAGE ALUMINUM SHEETS, TIME VARIABLE AND TEMPERATURE CONSTANT AT 200 DEG. CENT.

Sample	Annealed, minutes	Thickness in millimeters	Indentation in millimeters	Scleroscope hardness	Appearance of domes
7	5	1.07	6.89	13.8	
8	30	1.07	7.97	11.8	
9	60	1.08	8.40	9.5	
10	90	1.09	8.84	8.0	
11	150	1.09	8.87	8.0	

Note—(a) Temperature constant at 200 deg. cent.; (b) Values given represent the mean of two closely agreeing determinations.

was American metal of high purity containing over 99 per cent aluminum with impurities normal. The annealings were made in a laboratory electric furnace of the resistance type under pyrometric control and the temperatures are accurate within 10 deg. cent. The results are given in tables, of which two are here reproduced. Table 1 shows that the metal under discussion attained maximum softness by annealing at 300 deg. cent. for two hours. The effects of annealing at the constant temperature of 200 deg. cent. for various times is given in Table 2 and the data therein show that 200 deg. cent. is too low a temperature to employ for annealing 18-gage cold-worked sheets. Other tables show that complete softening below 5 Shore scleroscope number was obtained by annealing for 1 hr. and 20 min. at 300 deg. cent. Another table shows that complete annealing may be effected by an exposure of 5 min. at 400 deg. cent., which indicates that long-time exposures are unnecessary and may often lead to an increase in waste of material. Figs. 11 and 12 graphically reproduce the data in Tables 1 and 2, while Fig. 13 shows what happens in the case of annealing at 400 deg. cent.

The original article also refers to two other figures, which, however, do not appear in the article. (*The Iron Age*, vol. 101, no. 15, April 11, 1918, pp. 950-951, 4 figs. *ep*)

Mechanics

THE VALUE OF "g" IN ENGINEERING AND PHYSICAL WORK, Sanford A. Moss. The effects of variations in gravity, the cases where the effects are negligible, and the cases where they must be taken into account, are discussed from the point of view of the engineer and physicist.

The correction data, previously given completely only in inaccessible treatises on geodesy, are given in a form more convenient for actual use than ever given before.

The author collaborated with the Coast and Geodetic Survey officials, and with Prof. E. V. Huntington, so that the data may be regarded as authoritative.

The standard value of g is 980.665 cm. per sec.² or 32.1740 ft. per sec.² This has been arbitrarily selected by international agreement. It is nearly the average value at sea level, 45 deg. N. latitude, but is to be arbitrarily maintained regardless as to whether it is the exact average value, and regardless of

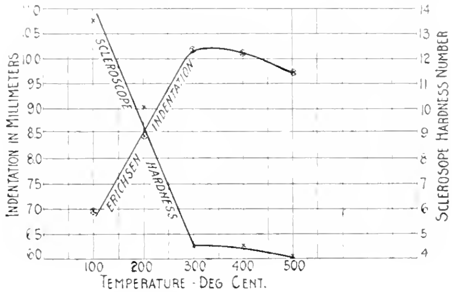


FIG. 11 TEMPERATURE-INDENTATION AND TEMPERATURE-SCLEROSCOPE-HARDNESS CURVES FOR ANNEALINGS ON 18-GAGE ALUMINUM SHEETS. TIME CONSTANT AT 120 MIN.

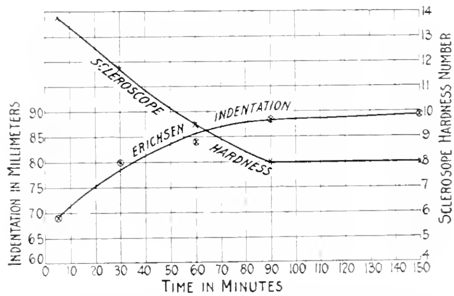


FIG. 12 TIME-INDENTATION AND TIME-SCLEROSCOPE-HARDNESS CURVES FOR ANNEALINGS ON 18-GAGE ALUMINUM SHEETS. TEMPERATURE CONSTANT AT 200 DEG. CENT.

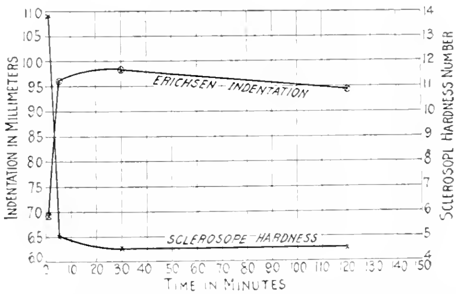


FIG. 13 TIME-INDENTATION AND TIME-SCLEROSCOPE-HARDNESS CURVES FOR ANNEALINGS ON 18-GAGE ALUMINUM SHEETS. TEMPERATURE CONSTANT AT 400 DEG. CENT.

changes in the average observed value due to addition of new data.

In all cases where a force of a pound is used it is to be understood as being the "standard pound force," which is a force giving the "standard weight" of one pound an acceleration of the standard value, g_s.

Whenever forces are measured by instruments which depend

ope. The attraction of gravity the readings must be reduced to standard pounds by use of the correction factors given. Examples are: platform scales used with Prony brakes or similar brakes, dead-weight gages, mercury or water U-tubes, and testing machines. The correction for latitude has a maximum value of about fourteen hundredths of one per cent (in the southernmost part of the United States.) The correction for elevation is about one one-hundredth of one per cent per 1000 ft. elevation. There is a further correction for "anomaly," which is about one one-hundredth of one per cent on a few mountains and less than half of this value everywhere else, so that it is negligible for engineering work.

The following table gives the principal correction factor to within 1/100 of one per cent, which is accurate enough for engineering purposes.

We multiply the measurements of a force in a weight scales by the correction factor in the body of the table and add it to the reading.

North Latitude, deg.	Elevation in feet, ft.							
	0	2000	4000	6000	8000	10000	12000	14000
25	0017	0019	− 0021	− 0023	0025	0027	− 0029	− 0031
30	− 0014	− 0016	− 0018	0019	0021	− 0023	− 0025	− 0027
35	0010	− 0011	− 0013	− 0015	− 0017	0019	− 0021	− 0023
40	− 0005	− 0007	− 0009	0011	0013	0015	− 0017	− 0019
45	0001	− 0002	0004	− 0006	− 0008	− 0010	− 0012	− 0014
50	− 0004	+ 0002	0000	− 0002	− 0004	0006	− 0007	− 0010

More accurate correction data are given, which are needed, however, only for refined physical work.

Taking W, as the weight of a body at any point found by comparing it with the "standard pound weight" by means of a weight scales, F as force measured in "standard pounds" as already defined, and a as acceleration in ft. sec.², the well-known fundamental equation then becomes

$$F = W\,a/g$$

In all formulæ in which g occurs in connection with the standard units mentioned, the value is understood as being g_s, regardless of place.

The now usually accepted definition makes the horsepower exactly equal to 746 watts. This gives 550.22 "standard foot-pounds." (*General Electric Review*, vol. 21, no. 5, May 1918, gt)

DESIGN OF SPRINGS FOR OSCILLATING MASSES, G. Lindner. (*Zeits. Vereines Deutsch. Ing.* 61, pp. 907-912, Nov. 10, 1917.) The author cities various applications in which oscillating masses are fitted with springs to relieve a crank drive of acceleration forces or, in general, to permit a certain latitude of motion in one part while relieving others of shock. A number of formulæ are given to facilitate the choice of a suitable type and size of spring for any particular application. One of the primary functions of springs is to relieve the driving members (e.g., connecting rod, eccentric and crankshaft bearings, etc.) of "free forces" due to reversal of oscillating masses, which free forces cannot be balanced within the machine itself. The spring should be capable of continuing the oscillating motion; in other words, the drive has only to overcome the air resistance and friction of the moving parts once the oscillation is started. In order to secure the same frequency, the force exerted by the spring at maximum deflection must equal the centrifugal force of the oscillating mass at its dead point. The centrifugal force exerted at the distance r cm. from the center by G kg. at n revolutions per minute is: $P = (Gr/100)(n/30)^2$. The spring is designed so that it is deflected r cm. by the force P, and is not then overstressed. The present comparison between various types of springs is based on the following assumptions: Spring steel with $E = 2{,}200{,}000$ kg./cm.²; bending stress at deflection r cm. = 3000 kg./cm.² unhardened and 4000 to 5000 kg./cm.² hardened; half these values for machine steel. In a numerical example for each case $G = 50$ kg.; $r = 2$ cm.; $n = 300$ r.p.m.: then the centrifugal force and spring force $P = 100$ kg. The cases considered are: Parallel plate spring with one end fixed and with both ends fixed; triangular plate springs and the practical form of the latter, the trapezium plate; rectangular and round rod springs (including the case of a bundle of rods and that of rods held at both ends); cubic paraboloid (round rod to uniform resistance); and tapered round-rod springs. In each case formulæ are given for the relation between length and cross-section of springs, for the volume and for the work done in bending the springs, etc. The liability to buckling is discussed, and it is shown how to complete practical designs after obtaining the dimensions theoretically desirable. Sections of uniform resistance or approximations thereto are most economical of material. Rod springs of standard profile may be conveniently applied to a variety of load conditions and they are flexible in all directions. Parallel round-rod springs require four times as much material as triangular plate springs and 4/3 times as much material as parallel plate springs and rectangular rods owing to the fact that maximum stress exists only in the clamped section and along the outer fiber thereof. If the form of the rod be a cubic paraboloid, the material required is only 1/3 that of a cylindrical round rod and 4/3 that of a triangular plate spring. The section in which maximum stress occurs in a tapered round rod depends on the degree of taper. Up to the critical ratio of taper, $D/d = 1.5$, the stress at the clamp determines the design; with more pronounced taper, the danger section moves toward the point of the spring. The relative economy in material of various patterns of spring is shown by the following formulæ for their volume:

	Volume		Volume
Parallel plate spring.........	2.2 Pr	Plain taper round rod:	
Triangular plate spring......	0.73 Pr	With D/d = 1.0	2.935 Pr
Trapezium plate spring:		D/d = 1.25..........	1.91 Pr
limits	0.73 to 2.2 Pr	D/d = 1.5	1.377 Pr
Trapezium plate spring:		D/d = 1.84 (max. economy).	1.18 Pr
b/B = 1/5.....	0.97 Pr	D/d = 2.0	1.20 Pr
Rectangular-rod spring	2.2 Pr	D/d = 2.5	1.45 Pr
Parallel round-rod spring.	2.935 Pr	D/d = 3.0	1.88 Pr
Cubic paraboloid..	0.978 Pr		

The thickness of a plate spring is limited by the deflection, and its breadth by the force and frequency. In a bundle of spring rods either the number or the length may be chosen freely. Some of the formulæ in the original may be simplified for approximate calculations. (*Science Abstracts,* Section B—Electrical Engineering, vol. 21, part 2, no. 242, pp. 64-65)

LES DÉPLACEMENTS DANS LES CHAMPS DES VECTEURS ET LA THÉORIE DE LA RELATIVITÉ, H. Varcollier. *Revue Générale des Sciences Pures et Appliquées*, 29e Année, no. 4, February 28, 1918, pp. 101-114. Discussion of displacements in vectorial fields and their bearing on the theory of relativity.

QUICK DESIGN OF T-BEAMS, Wm. Osborne Sell. *Concrete,* vol. 12, no. 4, April 1918, pp. 135-136, 5 figs.

Ingenious Mechanical Movements, Franklin D. Jones. *Machinery*, vol. 24, no. 9, May 1918, pp. 781-787, 15 figs.

An Interesting Application of a Reduction Gear. *The Electric Journal*, vol. 15, no. 5, May 1918, pp. 152-155. 9 figs.

Om Glidningsfriktion i Kullager. *Teknisk-Tidskrift*, Mekanik, 48 Arg., Haft 3, March 13, 1918, pp. 28-34, 14 figs. Discussion of sliding friction in ball bearings.

Compressibilité et Dilatabilité des Gaz, M. A. Beduc. *Annales de Physique*, tome 9, January-February 1918, pp. 5-28, 6 figs. Investigation of the subjects of compressibility and expansibility of gases.

Military Engineering and Munitions

Manufacturing the 75 mm. High Explosive Shell, J. H. Rodgers. *Canadian Machinery and Manufacturing News*, vol. 19, no. 16, April 18, 1918, pp. 399-403, 8 figs., 1 chart. (to be continued).

Manufacture of the 4.7-Inch Gun, Model 1906-11, E. A. Suverkrop. *American Machinist*, vol. 48, no. 16, April 18, 1918, pp. 649-658, 26 figs.

Il Problema del Tiro Antiaereo, Giuseppe Fioravanzo. *Rivista Marittima*, Anno 50, no. 12, December 1917, pp. 323-351, 6 figs. An extensive mathematical discussion of the problem of anti-aircraft firing. The ballistics of anti-aircraft shells are investigated.

Experiments with Eley Lead Crushers, F. W. Jones. *Arms and Explosives*, vol. 26, no. 307, April 1, 1918, pp. 48-49, 1 fig., 2 tables. Continuation of the article on the same subject abstracted in the previous issue. An abstract of this part will appear in an early issue of The Journal.

Inspection of the U. S. 75-Millimeter Shell, Erik Oberg. *Machinery*, vol. 24, no. 9, May 1918, pp. 794-799, 9 figs.

Machining a Nosed-In Shell, M. H. Potter. *Machinery*, vol. 24, no. 9, May 1918, p. 780, 1 fig.

Brass for Fuses and Other Munition Products, Alex. E. Tucker. *The Metal Industry*, vol. 16, no. 5, May 1918, pp. 212-214.

Motor Cars

Substitutional Tiring for Passenger Automobiles, A. Heller. (*Zeits. Vereines Deutsch. Ing.* 61, pp. 879-881, Oct. 27, 1917.) During the last year various substitutes have been devised for pneumatic tires on passenger automobiles; these substitutes being practicable under war conditions, though not entirely satisfactory. The decree of December 18, 1916, relaxed the law restricting the speed of vehicles with other than rubber or similar elastic tires to 25 km. per hr. The decree of April 24, 1917, recognized six patterns of substitutional tiring as permissible until further notice.

Substitutes for pneumatic tires fall into two classes: (1) Those with a rigid rim of metal or wood capable of moving only in the direction of the spokes; and (2) those in which "spoke springing" is supplemented by a species of "rim springing," i.e., a flexible rim in addition to springs between the two rims. Typical examples of both types of tires are given in the original.

The Arop wheel is simple and effective. A single or a double row of spiral springs wound from square steel is carried by doweled spring plates or mountings between an inner and outer rim; but this arrangement is not suitable for high-speed vehicles because the springs are not secure against displacement by lateral forces when running round curves or over obstacles. This risk is eliminated in the Moll wheel by placing each spring between two end caps which are spherical on their outside and provided with tubular extensions down the inside of the spring. One of these extensions slides within the other, forming a telescopic combination which prevents lateral displacement of the spring, while the spherical ends permit lateral displacement of the rim.

The special advantage of the Fruth wheel, built by the Maschinenfabrik Augsburg-Nürnberg, is that the springs are protected against bending or displacement by the peripheral force accelerating or retarding the vehicle. Oval springs are placed between the inner and outer rim on their sides, so that the wheel pressure comes in the plane of the winding. Successive springs are overlapped (going circumferentially round the wheel), and cross-bolts pass through the overlapping loops. The springs lie in two U-troughs which fit one within the other and relieve the springs from all transverse forces. The outer rim and the complete spring system can be mounted as one piece on the inner rim as substitute for a rubber tire. Replacement of broken springs is not easy.

The Sievert wheel uses a composite wooden rim (part of its timber being cross-cut) with steel side rings, between which and the sides of the inner rim are rings of rubber or other elastic material. The whole load is transmitted through the rubber side rings; these have a long life, since they are protected by the side plates. Wear comes on the wooden road rim.

The Siemens and Halske wheel uses spiral springs mounted radially between cups attached to the inner and outer rims. In addition, the outer rim consists of continuously wound strip steel secured by cross-clamps at intervals and protected by leather or similar material which is riveted on and renewed as required. The springs are inadequately protected against dirt and against transverse forces, but the elastic rim improves the smooth running of the wheel and reduces the risk of side slip. The Flohr wheel is of similar construction, but the outer rim is built up on the same principle as the link belt. The link pins serve as supports for the spring cups on the outer rim, but they are not protected against dirt and water. (*Science Abstracts*, Section B—Electrical Engineering, vol. 21, part 3, no. 243, March 31, 1918.)

Railroad Engineering

Intensive Locomotive Development, Capt. O. S. Beyer, Jr. *Railway Mechanical Engineer*, vol. 92, no. 4, April 1918, pp. 187-188 (Part 2).

Corrosions Provoquées par L'Acide Carbonique de la Vapeur dans les Machines Motrices à Vapeur, Dr. Ch. Chorower. *Revue Générale de l'Électricité*, 2 Annee, tome ? no. 14, April 6, 1918, pp. 509-511, 3 tables. Discussion on the subject of corrosion in steam engines produced by the presence of carbon dioxide in steam.

Santa Fe Locomotive for the Belt Railway of Chicago. *Railway Review*, vol. 62, no. 17, April 27, 1918, pp. 611-612, 1 fig.

Combined Steam and Westinghouse Brake Valve. *The Engineer*, vol. 125, no. 3250, April 12, 1918, p. 324, 1 fig. Description of a new device recently placed on the market in England.

Saving Coal by Mixing. Description of experiments on the Lehigh Valley R. R., where it is said the consumption of coal has been reduced by nearly a third by using the new plan.

This new plan provides for the crushing of bituminous coal and its mixture with anthracite silt, using two parts of the soft coal to one of the silt. Silt or slush is a dust which has passed through a mesh with openings less than 3/32 in. in diameter. It has always been considered as a useless waste, and all over the anthracite fields there are lying great banks of such silt.

A mixing plant has been erected at Hazleton, Pa., where the soft coal is crushed and mixed mechanically with the silt in the proper proportion. Additional mixing plants are now in process of erection. The process is important in view of the fact that it is estimated that millions of tons of silt are available. (*Railway and Locomotive Engineering*, vol. 31, no. 4, April 1918, p. 117.)

Brake Conditions in General Freight Service and Their Relation to Shocks and Break-in-Twos, H. F. Wood. *New England Railroad Club*, April 9, 1918, pp. 71-107.

The Waste-Heat Boiler for Malleable Furnaces, Arthur D. Pratt. Paper presented at the Boston convention of the American Foundrymen's Association. The theory of the waste-heat boiler is discussed and its advantages in the application in malleable-cast-iron foundries brought out.

The writer points out the changes in waste-heat-boiler design which have been developed in the last five years by a better comprehension of the theory of operation of this unit. The fact is especially brought out that in the modern design of waste-heat boilers high gas velocities are employed to secure the necessary rates of heat transfer. This necessitated the use of much smaller gas-passage areas, which, in turn, resulted in a greatly increased draft resistance through the boiler, with such changes in design as would naturally be brought about by this. (*The Foundry*, vol. 46, no. 309, May 1918, pp. 221-226, 6 figs.)

Value of Higher Steam Pressures, J. T. Foster. *Electrical World*, vol. 71, no. 19, May 11, 1918, pp. 977-978, 2 figs.

Steam Engineering

Feed Arrangements for Turbines Having a Steam Velocity Greater Than That of Sound, G. Zerkowitz. (*Zeits. Vereines Deutsch. Ing.* 64, pp. 869-873, Oct. 27, and pp. 889-892, Nov. 3, 1917.) The present papers contain a critical examination of the conditions prevailing in the inlets of steam turbines working at velocities exceeding that of sound. The form of the radial deflection of the inlet current of steam was determined for the cases of an ordinary parallel-walled pipe and a DeLaval nozzle. The experimental procedure adopted is described in detail. It was found that, at the diagonal cut, there was at one time the behavior of an enlargement, and at another time of a constriction. The case of free expansion was studied and a relation obtained for the average deflection which shows a noteworthy agreement with radial diagrams already in existence. It appears that the average deflection thereby arising is smaller than that given for a simple expansion from a point—a circumstance which is of value for the case of slot expansion. Finally the procedure during expansion from a point was examined and graphed. From the results the deviations which occur with ordinary feed apparatus were established, and a method of adjustment thereby indicated for obtaining a uniform deflection of all stream lines when the steam velocities are greater than that of sound. (*Science Abstracts*, Section B—Electrical Engineering, vol. 21, part 3, no. 243, March 31, 1918, pp. 81-82.)

Temperature Control for Superheated Steam, H. Huebner. (*Zeits. Vereines Deutsch. Ing.* 61, pp. 885-888, Nov. 3, and pp. 921-924, Nov. 17, 1917.) It is impossible to obtain precisely the desired superheat unless some means of control is provided. The dryness factor of steam leaving the boiler depends on the water circulation, which latter, even in the same boiler, varies with load and other factors. The heat-transmission factor is commonly taken to vary only with the velocity of the gases, but the temperature difference between gases and steam has undoubtedly an important effect. Even were a completely reliable formula available, it would still be impossible to determine the actual value of all the variables and to realize exactly the anticipated superheat. The steam temperature varies with the length of flame; and a higher temperature is reached with mechanical stoking and ash removal than when doors are opened frequently under manual control. Temperature and quantity of flue gases and dryness of steam vary considerably with the load on the boiler.

The effect of the superheat may be controlled by dampers, by water cooling, or by varying the moisture content of the "saturated" steam. Control by dampers is used most frequently, but this is not the best system. It is true that damper control strikes right at the root of the matter by cutting off the flue gases more or less completely from the superheater, but the damper doors are heavy to move and require massive supports, also they depreciate rapidly in service. The author illustrates several arrangements of swinging dampers and discusses their merits and defects. In one good form the dampers are not exposed to the hottest gases. It is generally easier to accommodate the dampers in water-tube boilers with vertical or steeply inclined tubes. Sliding dampers of refractory material are more durable and reliable than pivoted metal dampers in boilers with very high superheat. Bypass openings with refractory shutters may be used to allow more or less of the flue gases to escape without passing through the superheater; the bypass is adjusted to give correct superheat on normal load. On the other hand, the use of a bypass involves some sacrifice of boiler efficiency even though the hotter emerging flue gases be passed through an economizer. Any arrangement of dampers which involves providing a second gas path below the superheater, necessitates higher and more costly boiler setting and boiler house.

The Babcock and Wilcox temperature control uses the boiler water to cool the superheated steam to the desired temperature. This system is conveniently efficient and gives accurate control over a wide range without wasting space. A 3-way valve is used to determine the proportion of the superheated steam that is passed through the cooling pipes in the boiler. The steam temperature in the superheater itself is unaffected by this system of control and should therefore not exceed 180 deg. to 500 deg. cent., or there will be serious risk of the superheater tubes being overheated and softened. Subdivision of the superheater and taking part of the steam out to a cooling pipe in the boiler before returning it to the superheater, does protect the latter, but also introduces additional pipes, fittings, and pressure loss.

In the Kose regulator all the superheated steam is passed through a bundle of cooling tubes which is automatically submerged to a greater or less extent in the boiler water so as to maintain any desired steam temperature. If steam be passed through an independent cooling drum (fed with hot feed-water and delivering any steam raised to the main boiler), the

temperature of superheat is controlled effectively and the cooler and boiler are both more accessible for cleaning, etc. In the Wedertz regulator, water from the boiler is passed through a cooling tube mounted concentrically in a late stage of the superheater. Steam raised in the cooling tube is admitted to the steam main. The superheater itself is protected by this device, but fitting the cooling tubes offers mechanical difficulties. The Steinmuller regulator bypasses part of the steam rising through the front header and uses it to blow more or less water into the steam going to the superheater. From 80 to 100 deg. cent. control is obtained and the superheater does not exceed the temperature of the steam delivered. In the Germaniawerft regulator, water is sprayed into the superheater tubes from a concentric water pipe which has a number of fine holes on a spiral at the base of a helical strip mounted between the two tubes and serving to insure thorough evaporation.

In order to prevent formation of scale deposits in the superheater, Walther et Cie. use for cooling the overheated steam only pure condensate obtained by taking part of the boiler steam over a miniature surface condenser through which feedwater passes. In any case it is important that no unvaporized water particles be carried forward by the superheated steam. Temperature reduction by mixing saturated with superheated steam is practicable only where the superheat is moderate and the desired temperature decrease is small. A 3-way hand valve or an automatic valve may be employed. (*Science Abstracts*, Section B—Electrical Engineering, vol. 21, part 3, no. 243, March 31, 1918, pp. 86-87.)

STEAM TURBINE OF LARGE SPECIFIC OUTPUT AND THE EMPLOYMENT OF DISKS WITH SHRUNK-ON BOSSES. In order to take care of the great volume of steam after it has expanded and at the same time to avoid excessive leakage losses, the last disk of a large turbine must be of great diameter and have long blades. The body of the disk is then subject to great peripheral strains and speeds, and from this point of view has already pretty nearly reached the limits permitted even with the use of the best steel available. The writer shows, however, that these limits of loads and speeds may be materially reduced by a new method of construction of the turbine disks, based on the use of shrinking on in hub construction.

The writer starts by investigating the conditions under which the last disk of the turbine delivers the desired amount of power when rapidly rotating. While the absolute velocity V of the steam as it leaves every other disk may be high without inconvenience, because the energy which it represents is to a large extent recovered in the next disk, this does not apply to the case of the last disk, because there this velocity constitutes a loss (exhaust loss) the value of which it is well to know.

Assume a turbine which delivers 15,000 hp. at 3000 r.p.m. with an hourly consumption of 52,500 kg. of steam per hour. When expanding into a vacuum of 96 per cent, which is now common practice, this amount of steam represents a volume of 1,620,000 cu. m. and hence the last disk of the turbine has to handle 450 cu. m. (15,885 cu. ft.) per sec.

Let D_m = the average diameter of the disk in meters
S = surface covered by the blades of the disk
v = average tangential velocity of the blades
V' = relative velocity of steam at exhaust, Fig. 14
V = absolute remaining velocity of steam at exhaust
V_a = axial component of V' and V.

The condition is that $S \times V_a = 450$.

The length of the blades cannot usefully exceed one-sixth of the average diameter of the disk. If this maximum value be here adopted the preceding condition may be written as

$$D_m^2 \cdot V_a = 860$$

The ratio V_a/V' depends on the shape of the blades. The writer considers in this connection the three values of 0.5, 0.6, 0.7, of which the last seems to be the limit of what can be done. Once this ratio has been selected, all that is necessary is to select the value of D_m, in order to determine the velocities v, V_a, V', V and the exhaust loss $U_r = V^2/g$. If we take a kilo-

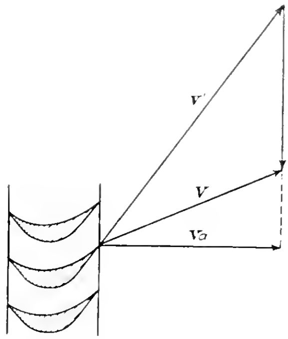


FIG. 14 DIAGRAMS OF VELOCITIES AT EXIT FROM DISK

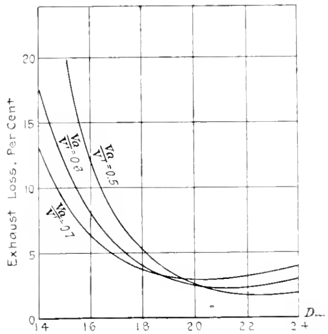


FIG. 15 GRAPHICAL REPRESENTATION OF THE MAGNITUDES OF EXHAUST LOSSES

gram (2.2 lb.) of steam assumed to be initially at 12 kg. pressure and 325 deg. cent. temperature and to contain an amount of energy equal to 95,000 kg-m., then the quotient $U_r/95{,}000$ represents the losses at the exhaust in percentage of energy initially available. The results of the computations carried out with various values of D_m are given in Table 3, and graphically expressed in Fig. 15. From these data it appears that it would have been good practice to give to the last disk of a turbine a diameter of from 2 m. to 2.2 m. Further, without making the consumption excessive D_m could be made 1.8 m. These values would permit the utilization in the last disk of one-fourth of the total energy available and bring us to a turbine with a comparatively small number of disks, for example, four, if all disks are of the same diameter.

As regards the hub C of such a disk, one must bear in mind that the diameter D = 1.4 m. (Fig. 16) and that the load uniformly distributed over its periphery amounts to about 750 tons due to the action of the centrifugal force on the blades and on the rim which encloses them. It is easy to see that

...ch loading conditions could not be applied in the case of a disk rotating at 3000 r.p.m. and built up of a single forging (hub and blade in one piece—as is the standard practice today), because such stresses would produce an excessive fatigue in the metal.

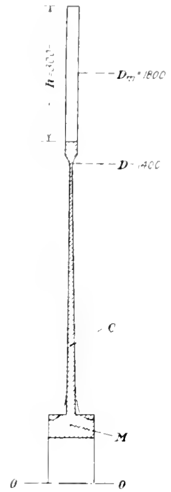


FIG. 16 SECTION OF THE LAST DISK WITH BLADES

The writer presents, therefore, a novel solution for the problem of disk construction based on the employment of shrunk-on collars on the hub.

A disk with a central bore comprises a body C (Fig. 16) and a hub M having parallel faces. This hub in itself is really a first disk of constant thickness having a low tangential velocity and acting as a basis for the radial stresses developed in the body C.

The body C and the hub M are usually connected by fillets which greatly reduce the harmful influence of reëntering angles, but these fillets may be made of quite small diameter on condition that they are located in a region of reduced stresses, it being quite easy to create such a region by a slight, purely local correction in the shape of the disk.

From this the writer proceeds to the discussion of the calculation of disks of uniform thickness. He uses a formula given by Anspach and Stodola, namely,

$$t=a+\frac{b}{r^2}-\frac{13}{32}Ar^2 \qquad [1]$$

$$t'=a-\frac{b}{r^2}-\frac{7}{32}Ar^2 \qquad [2]$$

in which t and t' are respectively the radial and tangential stresses present in the metal at a distance r from the axis of the disk. $A=\omega^2\frac{\delta}{g}$ is the product of the mass of a unit of volume of metal by the square of the angular velocity, while a and b are constants determined by the limiting conditions.

If r be expressed in meters and if $\frac{\delta}{g}=800\times 100^{-6}$ (for steel), then the main stresses t and t' may be expressed in kilograms per square millimeter by the preceding equations.

As regards disks of variable thickness, making one piece with the hub, their investigation is based on the use of two fundamental equations with three variables, these variables being, for example, the main stresses t and t' and the thickness z of the disk. Because of this, some additional arbitrary relation must be assumed in order to make possible the solution of these equations. The equations are as follows:

$$Ar+\frac{dt}{dr}+\frac{t}{z}\frac{dz}{dr}=\frac{t'-t}{r}$$

$$4\frac{dt'}{dr}-\frac{dt}{dr}=\frac{5}{r}(t-t')$$

TABLE 3 RESULTS OF CALCULATIONS WITH VARIOUS VALUES OF D_m

D_m		V_a	Exhaust loss for $\frac{V_a}{V'}=0.5$	$\frac{V_a}{V'}=0.6$	$\frac{V_a}{V'}=0.7$
			Per cent	Per cent	Per cent
1 4	220	439	37.3	17 5	13.1
1 6	251	356	11 9	8 15	6 5
1 8	282 5	265	5 43	4 03	3 78
2.0	314	215	2 67	2 52	2 96
2 2	345 5	178	1 78	2 34	3 17
2 4	377	149	1 95	2 89	3 92

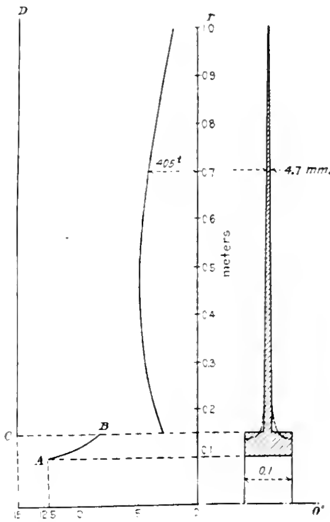


FIG. 17 SECTION OF ORDINARY DISK

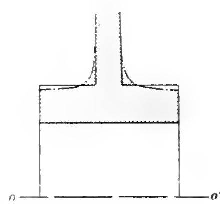


FIG. 18 HUB OF WRONG DESIGN, OF EXCESSIVE LENGTH

The solution of the auxiliary relation is actually limited by the fact that our knowledge is not always sufficient to enable us to carry out these computations. Nevertheless a good many examples which may be utilized in this conection are found in the works of Anspach and Stodola. The trouble is that even if various equations make it possible to arrive at certain results, these results are not always equally good, and one has to ask oneself which of the relations is the best. This question is of basic importance for practical purposes and the writer claims to be able to make an addition to the fund of knowledge given by the two investigators cited above.

A priori the best ratio is such as would at all points give to the two main fatigue values as nearly as possible approaching the limit F, a limit which should never be exceeded. In this way the utmost utilization of the metal is secured. This ratio is as follows:

$$t - t'/4 = F$$

and it shows that the radial fatigue (which expresses the proportional elongation) is constant and equal to the assumed

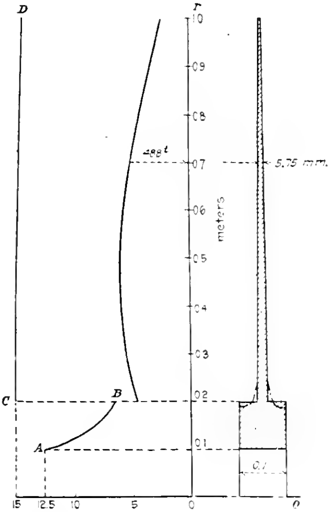


FIG. 19 SECTION OF DISK WITH REINFORCED HUB

limit F. The tangential fatigue, always quite small in the neighborhood of the hub, grows with great rapidity along the radius and tends toward the same value F. The comparison of the results thus obtained with those which follow from the other physical relations confirms the fact that the condition of constant radial fatigue leads to the selection of the highest values for such peripheral loads and speeds that can be actually used.

Let f'_o be the tangential fatigue of the metal at the junction of the body of the disk and the hub. If we write

$$\frac{4}{15}(F - f'_o)\, r_o = p$$

$$\frac{4}{3} F = q$$

the preceding condition leads to the following formulæ:

$$t = q - \frac{p}{r} \quad \ldots\ldots\ldots\ldots\ldots\ldots [3]$$

$$t' = q - \frac{4p}{r} \quad \ldots\ldots\ldots\ldots\ldots\ldots [4]$$

$$\frac{1}{A} L(\ldots) - \frac{r^2}{q^2}\left(t - \frac{q}{2}\right) - \frac{p^2}{q^3} L(rt) = C^{te} \quad \ldots\ldots [5]$$

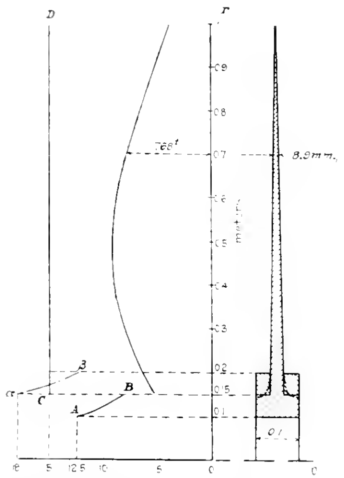


FIG. 20 SECTION OF DISK WITH HUB EQUIPPED WITH COLLAR (CURVE α β SHOWS FATIGUE IN COLLAR)

It in this last equation one makes $t = t'$ and hence $p = 0$, then, as may be proved easily, the equation reduces to the well-known formula of equal resistance disks, namely,

$$L\frac{z}{z_o} + \frac{A}{2t}(r^2 - r_o^2) = 0$$

The third item of the first member of this equatiou can be neglected under ordinary conditions, so that the equation takes the following practical form:

$$L(zt^4) + A\frac{r^2}{p^2}\left(\frac{3}{2}q - t\right) = C^{te}$$

Formulæ [1] and [2] on one hand, and [3] and [4] and [5] on the other, are sufficient for handling all numerical examples. As a rule, a large coefficient of safety should be provided in the selection of a value for F.

The use of shrunk-on collars on the hub makes it possible to extend materially the actual limits of stresses and peripheral velocities. To prove this the writer investigates the three disks shown in section by Figs. 17, 19 and 20. The hubs in Figs. 17 and 19 are of the usual type and differ in height according to the radius. The hub in Fig. 20 is similar to that in Fig. 17, but equipped with collars which raise its volume to that of Fig. 19.

All three are of the same width (100 mm.), same bore (200 mm.) and the same speed (3000 r.p.m.).

The writer selects for F a value of 15 kg. for the body of the disk, the steel used having the characteristics $R = 90$ kg., $E = 60$ kg., elongation 15 per cent. The fatigue in the bore of the hub is limited to 12.5 kg. because of the additional local stresses due to the presence of the key and also in view of the grave nature of accidents that might occur as the result of a crack in the hub. For the disk collars shown in Fig. 19 the maximum fatigue of 18 kg. would be moderate, because the presence of latent stresses is but hardly likely in these pieces of uniform thickness, and for them may be used a steel having

an elongation slightly lower than that of the disk and a tensile strength of, say, 100 kg.

Disk Shown in Fig. 17. Assume that in the bore $t = 0$ and $f' = t' = 12.5$. The constants a and b of Equations (1) and (2) are then found to be as follows: $a = 6.5$ and $b = 0.62$. These equations give us the stresses t and t' and the main fatigues $f = t - t'/4$ and $f' = t' - t/4$ of the hub along various radii.

Only the greater of these two main fatigues is of interest, namely f', the value of which is given by the curve AB. At the periphery of the hub where $r = 0$ or 0.15, it is found that $f' = 8.1$ kg. and $t = 3.03$.

In passing now to the body of the disk, it is found that the circular fibers in proximity to the hub and disk undergo the same elongation and are therefore subject to the same fatigue. The condition $f'_o = t' - t/4 = 8.1$, together with the arbitrary relation $F = t - t'/4 = 15$ kg. (straight line CD), determines the magnitudes of t and t'.

The radial stress thus found, viz., $t = 18.16$ kg., must be equal to the stress 3.03 kg. in the hub at its periphery, and hence the thickness z at the origin of the body of the disk is:

$$z = 100 \times 3.03 / 18.16 = 16.7 \text{ mm.}$$

Equations [3], [4], and [5] become then respectively:

$$t = 20 - 0.276\ r$$
$$t' = 20 - 1.101\ r$$
$$\log (zt') + 0.086\, r^2\, (30 - t) = 6.281$$

These equations completely determine the disk and the tensile stresses present therein. The load permissible at the periphery of the disk for a radius r is $2\pi rzt$ tons (the heavy-line curve, unit abscissa equal to 100 tons).

In the particular case considered above, with $r = 0.7$, the above equations give $t = 19.605$ kg., $z = 4.71$ mm., and 405 tons as the limit peripheral load. This load is considerably below the 750 tons which was thought to be necessary. The first thought would be to increase all thicknesses in the ratio 750/405 in order to obtain the desired resistance, but a simple scale sketch of the hub shows that this cannot be done because such a sketch makes it patent that the external parts are incapable of lending real support to the radial stresses in the disk, as shown by Fig. 18. Other stresses likewise limit the permissible length of the hub; thus one cannot with impunity increase indefinitely the turbine shaft, this latter being all the time under load and subject to rapid rotation (cp. *Revue de Mécanique*, June 1903).

Disk Shown in Fig. 19. One might attempt, in order to increase the resistance of the hub, to increase its height in the radial direction. As a matter of fact, the increase in the resistance amounting to about 20 per cent is secured through doubling the height of the hub, but such an increase of resistance is still quite insufficient and it cannot be increased further by employing a still higher hub.

Disk Shown in Fig. 20. The reason why fatigue cannot be materially reduced by increasing the height of the hub appears from an examination of curve AB in Fig. 19. This is because the added metal does not perform any work. Its maximum fatigue remains between the limits 6.5 kg. and 8 kg., and does not exceed that due to the centrifugal force of the hub structure itself.

The writer had the idea of substituting for this metal, which is only poorly utilized, metal which would work at its maximum efficiency. This result can be secured by adding to the hub of Fig. 17 collars placed with an initial, properly regulated compression. (Cf. British Patent No. 11849, in the year 1917.) The diagram in Fig. 20 shows that since metal added in the above manner is subject to a fatigue of from 12 to 18 kg., the peripheral load which may be applied to the disk at the radius, equal to 0.7 m., is as high as 768 tons.

In this case the compression stress exerted by the collar on the hub is 3.94 kg. and the thickness of the disk at its origin is 31.5 mm.

Still better results could be obtained by means of superimposed collars.

There was an impression that the present lack of certain special steels might hinder the construction of turbines having a large specific output. The preceding discussion shows, however, that when judiciously employed, ordinary good steel is amply sufficient for all present needs. (*La turbine à vapeur de grande puissance spécifique et les disques à moyeu fretté*, Maurice Delaporte, *La Technique Moderne*, vol. X, no. 3, March 1918, pp. 126-129, 7 figs., *tpA*)

Testing Materials

SOME EXPERIMENTS ON NOTCHED BARS, Captain Philpot. The paper describes a large number of experiments, the primary object of which was to obtain suitable dimensions and shape for a round notched-bar test piece, which could be used in acceptance tests on heat-treated steels in place of the standard square test piece. Under present conditions the pressure on milling and shaping machines is such that it appeared desirable, if possible, to remove the machining of notched-bar test pieces from such machines, and the first object in view when the experiments were started was to obtain a type of test piece which could be produced entirely by machining in an ordinary lathe.

Briefly put, Captain Philpot has met with considerable success, and a round test piece has been evolved which fulfils the conditions with sufficient accuracy for the purpose in view, the test piece being produced entirely by machining in a lathe, the notch being made by turning in an eccentric mandrel. This eccentric mandrel, however, has one disadvantage, in that it must turn through 360 deg., and the machining of the test piece takes place during but about 24 deg. of this motion. This objection, however, is partly overcome by mounting four test pieces in the mandrel, but an alternative method has been devised in which the notches in the round test piece can be milled or shaped, in place of turning them in the eccentric mandrel.

The experiments naturally carried Captain Philpot to other considerations than the mere round test piece, and the following conclusions which he came to indicate fairly well their nature:

1 Round test pieces (of types illustrated in the original paper) are sufficiently good approximations to the standard square test piece for use in acceptance tests on steel where facilities for machining the square test piece are lacking or insufficient.

2 Notched-bar test pieces, with relatively large radii at the roots of the notches, are insensitive, and are therefore unsatisfactory.

3 The tensile test, even where an extensometer is used, does not give any satisfactory criterion for detecting the condition of the material, which gives low values on the notched-bar tests.

4 The notched-bar test, made on a pendulum testing machine, is not *essentially* an impact test.

5 The notched-bar test may be made in either the Charpy or the Izod pendulum machines, and should give similar values except for very tough specimens. This similarity could prob-

ably be increased even for the higher values if the span for the 10-mm.-sq. test pieces were made 44 mm. instead of 40 mm., or the length of the Charpy specimen reduced, so that the specimens which were not entirely broken through were bent to the same included angle as in the Izod machine.

A point of importance brought out in the discussion was the view of the practical man of the value of the impact test. The matter was first raised by Commander Jenkins, who contended that the impact value of a steel has no direct value in designing, for instance, a crankshaft, and that we do not understand the relationship between elongation and impact value in regard to the factors which really govern the strength and the useful properties of a steel in a crankshaft. He thought it possible that elongation was some index of the fatigue range, and that probably the Izod figure was some indication of the rate at which minute cracks will extend in the shaft. At the same time he thought it was safe to assume that a high Izod test had a value.

Dr. T. E. Stanton said that the few cases at the National Physical Laboratory during the past four or five years in which failure had occurred through faulty heat treatment, were shown definitely by the impact test. He did not think the mere fact that one only had a lathe need prevent the use of the square test piece, and he sketched a device used at the National Physical Laboratory which enabled square specimens to be prepared by boy labor in twenty minutes.

Mr. H. W. Dickenson called attention to the fact that the bulk of Captain Philpot's work was with nickel-chrome steels. That fact should be borne in mind, because the impact test did not, in the same precise way, pick out the undesirable variations in the heat treatment when dealing with carbon steel as it did with nickel-chrome steels. His firm used the round test piece, and in the test house and workshops a preference was expressed for it. It was found to be easier to machine and easier and quicker to make. However, the trouble was that the impact test did not enable us to tell from the microstructure the quality of the steel. Take a piece of nickel-chrome steel, oil-harden it at 1000 deg. cent., temper it at 620 deg., and quench in water; take another piece of steel from the same bar and oil-harden it at 800 deg., quench at 620 deg., and very slowly cool, and very different results would be obtained. Most of them, a few years ago, would have said the second piece would give a good steel and the first one not, but the Izod test would give, say, 50 ft-lb. for the first one, while the second one, which gave a beautifully fine grain structure, would show about 15 ft-lb. He would not attempt to explain what it was that caused the difference, although he had a feeling that it was connected with the bonding between the crystals.

Mr. A. A. Remington did not think the author's round test piece was any improvement on the standard square piece from the point of view of enabling the properly heat-treated specimen to be sorted from the improperly treated one. He did not think the round test piece was easier to machine. So far as the value of the test piece was concerned, he contended that it represented the testing of materials under abnormal conditions. While all engineering structures had shoulders and corners, they were not usually designed so that they ripped right across at one blow. What it was desirable to know was the sort of notch or shoulder that could be put with safety in a material of a known tensile strength without risk and failure by fracture or fatigue. While the notched-bar test gave some information, the correlation between it and what the designer might safely put in was not very obvious to him.

Mr. T. Flather agreed with the views put forward by Mr. Remington. He had always felt that as far as possible physical tests should follow the definite requirements of the engineer and the designer; the notched-bar test, whatsoever its form, did not do so. What was there to prevent the adoption of an impact test piece which, while it had no notch on it, approximated very nearly to some of the things that were required in engineering practice?

Dr. W. H. Hatfield, speaking on the same point, said that if the tests were applied to carbon as to nickel steels, the carbon steels would be shown to be very brittle. Clearly, there was an explanation, and the obvious one was that a steel of 10 ft-lb., provided its elastic limit, yield, maximum stress, reduction of area and elongation were all right, was not a brittle steel. He would undertake to fly to Paris and back next week in an aeroplane that had a crankshaft with an impact value not exceeding 10 ft-lb. The fact was that large tonnages of steel used for the most vital purposes had values which would shock some people, yet these steels were faithfully fulfilling their functions under most stringent conditions; hence they could not be brittle. He had examined many failures, and had met with steels that had failed badly which had an impact value of 60 ft-lb. (Paper before Society of Automobile Engineers (British), read on April 10, 1918; abstracted through *The Engineer*, vol. 125, no. 3251, April 19, 1918, p. 338, *eA*)

Thermodynamics

Heat Transfer in Insulation, H. Harrison. *Refrigerating World*, vol. 53, no. 4, April 1918, pp. 11-14, 2 figs., 2 tables.

Varia

The Engineer in the New Democracy, George C. Whipple. *Journal of the Boston Society of Civil Engineers*, vol. 5, no. 4, April 1918, pp. 143-162.

Nomography—With Special Reference to Its Use in Engine Design, F. Leigh Martineau. *The Automobile Engineer*, vol. 8, no. 113, April 1918, pp. 103-111, 24 figs.

Charts

Chart for Determining the Cost of Belt Slip. *Metallurgical and Chemical Engineering*, vol. 18, no. 8, April 15, 1918, p. 426.

Chart for the Determination of Diameter, Velocity and Loss of Head in Pipes. *Engineering and Mining Journal*, vol. 105, no. 15, April 13, 1918, p. 684.

Chart Showing Penetration of Carbon, Howard Ensaw. *American Machinist*, vol. 48, no. 18, May 2, 1918, p. 756.

Thermal Efficiencies and Water Rate of Turbines with Different Steam Pressures, and Method of Ascertaining Capitalized Value of Saving Possible with Higher Steam Pressures, J. T. Foster. *Electrical World*, vol. 71, no. 19, May 11, 1918, p. 977, 2 charts.

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Survey.

LIBRARY NOTES AND BOOK REVIEWS

ARTICLES of interest from the Library of the four Founder Societies, selected list of accessions during the month, and reviews of books of special importance prepared by members of the A.S.M.E. and others particularly qualified.

Recent Gifts to the Engineering Societies Library

DURING the past twenty years the Westinghouse Electric & Manufacturing Company and the General Electric Company have collected a valuable library of some nine thousand volumes on electricity. The collection was intended especially for use in patent searches, and is particularly rich in patent material. Files of all the principal patents relating to electric light and power issued by America, England, France and Germany are present, together with copies of the patents owned or controlled by the two companies. Another feature, and one of unusual value, is a series of volumes containing the records of the important adjudicated patent causes of these companies and their predecessors during the past twenty-five years, and forming a storehouse of electrical history. There are also files of about one hundred electrical periodicals.

It is a pleasure to announce that this collection has now been presented by the owners to the Engineering Societies Library. This gift, which was arranged through Mr. Charles A. Terry, Vice-President, Westinghouse Electric & Manufacturing Company, and Mr. Charles Neave, Counsel, General Electric Company, was made with the thought that the collection would be useful to many engineers if housed in an easily accessible situation. It is an unusually valuable accession, for which the Library authorities are deeply grateful. The books have been transferred to the Engineering Societies Library, where they may now be consulted.

During April Mr. Jesse M. Smith presented nearly four hundred volumes and pamphlets selected from his private library, consisting of engineering periodicals and of records of patent causes with which Mr. Smith has been connected.

Mr. Putnam A. Bates has presented large portfolios containing a set of the drawings for the New York City fire-alarm system, which will prove interesting to engineers.

Dr. F. H. Newell has collected and presented a number of interesting publications relating to the Council of Engineering Societies on National Public Works, which was active in attempting to reform the policy governing the conduct of public works in this country during the eighties.

Space forbids the mention of many other gifts, but these have in nearly every case been of decided value to the Library, and have been appreciated also as evidence of friendly interest in its success. It is hoped that every member will bear the needs of the Library in mind and present from time to time any new or old engineering material which he can spare. General coöperation will bring to its shelves much scattered material which cannot be obtained in any other way.

Harrison W. Craver,
Director of Library.

BOOK REVIEWS AND NOTES

Kinematics of Machinery. A Text-Book on Mechanisms and Their Properties, with Many Practical Applications for Engineers and for Students in Technical Schools. By Arthur Warner Klein, M.E. McGraw-Hill Book Co., Inc., New York, 1917. 1st ed. Cloth, 6x9 in., 227 pp., 120 figs. and 7 folding plates. $2.50.

The first thirty-four pages of this book present the elementary ideas about motion, and the construction and operation of mechanism. Chapter IV explains the construction of displacement diagrams; Chapters V, VI and VII, constituting seventy-four pages, discuss the graphical determination of velocities; Chapters VIII, IX and X, of fifty pages, present graphical methods for finding accelerations. Chapter XII takes up the problem of force and mass reduction, that is, the determination of a mass assumed as concentrated at a given point in the mechanism which shall give an energy condition for the system equivalent to that existing before the mass was concentrated.

Appendix A elaborates a mathematical criterion for determining if an assemblage of links is a mechanism or not. Appendix B shows how to determine velocities and accelerations by polar diagrams.

The book presents the subject of kinematics of machinery from a mathematical rather than from the engineering standpoint. The author has elaborated very completely the instant-center method of analysis, reaching a culmination in its application to governor-gear problems. This, of course, is a very narrow field, and as all useful mechanism tends toward simplicity rather than complexity, most of its problems can be solved with quite elementary analysis. Much of what is contained in the book was presented thirty years ago by Burmester in his Lehrbuch der Kinematik, but as the author says in his preface, "the study of mechanism has always been a fascinating one for mechanical engineers," and we believe the real student of mechanism will find some stimulus here in reviewing his old ideas in the light of the original contributions of the author.

Alton L. Smith.

Mechanical Laboratory Methods. The Testing of Instruments and Machines in the Mechanical Engineering Laboratory and in Practice. By Julian C. Smallwood, M.E., Fellow, Johns Hopkins University, Mem.Am.Soc.M.E. D. Van Nostrand Co., New York, 1918. Second edition, revised and enlarged. Flexible cloth, 5x7¼ in., 399 pp., 114 illustrations. $3 net.

A second edition of this compact work on the broad principles of experimental apparatus and methods having been called for, the author has taken the opportunity afforded to make certain additions to the text. These include matter on the testing of condensers, feedwater heaters, ammonia absorption and compression refrigerating systems, and the horsepower output of electric motors; steam and ammonia tables, a Mollier diagram and tables of areas of circles, four-place logarithms and densities of water. The section on instruments has been enlarged to comprise recording apparatus, the treatment of valve setting and steam-engine testing has been extended and improved, and a section on hygrometry has been added. In the previous edition there appeared in print for the first time descriptions of a number of testing methods, among

them being a method of setting the slide valve by the Bilgram diagram, the application of the method of least squares to indicator-spring calibration, methods originated by the author for testing indicator-drum motion and reducing wheels, etc.

Finding and Stopping Waste in Modern Boiler Rooms. Compiled by George H Gibson, Mem Am Soc.M.E., assisted by Capt. Percy S. Lyon, Jun.Am.Soc.M.E. Harrison Safety Boiler Works, Philadelphia, Pa., 1918. Linen, 4¾x7 in., 270 pp., 213 illustrations $1 net.

This valuable and timely reference manual, designed "to aid the owner, manager and boiler-room operator in securing and maintaining plant economy," is a compilation of statements, tables and charts from a wide variety of sources, among which are the TRANSACTIONS of the Society, the publications of the U. S. Bureau of Mines and the files of technical periodicals. The work is divided into five sections dealing respectively with fuels, combustion, heat absorption, boiler efficiency and boiler testing, and boiler-plant proportioning and management. It is stated that only such material as is supported by the results of experiments and tests has been selected, and that statements of different authorities have been carefully compared and each source of information checked against others.

Efficiency Methods. By M. McKillop, M.A., and A D. McKillop, B.Sc. (Eng.), C.E. D. Van Nostrand Co., New York, 1917. Cloth, 5x7 in., 215 pp., 6 illustrations. $1.50 net.

A brief but reasonably comprehensive statement of the principles and aims of modern American methods of shop management, which the authors believe should be brought to the attention of all those with position and influence in British industry. The information given has been obtained from authoritative literature on the subject and from observation of the Taylor system in operation, and the book is written from the standpoint of those who have worked under that system and have been very favorably impressed with its effectiveness.

Theories of Energy. By Horace Perry. G. P. Putnam's Sons, New York and London, 1918. Cloth, 5x7¼ in., 231 pp., 4 diagrams. $1.75 net.

During the past twenty years the author has made a study of the various manifestations of energy, and the results of his thoughts and investigations are set forth in this book. A new theory of color is advanced which, it is stated, clears up a number of points not previously understood.

Agricultural Bacteriology. By H. W. Conn. 3rd ed. Revised by H. J. Conn. A Study of the Relation of Germ Life to the Farm with Laboratory Experiments for Students. Microorganisms of Soil, Fertilizers, Sewage, Water, Dairy Products, Miscellaneous Farm Products and of Diseases of Animals and Plants. P. Blakiston's Son & Co., Philadelphia (copyright 1918). Cloth, 6x8 in., 357 pp., 63 illus. $2.

The third edition has been brought up to date by the inclusion of the advances in bacteriological knowledge since the previous edition.

Aircraft Mechanics Handbook. By Fred H. Colvin. 1st ed. A Collection of Facts and Suggestions from Factory and Flying Field to Assist in Caring for Modern Aircraft. McGraw-Hill Book Co., Inc., New York, 1918. Flexible cloth, 5x7 in., 402 pp., 193 illus., 28 tables. $3.

A manual of the best practice in inspecting, adjusting and repairing airplanes, prepared for use by the machinists and riggers who are now being trained. Describes the construction, erection and testing of the planes, the various engines in use and the methods of caring for them. An account of the Canadian training camp at Borden is also given. Useful tables and a glossary are included.

Artificial Dye-Stuffs. B[illegible] Ram[illegible] Curtis Weston. Their Nature Manufacture and Uses. E P Dutton & Co New York, 1917 Cloth 6x9 in., 212 pp., 24 illus $1.60

A brief introductory work on the artificial dye-stuff industry, written for students and business men with little knowledge of organic chemistry, in which the industrial processes of the manufacture of dyestuffs and the nature of the substances used are explained at some length.

Aviation Chart. By Victor W Pagé Location of Airplane Power Plant Troubles Made Easy The Norman W Henley Publishing Co., New York 1918 Paper, 32x46 in $.50

A large chart outlining all parts of a typical airplane power plant, showing the points where trouble is apt to occur and suggesting remedies for the common defects. Intended especially for aviators and aviation mechanics on school and field duty.

Coal Gas Residuals. By Frederick H. Wagner. 2nd ed Revised and enlarged McGraw-Hill Book Co., Inc., New York 1918 Cloth 6x9 in., 244 pp., 45 illus., 12 pl. (10 folded), 7 diag., 32 tab. $2.50

The chief additions to this edition discuss the process of tar distillation and tar products, and give further information on the product derived from spent oxide, the production of nitric acid, naphthalene, benzol and toluol. A chapter on the manufacture of sulphuric acid from spent oxide has also been added, and the typographical errors in the first edition have been corrected.

Cold Drawn Steel. Issued by the Peerless Drawn Steel Co Bar Weights of Rounds, Flats, Hexagons, and Squares; Weight Tables for Plates, Metric Conversion Tables (Cover Title—Book of Weights). The Peerless Drawn Steel Co., Massillon 1918 Flexible leather, 5x8 in., 145 pp., 52 tab. $3.

Instead of giving only the weight per foot of steel bars of various sizes, this book gives the totals for bars of all the usual lengths in feet. A number of other useful tables are added.

Complete List of Base Prices, Differentials and Extras on Iron, Steel and Non-Ferrous Products. Fixed under Government Supervision. Penton Publishing Co., Cleveland (copyright 1918) Paper 6x8 in., 42 pp $2

A convenient summary of the Government prices. Prepared by the *Iron Trade Review* and presented to subscribers to that journal.

Creating Capital. By Frederick L Lipman Money-Making as an Art in Business Houghton Mifflin Co., New York 1918. Cloth, 5x7 in., 71 pp., $0.75.

Higher Education and Business Standards. By Willard Eugene Hotchkiss. Houghton Mifflin Co., New York, 1918 Cloth, 5x7 in 209 pp. $1.

Two essays delivered at the University of California on the Weinstock Foundation, established for the discussion of the various phases of the moral law in its bearing on business life under the new economic order.

Electrical Measurements. By O. J. Bushnell and A. G. Turnbull. A Practical Handbook Covering the Design and Construction of Measuring Instruments and their Uses in Measurement of Current, Resistance, and Commercial Power, with Special Reference to Watt-hour and Maximum Demand Meters. American Technical Society Chicago, 1914. Cloth, 6x8 in., 171 pp., 139 illus., 2 pl. $1

The authors' aim has been to supply an adequate description of the instruments and methods used for the measurement of electrical energy, and to show by diagrams exactly how meters should be connected under all conditions.

Electrodynamic Wave-Theory of Physical Forces. By T. J. See Announcing the Discovery of the Physical Cause of Magnetism, of Electrodynamic Action, and of Universal Gravitation Vol. 1, Bulletins 1 to 6 inclusive. Thomas P. Nichols & Son Co., Lynn, Mass., 1917 Paper, 10x12 in., 158 pp., 21 diag., 4 pl., 1 chart, 6 tab. (1 folded) $7

In these bulletins Dr. See presents his hypothesis that mag-

[illegible] action and universal gravitation are [illegible] propagated with the velocity of light through the free ether and at slower rates through solid masses. The author believes that his investigations have finally solved the problem of the nature and mode of propagation of physical forces.

Field Artilleryman's Guide. [illegible] Gun [illegible] Hoecker. Prepared for the Officers of the 108th [illegible] Field Artillery. 2d ed. P. Blakiston's Son & Co., Philadelphia (copyright [illegible]). Cloth, 4x7 in., 381 pp., 108 illus., [illegible] pl., [illegible] tab. $1.75.

A pocket guide intended to serve the immediate needs of field artillerymen in the United States Army by presenting the fundamentals of their duties.

Forging. By John Jernberg. Manual of Practical Instruction in Hand Forging of Wrought Iron, Machine Steel and Tool Steel, Drop Forging; and Heat Treatment of Steel, Including Annealing, Hardening and Tempering. American Technical Society, Chicago, 1917. Cloth, 6x8 in., 131 pp., 206 illus., 2 pl., 3 tab. $1.

A concise account, intended primarily for students. Describes the methods and tools used in hand forging, as well as the usual shop practice in hardening, annealing and tempering steel.

Galvanizing and Tinning. By W. T. Flanders. A Practical Treatise on the Coating of Metal with Zinc and Tin by the Hot Dipping, Electro Galvanizing, Sherardizing and Metal Spraying Processes, with Information on Design, Installation and Equipment of Plants. David Williams Co., New York, 1916. Cloth, 6x9 in., 350 pp., 142 illus., 3 charts, 5 tab. $4.

Discusses the various processes in a practical way, describing the machinery, materials and operations in detail. Intended as a guide in the installation and operation of galvanizing and tinning plants.

Handbook of Hydraulics for the Solution of Hydraulic Problems. By Horace William King. 1st ed. McGraw-Hill Book Co., New York, 1918. Flexible cloth, 4x7 in., 424 pp., 91 illus., 112 tab., 2 diagrams. $3.

The author has attempted to simplify the work of the hydraulic engineer by studying critically the empirical formulæ which have been devised and selecting those which are of value. These are presented with a description of their limitations and are accompanied by the necessary tables of coefficients. The twofold purpose of securing an accuracy consistent with the best experiments and of simplifying calculations has been kept in mind throughout the book.

Internal-Combustion Engine Manual. By F. W. Sterling. 4th ed. R. Beresford, Washington, 1917. Cloth, 6x10 in., 168 pp. $2.

This manual, representing the course on internal-combustion engines given at the U. S. Naval Academy, has been rewritten, enlarged and brought up to date. It now covers the theory and practice of these engines without including mathematical demonstrations and formulæ. Particular attention is given to the engines used by the Navy and to aviation engines.

Manual of Military Aviation. By Hollis Leroy Muller. Prepared for the use of Personnel of Aircraft Troops of the Army, National Guard and Reserve Corps, Members of Military Training Camps, and Airmen in General. George Banta Publishing Co., Menasha, Wis. (copyright 1917). Cloth, 5x8 in., 308 pp., 38 illus. $2.50.

Contains the theoretical information necessary for efficient military aviation service. Intended for use as a textbook and as a reference work.

Machine Shop Practice. By William L. Hartman. D. Appleton & Co., New York, 191[illegible]. Cloth, 5x7 in., [illegible]47 pp., 141 illus., 4 pl., 10 tab. [illegible]

A presentation of the elementary principles of machine-shop practice, intended for the instruction of beginners. Mathematical calculations are confined to the use of simple arithmetic.

Mechanics of the Household. By E. S. Keene. A Course of Study Devoted to Domestic Machinery and Household Mechanical Appliances. McGraw-Hill Book Co., New York, 1918. Cloth, 6x8 in., [illegible] pp., 273 illus., 11 tab. $2.50.

This book is intended to be a presentation of the physical principles and mechanism employed in the equipment that has been developed for domestic convenience. Equipment for heating, ventilating, water supply, sewage disposal, lighting, etc., is described.

Metallurgical Calculations. By Joseph W. Richards. McGraw-Hill Book Co., Inc., New York, 1918. Cloth, 7x10 in., 692 pp., tab. $5.

A convenient one-volume edition of the work, in which errors occurring in earlier ones have been corrected and new physical and chemical data have been added.

Power Stations and Transmission. By George C. Shaad. A Comprehensive Treatise on Electric Power-Station Equipment, Design and Management, and the Erection and Maintenance of Proper Transmission Lines. American Technical Society, Chicago, 1917. Cloth, 6x8 in., 180 pp., 50 illus., 3 pl., 10 tab. $1.

Presents concisely the important features of the topic. The treatment is largely descriptive and non-mathematical.

The Principles, Operation and Products of the Blast Furnace. By J. E. Johnson, Jr., 1st ed. McGraw-Hill Book Co., New York, 1918. Cloth, 6x9 in., 551 pp., 173 illus., 23 tab. $5.

A thorough, detailed discussion of the operation of the blast furnace, including both the theoretical principles and the practice of the present day. Completes the author's treatise on the manufacture of pig-iron, begun in his work entitled Blast Furnace Construction.

The Principles of Sanitary Tactics. By Edward Lyman Munson. A Handbook on the Use of Medical Department Detachments and Organizations in Campaign. George Banta Publishing Co., Menasha, Wis. (copyright 1917). Cloth, 5x8 in., 305 pp., 13 maps, including two folded maps in cover. $2.15.

The author's desire has been to provide a text book which will standardize the methods of instructing line and medical officers in the tactical use of the sanitary service with troops in campaign, and will also give a thorough grounding in the fundamentals of sanitary tactics as a whole.

Radio Telephony. By Alfred N. Goldsmith. The Wireless Press, Inc., New York (copyright 1918). Cloth, 6x9 in., 247 pp., 226 illus. $1.25.

The author has attempted in this work to give a full description of present methods of radio telephony and of the various types of apparatus employed. The first systematic exposition of the subject to appear since 1907.

The Science of Management. By Frederick A. Parkhurst. Published by the Author, Cleveland (copyright 1918). Cloth, 6x9 in., 203 pp., 7 tab. $3.

A textbook prepared to accompany the author's course of thirty lectures, delivered during 1917-18 at the Case School of Applied Science.

A Short Handbook of Oil Analysis. By Augustus H. Gill. 8th ed., revised. J. B. Lippincott Co., Philadelphia, (copyright 1918). Cloth, 5x8 in., 209 pp., 9 illus.

This well-known manual is designed to provide a concise account of the methods of applying the usual physical and chemical tests to oils. The eighth edition has been revised, descriptions of some new forms of apparatus included and some minor tests and new methods added.

Technical Mechanics. By Edward R. Maurer. Statics and Dynamics. 4th ed., revised and enlarged. John Wiley & Sons, Inc., New York, 1917. Cloth, 6x9 in., 381 pp., 178 illus. $2.50.

A theoretical mechanics written for students of engineering, in which each subject discussed has a direct bearing on some engineering problem. The book thus differs from those commonly called theoretical mechanics, and is, on the other hand,

dissimilar to books commonly entitled applied mechanics. The fourth edition has in addition 176 more problems and the modification of the articles on axle reactions, efficiency of machines, hoists, gyrostats kinetics of plane motion, rolling resistance, kinetics of a body with a fixed point, and the dynamics of any motion of a rigid body.

Text Book of Advanced Machine Work. By Robert H. Smith. 4th ed. Revised and enlarged. Prepared for Students in Technical, Manual Training, and Trade Schools, and for the Apprentice and Machinist in the Shop. Industrial Education Book Co., Boston (copyright 1916). Cloth, 5x8 in., 648 pp., 680 illus., 44 tab. $3.

A continuation of the author's Principles of Machine Work. This volume treats of engine-lathe work, drilling and boring machines, grinding, planing, milling, gear cutting and tool making. Careful explanations are given in each case.

War Administration of the Railways in the United States and Great Britain. By Frank Haight Dixon and Julius H. Parmelee. Carnegie Endowment for International Peace, Division of Economics and History. Preliminary Economic Studies of the War. Oxford University Press, New York, 1918. Paper, 7x10 in., 155 pp. $1.

An account of the methods used in the two countries and of the results achieved prior to December, 1917, during the period when the American railways were voluntarily coöperating with each other. The authors present a simple narrative, without attempting to draw conclusions.

War-Time Control of Industry. The Experience of England. By Howard L. Gray. The Macmillan Co., New York, 1918. Cloth, 5x8 in., 307 pp. $1.75.

A summary of the development and status of governmental control of industry in Great Britain, arranged to show its successive stages. Part of the information was collected for the Commercial Economy Division of the Council of National Defense. The book concludes with a comparison of English and American experience.

The Petroleum and Natural Gas Register. A Directory of the Petroleum and Natural Gas Industries in the United States, Canada and Mexico. The Oil Trade Journal, New York, 1917-1918. Cloth, 9x12 in., 548 pp. $12.

This work is based on statements made by officials of the companies listed, and gives the usually needed information as to properties, capital stock, officers, etc. The price includes an annual subscription to the *Oil Trade Journal*, in each issue of which supplemental data are to be published.

LIBRARY ACCESSIONS

Airplane Building. List of books in collection of Brooklyn Public Library, January 1918. *Brooklyn, 1918.* Gift of Brooklyn Public Library.

Alcohol as a Source of Power. (South Australia. Dept. of Chemistry. Bulletin No. 8.) *Adelaide, 1917.* Gift of South Australia Dept. of Chemistry.

Apparent Dielectric Strength of Varnished Cambric. By A. E. Kennelly and R. J. Wiseman. Reprinted from *Electrical World*, Dec. 15, 1917. Gift of Massachusetts Institute of Technology, Electrical Engineering Dept.

Ascertainment of Machinery Values and Losses. Read before the Insurance Society of New York, Jan. 11, 1916. By John Hankin. Gift of Insurance Society of New York.

Bolivia, the Republic of—Official Information and Statistics, Summarized by Julio Zamora. *New York, n. d.* Gift of Bolivia, Minister of Foreign Relations.

California Railroad Commission. Opinions and Orders, Dec. 1, 1916-March 31, 1917. vol. XII. *Sacramento, 1917.* Purchase.

Chamber of Commerce of the United States of America. Year Book, 1917. *Washington, 1917.* Gift of Chamber of Commerce.

The Chemical Constitution of the Proteins. By R. H. A. Plimmer. Part 1, Analysis. Longmans, Green and Co., *New York, 1917.* Boards, 6 x 10 in., 174 pp., 7 illus., $1.80. Gift of the publishers.

Chemistry of Linseed Oil. By J. Newton Friend. *London, 1917.* Purchase.

Cotton Production and Distribution, 1916-17. U. S. Bureau of the Census, Bulletin 135. *Washington, 1918.* Purchase.

Curtiss Standard JN4-B Military Tractor. Handbook, 1917.

Curtiss Standard Model V-2 Aeronautical Motor. Handbook, 1917.

Curtiss Standard Model OX Aeronautical Motor. Handbook, 1918.

Curtiss Standard Model OX 5 Aeronautical Motor. Parts list. *Buffalo, 1917-18.* Gift of Curtiss Aeroplane & Motor Corporation.

Design and Construction of Industrial Buildings. By Moritz Kahn. *London, 1917.* Purchase.

Dust Explosions and Fires in Grain Separators in the Pacific Northwest. (U. S. Dept. of Agriculture. Bulletin No. 379.) *Washington, 1916.* Purchase.

The Examination of Milk for Public Health Purposes. By Joseph Race. John Wiley & Sons, Inc. *New York, 1918.* Cloth, 5 x 8 in., 224 pp., 4 illus., $1.75. Gift of the Publisher.

Factor of Safety of Wire Ropes Used for Winding in Mine Shafts. By J. A. Vaughan. Reprinted from the *Journal of the South African Institution of Engineers*, Nov. 1917. Gift of author.

Foaming of Boiler Waters. (South Australia. Dept. of Chemistry. Bulletin No. 5.) *Adelaide, 1917.* Gift of South Australia, Dept. of Chemistry.

Freight Handling and Terminal Engineering. Vol. 2; 3; Vol. 4, No. 1. *New York, 1916-18.* Gift of H. McL. Harding.

Fresh Water Biology. By Henry Baldwin Ward and George Chandler Whipple with a collaboration of a staff of specialists. John Wiley & Sons, Inc. *New York, 1918.* Cloth, 6 x 9 in., 1111 pp., 1547 illus., $6. Gift of the publisher.

The German Union of Technical and Scientific Societies. By Sir Robert Hadfield. *January, 1918.* Gift of Sir Robert Hadfield.

Gold Deposition in the Bendigo Gold Field, the Factors Influencing Australian. Advisory Council of Science and Industry. Bulletin No. 4. *Melbourne, 1917.* Gift of Advisory Council of Science & Industry.

Great Britain. Department of Scientific and Industrial Research Advisory Council. Report on the sources and production of iron and other metalliferous ores used in the iron and steel industry. *London, 1918.* Gift of A. D. Flinn.

Heat Treatment of High Speed Steel. By Garnet W. McKee. Ed. 3. *n. p. n. d.* Gift of Eclipse Fuel Engineering Company.

Heat Treatment of Steel in Gas Furnaces. By Garnet W. McKee. Ed. 4. *Rockford, Ill., 1918.* Gift of Eclipse Fuel Engineering Company.

Helicopter Flying Machine. By J. Robertson Porter. *London, 1911.* Purchase.

How Baltimore Manufacturers Can Do Business with the Government. Suggestions and Information. Gift of the Civic and Industrial Bureau of the Merchants and Manufacturers Association.

Hydraulic Turbines. I. P. Morris Company, Hydraulic Dept. Bulletin No. 4. The William Cramp & Sons Ship & Engine Building Co. *Philadelphia, 1915.* Gift of F. H. Rogers.

Hydrometric Surveys (Stream Measurements) for 1916. Canada. Department of the Interior. *Ottawa, 1917.* Gift of Department of the Interior.

Industrial Plant Construction. *Buffalo, 1918.* Gift of The John W. Cowper Company.

Industrial Research in Canada. By J. C. McLennan. *Toronto, 1916.* Gift of Royal Canadian Institute.

LA NAVE A MOTORE DIESEL. [illegible] By Giorgio Supino. *London*, [illegible]. Purchase.

L'INDUSTRIE DE L'ACIER EN FRANCE. By J. Tribot Laspière. *Paris*, 1916. Purchase.

LIQUEFYING AIR BY THE LINDE THROTTLE RELEASE VALVE AT ATMOSPHERIC PRESSURE AND THE PLACE PROCESS OF 4 STEP RELEASE WITH LIQUEFACTION AT THE CRITICAL PRESSURE. Both systems availing of the Joule-Thomson equation for expanding air without recoverable mechanical work. By J. F. Place. *Glen Ridge*, 1918. Gift of J. F. Place.

MAGNESIA ASSOCIATION OF AMERICA. Anniversary advertising portfolio of "85% Magnesia" 1917. *Philadelphia*, 1917. Gift of Association.

MECHANICAL EQUIPMENT OF BUILDINGS. Vol. II.—Power Plants and Refrigeration. By Louis Allen Harding & Arthur C. Willard. John Wiley & Sons. *New York*, 1916. Purchase.

MEMORANDUM RESPECTING THE QUALITY OF SPELTER SUITABLE FOR THE MANUFACTURE OF CARTRIDGE BRASS AND OTHER HIGH GRADE BRASS. By W. R. Ingalls. *New York*, 1917. Gift of author.

MERCHANTS' ASSOCIATION OF NEW YORK. Summary of laws and ordinances applying to streets and public places in the City of New York, April 15, 1916, and the duty of police officers and citizens in connection therewith. *New York*, n. d. Gift of Merchants' Association of New York.

MUNITION WORKERS, BOOK HELPS FOR. Gift of Brooklyn Public Library.

NATIONAL PHYSICAL LABORATORY. Notes on screw gauges by the staff of the gauge testing department. *Teddington*, 1917. Gift of National Physical Laboratory.

THE PHYSICAL CHEMISTRY OF THE PROTEINS. By T. Brailsford Robertson. N. Y. and Lond. Longmans, Green & Co., *New York*, 1918. Cloth, 6 x 9 in., 483 pp., 8 illus., $5. Gift of the publisher.

THE POWER COMPANY AND THE DISTRIBUTION OF ELECTRICAL ENERGY. By Wm. C. L. Eglin. (Supplement to Current News, April, 1917.) Gift of author.

THE PRESERVATION OF WOOD. By A. J. Wallis Tayler. *London*, n. d. Purchase.

PRODUCTION OF HIGH TEMPERATURE AND ITS MEASUREMENT. By E. F. Northrup. Reprinted from the Transactions of the Faraday Society, v. 13. Gift of Alfred D. Flinn.

REFRACTORY MATERIALS: THEIR MANUFACTURE AND USES. By Alfred B. Searle. *London*, 1917. Purchase.

REINFORCED CONCRETE CARGO STEAMSHIP "FAITH," THE LARGEST CONCRETE VESSEL AFLOAT. Gift of Portland Cement Association.

SCIENTIFIC RESEARCH IN RELATION TO COTTON AND THE COTTON INDUSTRY. Manchester, Provisional Committee on Research and Education for the Cotton Industry, 1917. Gift of A. D. Flinn.

THE SHIPBUILDER'S LIBRARY. BOOKS ON NAVAL DESIGN AND CONSTRUCTION TO BE FOUND IN THE BROOKLYN PUBLIC LIBRARY. August 1917. Gift of Brooklyn Public Library.

THE SYNTHETIC DYESTUFFS AND THE INTERMEDIATE PRODUCTS FROM WHICH THEY ARE DERIVED. Ed. 3. By J. C. Cain and J. F. Thorpe. *London*, 1917. Purchase.

THEORY OF THE SUBMARINE TELEGRAPH AND TELEPHONE CABLE. By H. W. Malcolm. *London*, 1917. Purchase.

TRADE CATALOGUES

ADJUSTABLE SPRAY HEADS. Bulletin No. 601. Simplex "Seatless" Blow-Off Valve. (Descriptive circular.) Yarnall-Waring Company. Philadelphia, Pa.

ADVANTAGES OF SELF OPENING DIES. 1917. Greenfield Tap and Die Corporation. Greenfield, Mass.

AMMONIA FITTINGS AND ACCESSORIES. (Catalogue.) De La Vergne Machine Company. New York City.

AUTOMATIC EQUALIZING STOP AND CHECK VALVES. Booklet. Jenkins Bros. New York City.

AUTOMATIC REFRIGERATION WITH ELECTRIC POWER, descriptive booklet. Automatic Refrigerating Company. Hartford, Conn.

BOOKLET JUST ABOUT BOILERS. 1917. Badenhausen Co., Philadelphia, Pa. 3rd Enlarged Edition. 1917.

BOOKLET JUST ABOUT MARINE BOILERS. Badenhausen Co., Philadelphia, Pa. 1917.

CATALOGUE DESCRIBING RILEY UNDERFEED STOKERS. Sanford Riley Stoker Co., Worcester, Mass.

CATALOGUE OF BUCKEYE BARRETT OIL ENGINES FOR OPERATING ON LOW GRADE FUEL OIL. Buckeye Machine Co., Lima, Ohio.

CATALOGUE OF THE BIGELOW-HORNSBY WATER TUBE BOILER. The Bigelow Co., New Haven, Conn.

CENTRIFUGAL PUMPS. 1918. Bulletin 108-B. Wheeler Condenser & Engineering Co., Carteret, N. J.

CHAIN DRIVEN MOTOR TRUCKS AND TRACTORS. Book No. 359. Link Belt Company. Chicago, Ill.

CIRCULARS COVERING DE MANT PRECISION BENCH LATHE. De Mant Tool & Machine Company, Inc. New York City.

DIAMOND SOOT BLOWERS FOR WATER-TUBE BOILERS. 3rd Ed., 1918. Bulletin No. 119. Diamond Power Specialty Company. Detroit, Mich.

ELECTRIC ARC WELDING AND CUTTING. The Wilson System. Manual No. 1. March, 1918. The Wilson Welder & Metals Co. New York City.

ELECTRIC STORAGE BATTERY INDUSTRIAL TRUCKS AND TRACTORS. Catalog No. 117. Elwell Parker Electric Co., Cleveland, Ohio.

ELECTRIC WELDING. 1916. Catalog No. 1. The Wilson Welder & Metals Co., New York City.

ELECTRICAL SUPPLIES. 1917. General Catalog No. 20, With Price List and Discount Sheet. Monarch Electric & Wire Co., Chicago, Ill.

HAJOCA BATHS. Supplement No. 2 to Catalog R. Haines, Jones & Cadbury Co., Philadelphia, Pa.

HISTORY OF THE PLANER. 1751-1916. Cincinnati Planer Co., Cincinnati, Ohio.

HOW TO SAVE COAL. April, 1918. Bailey Meter Co., Boston, Mass.

JEFFREY STORAGE BATTERY LOCOMOTIVES FOR INDUSTRIAL PLANTS. Catalog No. 231. Jeffrey Manufacturing Co., Columbus, Ohio.

LIST OF PUBLICATIONS IN FORCE, November 1st, 1916, Classified According to Subject. Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

LUDLUM STEEL—CARBON AND ALLOY TOOL STEELS. Ludlum Steel Co., Watervliet, N. Y.

MELTING FURNACES AND COMPLETE FOUNDRY INSTALLATIONS. Frederic B. Stevens, Detroit, Mich.

PIPE TOOLS. Catalog No. 38. Greenfield Tap and Die Corporation. Greenfield, Mass.

ROPE AND TWINE INFORMATION. 79 pp. Chatfield & Woods Co., Cincinnati, Ohio.

STOCK LIST OF CUTTERS. April 15, 1918. Cleveland Milling Machine Co., Cleveland, Ohio.

SUPPLEMENT NO. 1. Feb., 1918. Containing Additions and Improvements to the O-B Materials, Listed in General Catalog No. 16. Ohio Brass Co., Mansfield, Ohio.

THE ECONOMY OF MECHANICAL FIRING. Moloch stoker, type "H." Moloch Stoker Company. Chicago, Ill.

THE LABOR SAVER, NO. 82. Feb., 1918. Stephens Adamson Manufacturing Co., Aurora, Ill.

THE POWELL PATENT PLANER. "Hy-Speed Cut". (Descriptions). Powell Machine Co., Worcester, Mass.

THE PUMP THAT "MANISTEE" BUILDS. Booklet. Manistee Iron Works Co., Manistee, Mich.

THE STUB TOOTH GEAR. Ed. 4. 1918. Fellows Gear Shaper Company. Springfield, Vt.

VERTICAL TYPE ALTERNATORS. Bulletin No. 176. January, 1917. List No. 150. Users of vertical alternators. Chart showing range of sizes and speeds of all vertical alternators. Electric Machinery Company. Minneapolis, Minn.

WESTINGHOUSE ELECTRIFICATION DATA. Feb., 1918. Vol. 2. No. 2.

WESTINGHOUSE LIGHTNING ARRESTERS, 1918, Catalogue 1-A; PORTABLE HOIST AND DUMBWAITER MOTORS, Leaflet 1395; TYPE C AUTOMATIC STARTERS WITH COUNTER E. M. F. ACCELERATION, Leaflet 1483; TYPE KN OVERLOAD RELAY, Leaflet 1728. Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.

WILLIAMS COAL CRUSHERS FOR POWER PLANTS. Bulletin No. 196. Williams Patent Crusher & Pulverizer Co., Chicago, Ill.

THE SPRING MEETING

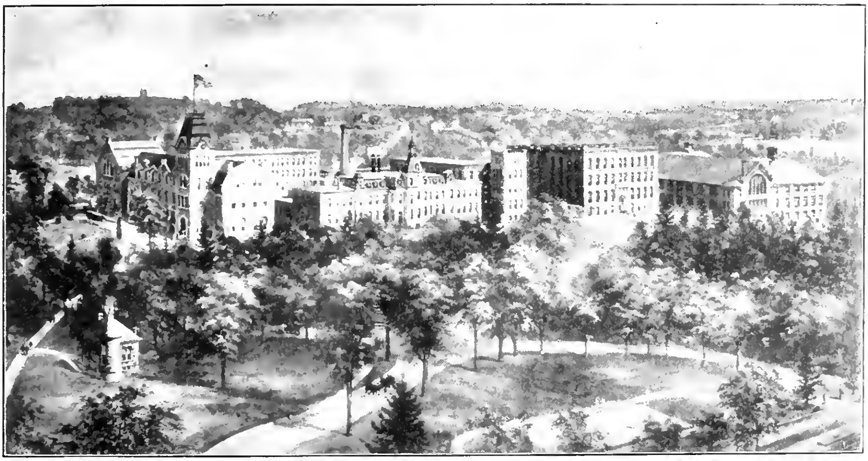
THE Spring Meeting of 1918 is destined to go down in the annals of the Society and to become generally known as "The Great Worcester Meeting." It was great in attendance, with a registration of 472 members and 514 guests, a total of 986—much the largest Spring Meeting of the Society; it was great in practical accomplishment in the interests of the Society and its work, particularly in relation to the war; and it was great in the good-fellowship and hospitality displayed by the citizens of Worcester and provided for with such admirable care by the members of the Local Committee.

It was very evident to those arriving that they were expected guests and that the people of Worcester were prepared to extend a royal welcome. Throughout the city, in every business window, was displayed an artistic placard bearing the emblem of the Society and announcing the convention. For days previous there had been articles on the Society and its meeting in the daily press, and it should be said in this connection that the publicity both before and during the convention, due to the effective work of the local Printing and Publicity Committee, was the most extensive the Society has ever received.

In the Hotel Bancroft, the headquarters, a large electric sign heralded the meeting, and at the registration desk every one received a handsome brochure and entertainment program issued by the local committee. The ballroom of the hotel was appropriately decorated, as shown in the view on the following page.

Professional sessions, however, were mainly held in the several large halls of the Worcester Polytechnic Institute, splendidly adapted for this purpose. Here the decorations were simple but effective, comprising the flags of the Allies. The opening session was in the large new gymnasium of the Institute, and on the first day of the meeting luncheon was served in the electrical engineering laboratories. These laboratories are large and extensively equipped, easily affording space for serving the four hundred or more in attendance at the first session. The Society was particularly fortunate in having these facilities, and it was a pleasure to the members to be able to spend so much time at the Institute, where inspection could be made of its laboratories, shops and general equipment. No small part of the pleasure was to be greeted there by Dr. Hollis, president of the Institute and former president of the Society.

The large attendance at the meetings was no doubt due in part to the fact that Worcester is the "center," as one speaker expressed it, "of a circle of 50 miles radius, in which is a population of 4,000,000 people," a large number of whom are engaged in the industries. It is convenient of access to many of our members. Through the coöperation also of the Boston Local Section, the Providence Engineering Society and the New York Section, delegations came to the meeting, which swelled the attendance.



Worcester Polytechnic Institute where the Members were Cordially Welcomed and Most of the Professional Sessions were Held

Professional Sessions

An account of the several sessions is given in this number of The Journal, and one, on The Economical Use of Fuel, resulted in so large an amount of contributed discussion of vital importance to the fuel question at the present time that it has been made a supplement to The Journal, issued as Part 2 of the present number. The spirit of the war and the service which the engineer must render, not only as a citizen, but because of his special attainments, pervaded the whole meeting. The papers at the New England Day Session on Wednesday very largely discussed war problems, and at the meeting on Emergency Technical War Training on Thursday there were ringing addresses which enthused the audience and impressed all with the responsibilities which must be assumed in preparing men for technical service. There were the usual technical papers on general subjects and an interesting session at the Norton Companies' plants, the latter relating to the housing of workmen and employees and work for the betterment of conditions existing among employees and of their relations to their firms.

BALLROOM OF HOTEL BANCROFT DECORATED FOR THE MEETING

SPRING MEETING ENTERTAINMENT

It was the evident purpose of the Local Committee at Worcester that, however restricted transportation facilities might be in the future, every one at the Worcester meeting, at least, should have an opportunity to ride. Special trolley cars were provided and owners of automobiles in the city freely contributed their machines so that every visitor was transported to or from the points which he wished to visit. Besides this, there were automobile trips for the ladies and the memorable all-day trip on Friday, which were enjoyed to the fullest extent.

While automobiling was a characteristic feature, it was, however, only incidental to the several social affairs which the Committee provided. These opened brilliantly on Tuesday evening, following the more formal proceedings at the hotel, by a reception at the Art Museum and a dance at the Woman's Club building adjoining, which is one of the fine club buildings of the country. This was the first affair of the kind ever held in the beautiful rooms of the Museum, and it made a most favorable impression upon every one as the initial event of the convention. Exquisite music was rendered by Boston opera players. Tuckerman Hall, where the dance was held in the Woman's Club Building, was attractively decorted with huge masses of peonies and roses. Dancing continued until a late hour and refreshments were served throughout the evening.

TRIP TO THE NORTON COMPANIES' PLANTS

On Thursday noon the members and guests were conveyed either by automobile or special train to the Norton Companies' plants, where a bountiful buffet lunch was served in Plant 6 dining room. Trips were projected for the afternoon to the model homes of the Norton employees at Indian Hill; to the company's farm gardens and to various departments of the manufacturing plants, especially that of the Norton Grinding Company, to witness a demonstration of grinding machines on Government work. The weather was rainy during the early part of the afternoon, so that these plans could not be fully carried out. Nevertheless, between showers several trips were made, and the afternoon was pleasantly spent.

It may be of interest to add that the large new athletic field and ball grounds, which were pointed out to the visitors, have since been dedicated by a large meet of the employees at which athletic games were held.

Coincident with the trips mentioned was the professional session, at which valuable information was given about the employees' service work of the Norton Companies, a report of which appears elsewhere in this number.

DELIGHTFUL EVENING AT THE WORCESTER COUNTRY CLUB

On Thursday evening was the garden party at the Worcester Country Club, the closing festivity. The location of the club, with its broad view of green slopes and foliage, is ideal, and the long evenings of daylight which we are now enjoying contribute greatly to the success of an evening party such as was here held. The club building has a large tiled terrace, where a buffet supper was served. The decorations were elaborate, and had been made under the direction of a Worcester architect, to give the effect on the terrace of an Italian garden, with well curb, statuary, and shrubbery and flowers, the latter massed against a temporary wall which had been erected on one side of the terrace or intertwined in trellises about the other three sides. Every service table bore a large bouquet of roses, and it should be said that the luncheon was admirably served, without crowding, although it was estimated that there was an attendance of 600 people. Music on the lawn was supplied by the well-known Reeves American Band of Providence, and later in the evening an orchestra in the main hall of the club supplied music for dancing.

Throughout the evening members gathered in groups about the verandas or on the lawn and enjoyed to the utmost the opportunity for a social time, and were unanimous in saying that it was one of the most successful social events they had ever attended.

ENTERTAINMENT FOR THE LADIES

Wednesday, the first full day of the meeting, was strictly a business day, with sessions morning, afternoon and evening. All-day entertainment, therefore, was provided for the ladies under the guidance of the Woman's Committee, of which Mrs. R. Sanford Riley was chairman, assisted by the wives of the Worcester membership. At ten o'clock in the morning automobiles left the Bancroft Hotel bearing the ladies to an interesting exhibit at the Crompton and Knowles Loom Works, where fancy looms were in operation. This was followed by a motor ride around Lake Quinsigamond and to Shrewsbury for a call at Iristhorpe, the summer home of Major and Mrs.

MAIN STREET AND CITY HALL, CHARACTERISTIC OF WORCESTER'S BUSINESS SECTION

Homer Gage, where the visitors were afforded the opportunity to see the magnificent gardens and landscape architecture of the estate.

The plant of the Worcester Corset Company was the next stopping place. This is one of the model factories, not only of Worcester, but of the country. Although its main buildings were erected several years ago, its features, with respect to cleanliness, ventilation and general hygienic and attractive surroundings, are comparable to the best that is to be found anywhere. The guests were received by Mr. E. Seward, treasurer of the company, and lunch was served in the main dining room. Each table was decorated by flags of the allied nations, with a carnation at each cover. After lunch the guests inspected the factory and the specially arranged exhibit of the company's products.

The next event was the trip to the Tatnuck Country Club, where tea was served and the guests spent an hour in enjoyment of the club honse and grounds. The interior was beautifully decorated by bouquets of rare flowers contributed by Mrs. Charles H. Morgan, wife of the late Charles H. Morgan, former president of the Society.

In the evening, during the professional session, a bridge party was arranged at the Bancroft in which many of the ladies participated.

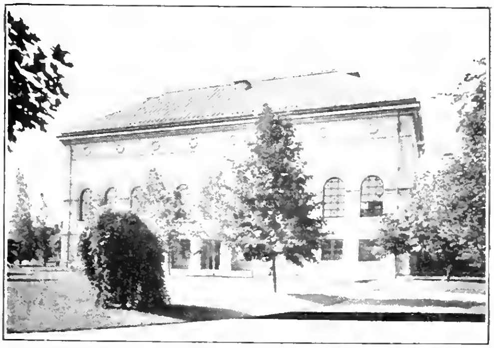
Thursday was a patriotic day, symbolized by a visit to the famous Salisbury mansion, built by Stephen Salisbury in 1770 and now used as headquarters for the Red Cross. At noon the party was taken to the plants of the Norton Companies to join with the engineers at luncheon and in the inspection of the interesting featnres of the Norton Companies' plants.

The ladies who attended the Worcester meeting were most appreciative of the reception which they had received and the care and thonght which had been displayed by the wives of the Worcester members in making their stay at Worcester so enjoyable.

The Automobile Trip on Friday

Members were warned to be on hand early on Friday morning to secure their assignment to cars for the all-day trip to Camp Devens, Lexington, Concord and the Wayside Inn. The guests were there and started on time, but shortly after it began to rain, and at times during the forenoon there was a

Norton Company's Administration Building, where Session was held on Friday Afternoon



Art Museum where Reception was held on Tuesday Evening

downpour which resulted in some delay and difficulty in getting about when Camp Devens was reached.

The visitors were to witness an artillery exhibit, and about twenty cars reached the artillery grounds, but *fortunately*, rather than unfortunately, the others did not reach this point, for, owing to the muddy condition of the road leading to the field, it would have been difficult not only to have made the trip, but to arrange for the parking of the cars. Toward noon the showers abated while the company waited for lunch, and in the afternoon the skies cleared and the balance of the trip was made under ideal weather conditions.

Camp Devens was a revelation to many of the party, who realized what equipment was required for water supply, sewerage, heat, etc., in addition to the visible buildings.

Luncheon was served promptly at the appointed time in one of the dining halls, each person bearing his tray and being served in a manner akin to what might be devised by an expert scientific manager—an example that might well be studied by many who have attempted to conduct similar functions on a much smaller scale.

After continuing through Concord and Lexington most of the party returned by the way of the Wayside Inn, where tea was served and another delightful hour was spent in the inspection of this quaint and historic hostelry.

General and Local Committees

The professional sessions, as usual, were in charge of the Committee on Meetings of the Society, L. P. Alford, chairman. The chairmen of the local committees having the general direction of the convention were as follows:

General Committee, George I. Rockwood (Paul B. Morgan; vice-chairman, Howard P. Fairfield, secretary, William W. Bird, treasurer); *Reception*, John W. Higgins; *Women's Committee*, Mrs. R. Sanford Riley; *Hotel*, R. C. Cleveland; *Transportation*, James F. Healey (John P. Coghlin, vice-chairman); *Automobile*, John C. Harvey; *Finance*, William W. Bird; *Entertainment*, George N. Jeppson; *Printing and Publicity*, Howard W. Dunbar; *Chamber of Commerce*, Charles E. Hildreth.

Various sub-committees and individuals comprising the membership of the above committees were directly in charge of the several events of the meeting; and in fact the whole Worcester membership and their wives, and many other of the local people personally helped to make the meeting the great success that it was. Everyone in attendance was enthusiastic in his praise and pronounced the gathering one long to be remembered.

OPENING SESSION

ON Tuesday evening the first gathering was held in the ballroom of Hotel Bancroft and constituted a reception to the visitors by the Worcester Chamber of Commerce, of which R. Sanford Riley, Mem.Am.Soc.M.E., is president. Mr. Riley greeted all present in behalf of the men of Worcester who make up the membership of the Chamber, saying in part:

"You will find our city interesting in many ways. First of all on account of its geographical situation. It is called a one-street town, because the main street runs along a valley with comparatively little level space at either side for cross streets. Our 200,000 population is strung out over a length of nearly nine miles. But the part of Worcester that is the most significant to engineers is the section parallel with Main Street where the industrial buildings stand. Mr. Washburn will speak later about the influence these early manufacturing buildings had in bringing to Worcester the infant industries which have now made the city famous.

"The ladies have even had to come to Worcester for such fundamental equipment as is required in the kitchen, for what kitchen is complete without some wire-goods device made from Worcester drawn wire. Machine shops all over the country send to us for their lathes, drills, grinding machines, planers and shapers. When one writes a letter he mails it in a Worcester-made envelope. Certainly the clothes one wears could not be woven without some of Worcester's looms. Shafting is driven by Worcester belts and trucks by Worcester chains. People travel in Worcester-built cars, both railroad and trolley. Every one has come in intimate contact with grinding wheels from Worcester because even if he does not require them for giant rolls or machine-shop work his dentist forces them on to you and into you where you feel them most. Our houses have Worcester rugs and carpets."

Mr. Riley referred to the splendid enthusiasm which Worcester had displayed in its campaigns for activities connected with the war and said this combination of coöperation and determination was its greatest asset. He hoped that the visitors would catch something of this spirit of Worcester. They had a very hearty welcome and a most cordial greeting from their friends of the city.

The chairman then introduced Mayor Pehr G. Holmes, who gave every one present assurance of the pleasure which the citizens of Worcester felt in welcoming a body such as that represented by the mechanical engineers who were in attendance.

President Charles T. Main, responding, presented the thanks of the Society to Worcester for its invitation to hold its convention in the city and for the hearty way in which the Society was received. He knew that the visiting members were in good hands with Dr. Ira N. Hollis, their past-president, as chairman of the Worcester Public Safety Committee.

Hon. Charles G. Washburn, president of the Worcester Polytechnic Institute Corporation and ex-congressman, gave an address on the Growth of an Industrial City, a report of which is here given. Following the address the members and guests were conveyed by automobile to the Worcester Art Museum, where a reception was held and an opportunity was given to view the remarkably fine collection of paintings, statuary and art objects. In close proximity to the Art Museum is the Worcester Woman's Club House, where, in Tuckerman Hall, beautifully decorated for the occasion, was held a dance.

THE DEVELOPMENT OF AN INDUSTRIAL CITY

By HON. CHARLES G. WASHBURN, WORCESTER, MASS.

I OWE it rather to the too favorable opinion of some of my friends in this Society than to any power of my own to either interest or instruct that I have the honor to address this distinguished audience this evening.

The Development of an Industrial City is the theme of my discourse; and, as this meeting is held in Worcester, it is very natural that I should confine myself to the development of industrial Worcester, typical, perhaps, of all New England communities of like character, excepting that no one industry has exclusively absorbed its energies.

The first record of any mill in Worcester is that of Capt. John Wing who had a saw and grist mill on Mill Brook, near Lincoln Square, in 1685.

The first manufactured product in Worcester was potash, made quite extensively in 1760. This gave the colonies an article of export with which to pay for manufactures imported from Great Britain. Isaiah Thomas manufactured paper here in 1785.

There was an increase in the variety of manufactures in Massachusetts early in the nineteenth century because of the embargo declared in December, 1807, and to the complications then existing between this country and France and England which led to an almost complete stoppage of importations, and manufactories of cotton goods, woolen goods, iron, glass, pottery and other articles rapidly sprang into existence. Some idea of the advancement of the world at this time from the engineering standpoint may be gained from the fact that the Academy of Science in France when consulted by Napoleon at the beginning of the century as to the steamboat spoke of it as a "mad idea, a gross error, an absurdity." When Fulton's first steamboat made the trip from New York to Albany in 1807, it happened to be the 17th of August, which caused many preachers to curse the machine on the ground that seventeen was the total of the horns and the seven heads of the beast of the Apocalypse.

Manufacturing Advantages

In 1823 attention was called to the advantages possessed by Worcester which should make it a large manufacturing center. Encouragement was found in the fact that towns in the interior of England, with no great local advantages, contained from 10,000 to 15,000 inhabitants, and that since the introduction of steam power, a population of from 80,000 to 100,000 had been reached. It was stated that Worcester would soon be at the head of canal navigation, and, in addition, her "inexhaustible store of anthracite coal, well calculated for steam engines," was referred to as being of the greatest value. There were deposits of coal here and a company was organized in 1829 to work them, but it was found to be too impure for economical use.

Peat, too, was found in the meadows about Worcester, and

in 1856 it was used to some extent as a substitute for wood and coal.

In June, 1827, Worcester is spoken of as containing "the largest paper mills, belonging to Elijah Burbank, five machine shops, at which great quantities of machinery of various kinds are made; one small cotton factory, a lead aqueduct factory and other works of minor note."

Use of Water Power

Worcester, unlike many other manufacturing cities of New England, has always been without any great water power. Commenting upon this fact, a citizen of Worcester said some time before 1835, to Samuel Slater, who had mills in the adjoining town of Webster: "We shall never be a manufacturing town in Worcester because we have so little water power." Mr. Slater said in reply: "You may live to see the time when Worcester will need all the water of Mill Brook to provide the steam for her steam engines." While it is true that we have no great water power here, it is interesting, and I think to most people a rather surprising fact, that the small streams tributary to the Blackstone River have played a most important part in making possible manufacturing enterprises which have subsequently developed to a considerable size.

If I were asked to give the reasons for Worcester's growth in manufactures, I should mention as one of them the unusual opportunities offered to mechanics to begin business in a small way without incurring the risk incident upon the erection and equipment of a shop. Had this not been the case, many individual companies and corporations doing today a large business could never have started.

Many incidents might be given of individuals who have begun with one machine, gradually increasing their business until it has reached a considerable magnitude. Growth of this kind is likely to be permanent. It would be almost literally true to say that there is no large manufacturing business long established in Worcester that has not at some time in its history occupied one or another of the buildings erected for rent with power to a number of tenants. There are some exceptions, but they are few.

Another very important condition has been that of abundant transportation facilities, beginning in 1828, with the Blackstone canal, connecting Worcester and Providence, and followed by the railroads connecting Worcester with Boston in 1831, with Springfield in 1839, with Norwich in 1840, with Providence in 1847, with Nashua in 1848. It will thus be seen that from an early date Worcester had the advantage of the best railroad facilities existing at the time, which, with the introduction of steam power, made certain her rapid growth as a manufacturing city. Thirty years ago there was not only direct communication with all points north and south, but there were five outlets and thirteen different lines, more or less, affording direct communication with the West.

Of course, manufacturing here, as elsewhere, was dependent almost exclusively upon water or horse power until 1840. William A. Wheeler is said to have had a steam engine of some sort to run a fan in his foundry, but in 1831 or 1832 he abandoned this engine and substituted horse power, which he used until 1840, when he put in another engine. He is credited with having the first steam engine employed in the state west of Boston.

Industrial Growth

It will obviously be impossible to treat in any detail the development of all of the manufacturing plants in Worcester. The story of each of them is full of romantic interest. I must content myself, however, with dealing with a few of them, typical, perhaps, of all. It is always interesting to know why a business is located where we happen to find it, and there is usually a good reason.

Among the most important industries in Worcester is the manufacture of machine tools. The founder of this industry here was named Samuel Flagg, or, as he was more familiarly known, "Uncle Sammy Flagg." He had a machine shop in West Boylston, a neighboring town, and moved to Worcester

Hon. Charles G. Washburn

in 1839 in order that he might save the cartage of his castings to his machine shop in West Boylston, where he built tools and cotton machinery from patterns made by William A. Wheeler.

Mr. Flagg hired room and power in what was then known as Court Mills, built on that triangle of land bounded by Main, Union and Old Market Streets, and adjacent to Lincoln Square. He had no planer when he commenced; the work was done by hand chipping and filing. Court Mills was the cradle of the machine-tool industry in Worcester, and Mr. Flagg rocked the cradle. To his men and apprentices and to those who, in turn, served them, can be traced almost all of the concerns now engaged in this business.

Manufacture of Looms

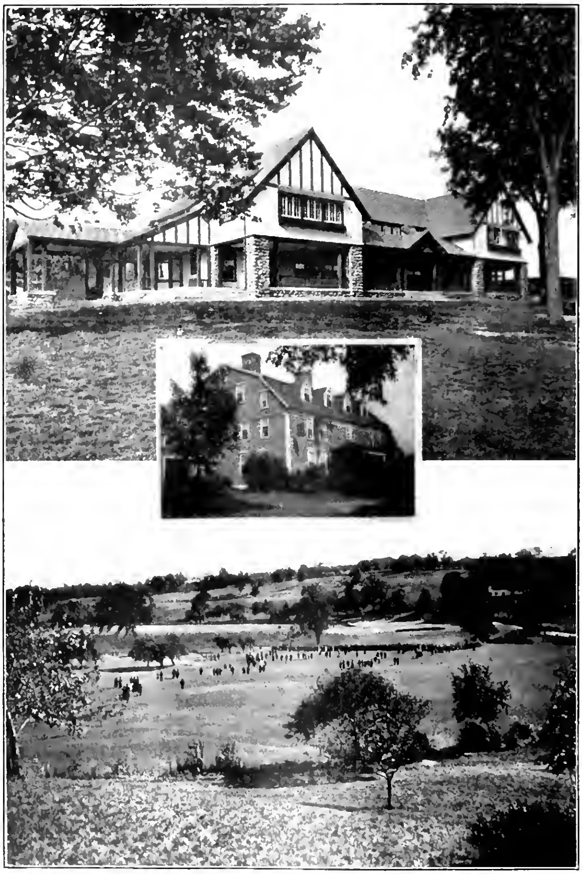
The manufacture of looms has for many years occupied a prominent place in Worcester, and it owes its location here to a very trivial circumstance. In 1836 William Crompton, then thirty years old, a native of Lancashire, England, came to Taunton, Mass., and went from there to Lowell at the request of the Middlesex Mills, where he applied his patented fancy harness motion, and, for the first time, wove fancy woolens by power. The late Samuel Davis soon after this happened to meet Mr. Crompton at a hotel in Boston. Mr. Crompton told him that he wanted to find someone to build his looms and expected to make a contract at Lowell. Mr. Davis suggested that Worcester would be a good place to build the looms. Mr. Crompton came here and made an arrangement with Messrs. Phelps and Bickford to build looms upon royalty. It was

in this way that the seed of the loom business was planted in Worcester.

In 1847 the late L. J. Knowles commenced the manufacture of cotton warp at Spencer, and subsequently was engaged in the manufacture of satinets in Warren. He made some improvement on the looms he was then running, and operated the germ of the mechanism of the fancy looms which were later built by his company, which moved to Worcester in 1866. In 1897 these two industries were consolidated under the names of Crompton and Knowles Loom Works with which the name of Worcester is associated the world over.

Perhaps I may be permitted to diverge at this point to consider for a moment the genealogy of business. Every manufacturing enterprise, like individuals, has ancestors and often descendants, although we know of some that have been childless. It is a very natural thing that the late George Crompton, a manufacturer of looms, should have become interested in developing a loom for weaving Brussels carpets by power. This led to the organization of The Crompton Carpet Company, of which M. J. Whittall was the superintendent. This association led to the subsequent absorption of the business by Mr. Whittall.

But this is not all; one of George Crompton's associates, and a man of great inventive capacity was Horace Wyman. His son, H. Winfield Wyman, and Wyman F. Gordon, a son of another of Mr. Crompton's associates, began in 1883 the manufacture of forgings for parts of looms, such as crankshafts, shuttle-box binders, and other forgings used in the manufacture of this class of machinery. That business has developed into the Wyman Gordon Company, whose products are now known in every part of the country. It may truthfully be said that if Samuel Davis had not accidentally met William Crompton in Boston in 1840, the loom industry, carpet industry, and the Wyman-Gorden drop-forgings plant might never have existed here and the manufacturing aspect of the city would have been far different than at present.



WORCESTER COUNTRY CLUB, THE SCENE OF THURSDAY'S GARDEN PARTY. THE WAYSIDE INN IN THE CENTER, VISITED DURING THE AUTOMOBILE TRIP ON FRIDAY

THE WIRE BUSINESS

Perhaps Worcester is as closely associated with the development of the wire business as with any other. This was begun in Worcester in August, 1831, by Ichabod Washburn and Benjamin Goddard, on a small water privilege on what was known as Mill Brook, where they manufactured wire and wood screws. There is an interesting incident connected with the early history of the business which illustrates the great importance of comparatively tritlng circumstances.

It seems that some time during the year 1831, Mr. Washburn, Mr. Goddard and General Heard visited North Providence, where three brothers by the name of Read were making wood screws. An arrangement was made with them and they moved their screw machinery to Worcester on a canal boat. The journey occupied three days. The business was conducted here under the patronage of Washburn and Goddard, at the Northville wire mill. At some time between April, 1836, and March, 1837, the screw business was moved back to Providence on a canal boat and ultimately became the nucleus of the Eagle, now the American Screw Company. Had the differences been adjusted — and they were probably trifling—the business of the American Screw Company might have been developed in Worcester rather than in Providence.

Washburn and Goddard also made card wire; indeed, the demand for card wire was probably the reason why the business started in this vicinity. The manufacture of cards was a very ancient industry. Tacks were first used in making hand cards, and the industry in the neighboring town of Leicester dates back to 1785. The card wire had been imported from England. From a report of Albert Gallatin, then Secretary of the Treasury, made in 1810, it appeared that the demand for cards was twice as much in 1809 as in 1808, and was increasing. Then this statement was made: "The wire is imported, and serious inconvenience would attend the stoppage of the supply, although the manufacture might and would be

immediately established to supply all demands if the same duty were laid on wire, now free, as on other articles of the same material."

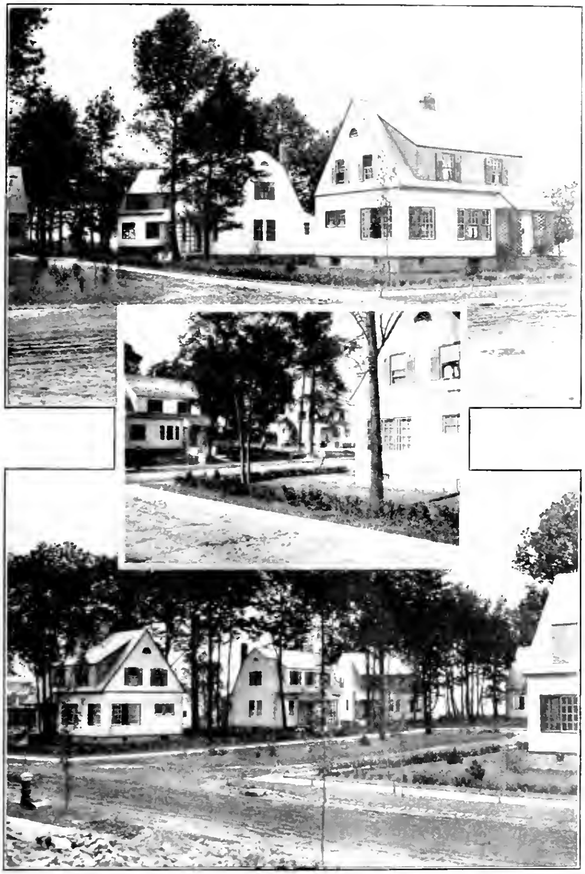
In 1835 Ichabod Washburn moved to the fourth privilege on Mill Brook, the present location of the North Works of the American Steel and Wire Company. From 1837 until 1847 he purchased in Sweden his wire-rod billets. These were rolled into wire rods at Fall River, Troy and Windsor Locks, Conn., which were brought to Worcester to be drawn into wire. The inconvenience of having rolling done at a distance led Ichabod and his brother Charles, in 1847, to locate a rolling mill at Quinsigamond, the eighth privilege on Mill Brook, now the South Works of the American Steel and Wire Company.

The manufacture of music wire in 1850; the introduction of continuous tempering in 1856; the manufacture of crinoline wire in 1859; the introduction of continuous cleaning and galvanizing in 1860; the use of the continuous rolling mill in 1869, mark the conspicuous products and processes up to 1870.

The introduction of bessemer steel about 1876 created, as is well known, a revolution in the wire business, and furnished a better and cheaper material for many purposes, among them, and in the wire business chief among them, for the manufacture of barbed wire.

Factor in City's Growth

In the spring of 1876, upon the urgent advice of Charles F. Washburn, an officer of the company, who believed that the introduction of barbed wire would solve the fencing problem for the farmers of the West, the Washburn-Moen Manufacturing Company caused automatic machinery to be constructed and patented, and in conjunction with Isaac L. Ellwood of DeKalb, Ill., acquired control of the underlying barbed-wire patents. The amount of barbed wire manufactured in the country increased from five tons in 1874 to about 150,000 tons in 1888. Its effect upon the business of the Washburn and Moen Company may be measured by an increase in the number of operatives from 700 in 1875 to 2100 in 1889.



Views in the Indian Hill Community of Employees' Model Homes, Developed by the Norton Company—A Point of Attraction for the Visitors on Thursday

Among the first experiments with the telephone were those at the Washburn and Moen Works. A memorandum found among the papers of the late Charles F. Washburn states that the first experiments in talking through a telephone wire on the premises of the Washburn and Moen Manufacturing Company were in the month of March, 1876, with No. 20 bright iron wire laid on the floors of all the rooms in the lower story, from the rolling mills into the office of Charles H. Morgan, superintendent, at 94 Grove Street. The Washburn and Moen Company were large manufacturers of bale ties for binding hay, of copper wire, of wire rope, wire nails, and of insulated wire and cables, all of which greatly contributed to the growth of the business, and of the community. This business was acquired by the American Steel and Wire Company in 1899, which became one of the constituent companies of the United States Steel Corporation in 1901.

The Worcester Wire Company, the Spencer Wire Company, the Wright Wire Company, and several wire-working plants, have all greatly stimulated Worcester's growth.

It was natural that Charles H. Morgan, Past-President, Am.Soc.M.E., who, while general superintendent of the Washburn and Moen Manufacturing Company, had devoted much time to the construction of mills for rolling wire rods, should have continued in that field after he left the service of the corporation. He organized the Morgan Construction Company in 1891, to build metal-working machinery.

Wire rods have always been rolled in this country upon two distinct types of mills, the "Garrett Mill" and the "Morgan Continuous Mill." The latter has gradually displaced the former. The first continuous mill in this country was the one I have referred to, built in the fall of 1869 by the Washburn and Moen Company, and, in its essential features, an English invention. These continuous mills now produce an average of 400 tons a day of No. 5 wire rods.

By way of comparison, it may be interesting to state that in 1853 the capacity of the rolling mill at Quinsigamond was six

Camp Devens, Near Ayer, Mass., Visited by the Members and Their Guests on Friday of the Spring Meeting. This Visit New England Cantonment Was an Exhibition of Engineering and Contracting Skill, Constructed as it was in Ten

long tons a day of 10 hours. The automatic reels known as the laying and pouring type, now in universal use throughout the world and absolutely essential to a large tonnage, were invented by Charles H. Morgan and Fred H. Daniels, while they were with the Washburn and Moen Company.

Other Great Industries

Worcester has taken a foremost place in the development of the manufacture of machine-made envelopes. The third United States patent on a machine for making envelopes was issued to Dr. Russell L. Hawes of this city in 1853. This was the first successful machine in the country. Arnold, Rheutan, and the Messrs. Swift, made their contributions to the development of envelope-producing machinery. The three largest plants here were absorbed in the United States Envelope Company in 1898. Besides these, several independent plants are in operation, all contributing to give Worcester a conspicuous place in this industry.

In 1875, F. B. Norton had a pottery in a small wooden building on Water Street, where, in 1879, he began the manufacture of grinding wheels by the vitrified process. Since that time the production of these wheels has far outstripped that of any other kind and grinding has taken a large and revolutionizing place in many lines of manufacture.

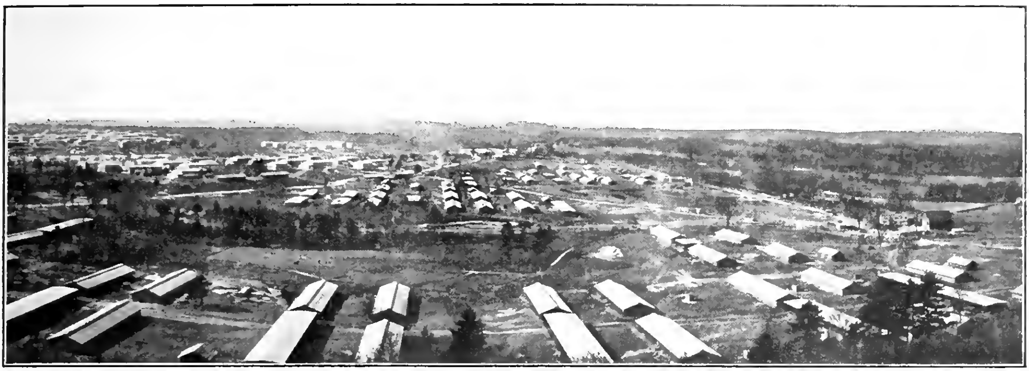
The Norton Emery Wheel Company was incorporated in 1885. Two of the prime movers in the development of this business were Milton P. Higgins, then superintendent of the Washburn shops of the Polytechnic Institute, and George I. Alden, then professor of mechanical engineering. Both of them have been vice-presidents of this Society. In 1886 the Norton Company erected new works at the present location at Barbers Crossing. Of the marvelous development of the business of this company I need say nothing. You have seen the plant. But if you would keep pace with the growth, you must see it every day.

When I last inquired in March, 1917, they had over 3500 employees engaged in the manufacture of grinding wheels and other abrasive products and 850 engaged in the manufacture of grinding machines. But the story is not yet told. This company has been among the pioneers in establishing free medical service and a system of medical supervision of its employees, has provided homes for them in what is now a most extensive and attractive community, has supplied them with garden plots, has an agricultural society and an annual fair.

This company not only makes a tremendous contribution to the material prosperity of Worcester, but to its fame as well. Mr. Higgins was a strong believer in giving students in mechanical engineering part of their training in a commercial shop. He had administered this system when he was superintendent of the Washburn shops of our Polytechnic Institute. He became a strong advocate of this half-time school and read a paper on this subject before the Society in 1899. Mr. Higgins subsequently was instrumental in securing legislation which provided that any city or town might establish an independent industrial school, the state and city or town to share equally in the cost of maintenance. He later became chairman of the first board of trustees of the Worcester Trade School.

I must resist the temptation to speak in any detail of the numerous industries not already mentioned that have contributed much to Worcester's growth and prosperity, of the manufacture of textile machinery, of the manufacture of card clothing begun here over seventy-five years ago, a business with which the name of Earle was associated for over one hundred years; of the manufacture of wool spinning machinery, once a prosperous but now a decadent industry because of the tremendous growth of the manufacture of worsteds; of the manufacture of thread, and of twisting machinery; of the foundries; of agricultural implements and machinery; of wrenches with which the name of Coes has been associated since 1840; of the building of cars, begun here in 1833 by Osgood Bradley, now under the management of the third generation of that surname; of the numerous manufacturers of woodworking machinery; of firearms, the manufacture of which by Ethan Allen was begun seventy years ago; of the Worcester Machine Screw Company, now one of the constituent companies of the Standard Screw Company; of the manufacture of steam engines, more extensive formerly than now; of the manufacture of boots and shoes, and of the manufacture of leather belting—one of Worcester's great industries.

Referring again to the genealogy of business, Isaac Goddard came to Worcester in 1812 and was apprenticed to Elijah Burbank at Quinsigamond to learn paper making. What more natural than that he should later begin to make paper machinery. The firm of Howe and Goddard became Goddard, Rice and Company, which, in turn, became Rice, Barton and Fales, the firm name for over forty years, and now in the management of the third generation of the Barton family. The J. R. Torry Razor Company, incorporated thirty-eight



Sanborn Photo Co.

Was Made Through the Courtesy of Secretary of War Baker and Major General H. F. Hodges. The Building of This Weeks, and Consisting of 1500 Buildings Covering 10,000 Acres and Having a Housing Capacity for 43,000 Soldiers

years ago, was the first to successfully manufacture razors in the United States.

The Worcester Corset Company, to be visited by some of our guests during this convention, is a monument to the sagacity of D. H. Fanning. Sixty-one years ago the late Samuel Winslow ventured to make twenty-five pairs of skates, and in the first year sold nineteen pairs. The business still continues on a somewhat larger scale under the administration of his son.

The plunger elevator was designed nearly fifty years ago by Charles H. Morgan and Milton P. Higgins, and is still made here. The manufacture of cartridge belts, begun in 1880, has vastly increased because of present war conditions. The Worcester Pressed Steel Company, the Morgan Spring Company, the Heald Machine Company and the Allen-Higgins Wall Paper Company are all a part of Worcester's new industrial center—Barbers Crossing, created by the Norton Company.

In the short space of twelve years the Rockwood Sprinkler Company, product of the inventive genius of your associate, George I. Rockwood, Mem.Am.Soc.M.E., has sprung into national prominence as designer and installer of fire-sprinkler systems.

Such, my friends, is the brief story of the causes of Worcester's industrial growth, not unlike, I fancy, the growth of other industrial cities in New England. There is nothing spectacular about it. Indeed, judged by the standard of the modern industrial community created by the hand of the engineer almost over night, the development seems slow, covering, as it does, a period of eighty years, more or less, but if it has been slow, it has been sure, and the roots strike down deep. Most of those who laid the foundations were men of simple character who began life in a small way and made slow progress. They were reticent, modest, industrious, shrewd, enterprising and some of them very public spirited. They accumulated their property not always because of great gains, but more often because of frugal living and large savings.

BUSINESS MEETING

Amendments to the Constitution Adopted and Another Amendment Proposed; Five Committee Reports Presented; Address by Prof. O. Steels of Belgium; Tributes to Prof. Hutton

On Wednesday morning, the members were taken by special cars from the Hotel Bancroft to the gymnasium of the Worcester Polytechnic Institute, where the Business Meeting and the first Professional Session were held.

President Main presided and in opening the meeting called for the result of the ballot by the membership on the amendments to the Constitution, which were first announced to the Society at the Spring Meeting of 1917 and were published in The Journal for October, 1917. The vote was as given below, and the President declared the amendments adopted.

Amendments	*Yes*	*No*
C 26	1110	20
45	1113	17
47	1116	14
55	1121	9
56	1124	6
58	1128	2

Next in order was the presentation and discussion of reports by special committees. Three of these were brief reports, presented by title, one by the Sub-Committee on Fire Protection, John R. Freeman, Chairman, on new tests of materials for fire prevention; one by the Committee on Steel Roller Chains, Prof. C. H. Benjamin, Chairman, constituting a progress report of this Committee; and a report by the Committee on Flanges and Pipe Fittings, of which the late John P. Sparrow was Chairman, constituting an addition to the 1914 American Standard for pipe fittings. This supplementary report covers heavy pressures up to 3000 lb. per sq. in.

Report on Screw-Thread Tolerances

The next report was that of the Committee on Limits and Tolerances in Screw Thread Fits, Luther D. Burlingame Chairman, which is the result of several years' work of this Committee, during which not only was an extended investigation made of the subject, but a large number of taps and screws were measured, both for diameter and lead, and the

results tabulated to determine the present practice. A large number of gages were also distributed among manufacturers, which were tried out in their regular work to determine what could be considered commercial practice.

In presenting the report, Mr. Burlingame said that the proposition was such as might present itself to the individual who purchases taps in one part of the world, bolts and screws in another and nuts in another, from different manufacturers and at different times; and who desired to produce interchangeable work commercially, in distinction from precision work.

In taking up the matter, the Committee endeavored to weigh all the phases of the situation and naturally found many viewpoints, so that the report as finally worked out was in the nature of a compromise. The attempt had been made to put it in such a form that it could be used in the every-day shop in a practical way. The Committee had voted to present the matter as a tentative report in order to bring about discussion and to enable further steps to be taken, if necessary, to better adapt it to the purposes for which it was prepared. Since that time, a measure had been introduced into Congress and passed by the House (the Tilson Bill), calling for a commission to take up the whole matter of limits and tolerances of screw threads with the idea of having the authority and sanction of the Government back of whatever might be adopted. It was to be hoped that this bill would become a law.

After a general discussion, an adjournment by those interested was made to another room so that more time could be given to the subject than could be allowed during the regular business session. Since this discussion was primarily for the benefit of the Committee in its future consideration of the report, it is of interest only to a limited extent to the membership at large. It will be the purpose of The Journal, however, to touch upon its salient features when the report is later published in its pages.

Report of Committee on Weights and Measures

The last report to be presented was that of the Committee on Weights and Measures, of which Mr. Burlingame is also Chairman. It comprises an abstract of a report entitled the Metric System in Export Trade, by F. A. Halsey, of this Committee, based upon more than 1400 answers to a questionnaire sent to several thousand manufacturing firms in the United States. It was considered by the Committee that the resulting information was of such interest and value that the Society would be rendering real service if the essential facts, as deduced from the replies, were presented to the membership.

Samuel S. Dale, of Boston, opened the discussion by reporting the results of investigations made in South America by means of questionnaires issued by the Institute of Weights and Measures. He said these investigations show "that the metric system has caused confusion in South America instead of promoting uniformity. The people of Latin America, both Portuguese and Spanish, had a very good system which they are still using. The metric system, however, has been made compulsory by law, and to a certain extent they are using both systems; and in proportion to the extent to which they are using the metric system, the confusion has increased."

C. A. Briggs, of the Bureau of Standards, said that the subject should have a fairer discussion than appeared to be the case in the report, and he considered it unfortunate that it had come up at this time when the country was devoting its energies to the war. He declared that both the report and Mr. Halsey, its author, were biased and he was critical also of the American Institute of Weights and Measures which, while there was a great deal to do in relation to the subject of weights and measures, had devoted its energies to opposing the metric system.

He contended that the report was of value only if it were considered that foreign trade relations were satisfactory at the present time, but that the Government's interest in the matter was to increase export trade and our foreign trade relations. The question was how best to do this.

William Kent said he had heard the metric system discussed for 40 years and had noticed the unwillingness of advocates of the system to read the facts. In consequence, when metric advocates received a pamphlet like this from Mr. Halsey, it would go into the waste basket. They do not want anything of that kind. The thing to do is to try to get this report to the people who *will* read it. Here are hundreds of statements of facts and what is wanted are the facts.

L. P. Alford was in sympathy with Mr. Briggs in deprecating the expenditure of energy at the present time in the discussion of the metric system, when our efforts should all be in the direction of winning the war. He desired to point out, however, that the initiative which resulted in this report, was the report made in 1916 on the metric system in export trade, by the Bureau of Standards. In other words, this assemblage of facts is a reply to the previous report.

F. A. Halsey, in referring to the statement that the only activities of the Institute of Weights and Measures had been to combat the metric system, said he fully agreed that it was an unfortunate time to bring up the subject, but that they were defending themselves. They had a constructive program and had a great deal of work of a constructive character to do; but they had had no chance to take it up because they had to oppose the movement for the metric system.

With regard to the report of this Committee and the suggestion that it was biased, he said it was a statement of facts by others. He invited anyone to read the questionnaire as printed, and to judge for himself as to whether the questions were fair.

Proposed Amendment to the Constitution

On the initiative of the Council, Jesse M. Smith, Chairman of the Committee on Constitution and By-Laws, proposed an amendment to the Constitution to take the power of appointing the regular Nominating Committee out of the hands of the President and transfer it to the voting membership. The President stated that this proposed amendment was the most important that had come up for the Society in recent years. The proposed amendment was as follows:

"Strike out line 3 of C-47 which reads 'A Nominating Committee appointed by the President,' and insert the words 'Committees of' before 'Tellers' in line 4."

"Amend C 48 to read as follows:

"There shall be a Nominating Committee whose duty shall be to select candidates for the elective offices to be filled at each election. This Committee shall be elected annually by the voting membership of the Society. Other nominating committees having the same powers, may be constituted by the voting membership. The number of members, the election, organization and procedure of all Nominating Committees shall be as the By-Laws shall provide."

In proposing the amendment, Mr. Smith said that it embodied the fundamental principles and that the details of carrying out the election in any manner would be embodied in the By-Laws to be prepared later.

George I. Rockwood asked how the candidates were to be nominated, a question which led to a general discussion which was concluded by Louis C. Marburg of the Sections Committee, who confirmed what Mr. Smith had said and stated that the matter had been discussed by that Committee and a somewhat elaborate scheme worked out for a large Nominating Committee comprising delegates from the different Sections. The matter was brought before the Council and finally the point was raised that the Constitution should contain only fundamental ideas and that the details of appointing or selecting the Nominating Committee should be left to the By-Laws, which, however, could not become workable until the constitutional change was made.

Discussion Desired by Membership

On motion of Prof. Arthur M. Greene, Jr., the meeting voted to request a general discussion by the membership on the proposed amendment, with a view to publishing comments, and particularly adverse comments, if there are such. Communications on this subject are, therefore, solicited.

Engineering Council

Alfred D. Flinn, Secretary of the Engineering Council, was in attendance and gave a brief review of the organization of the Council and of the work which has developed under its direction during the past few months. The organization of the Council has already been fully presented to the readers of The Journal and the following summary of its committees will be of added interest:

Besides the usual standing committees is the American Engineering Service Committee, engaged in finding specialists for Government service, one of the recent requests being for men for submarine service and in response to which Mr. Flinn appealed to those in attendance at the meeting to send the Engineering Council the names of any graduates of technical schools under 35 years of age who might be ambitious for submarine service; the committee on Fuel Conservation is in coöperation with the Bureau of Mines and the U. S. Fuel Administrator; a recently established committee on Water Conservation through one of its members, Calvert Townley, recently presented a most valuable paper on the subject to the U. S. Chamber of Commerce; also, a committee on Industrial Affairs, which has been engaged in combating with other large organizations the so-called "anti-efficiency rider" in appropriation bills before Congress. Recently, the naval appropriation bill as finally passed indicated at least partial victory for the position which engineers are taking in permitting bonuses and similar rewards for additional or better work accomplished in the processes of production.

Arthur M. Greene, Jr., said that the Council of the Society at its meeting in Philadelphia recently, went on record as approving the action of the Engineering Council and believed it was its intention to have notification to this effect sent to Washington. He therefore introduced the following resolutions which were approved unanimously by the meeting:

"Whereas, It has come to the attention of the Spring Meeting of The American Society of Mechanical Engineers that the Engineering Council has sent a communication to Washington protesting against the riders to the appropriation bills preventing the use of money for work where time studies are made and where bonus is to be paid for work, and that this protest has been approved by the Council of The American Society of Mechanical Engineers; and

"Whereas, It is the opinion of this Society that accuracy and speed of production are important factors for the successful prosecution of the war, and, as engineers, we think time studies and bonus systems will aid in the increase of production and accuracy;

"Be It Resolved, The membership of this Society at its semi-annual meeting held in Worcester, Massachusetts, June 5, 1918, approve of the resolutions of the Engineering Council and respectfully request the President of the United States and both Houses of Congress to give careful consideration to the disastrous effects of these riders to the proper amount of production of material for our men at the front."

The resolutions were immediately wired to President Wilson, to the President *pro tem.* of the Senate, and to the Speaker of the House, and have since been acknowledged.

Telegrams were read, one from Col. John J. Carty of the Signal Corps and one from John D. Ryan, Chief of the Aircraft Production Board, asking for names of engineers to enter the service, one for a man to undertake the management of a large Signal Corps shop and the other for men who could in any way assist in aircraft production. These are indicative of the many calls which are coming to the Society for specialists in different fields which, to a large extent, have been successfully taken care of by its employment department.

Remarks by Prof. O. Steels

Prof. O. Steels, of the University of Ghent and the head of the Belgian Mission on Industrial Management, then gave a brief address, expressing his appreciation of the Society's assistance to the Mission. The industrial energy of Belgium is still great even in the face of the destruction of most of its sources, and will need the special impetus of scientific organization and management. This Mission represents the Belgian Government's study and preparation of steps toward starting industry after the war.

Some idea of the magnitude of the task of reconstruction to which the Mission looks forward was obtained from Professor Steels' brief review of the country's activities.

Only 30 per cent of the population (7,500,000 in 1910) was engaged in agriculture but the culture was so intensive that the yield was $2,000,000 per year. Horse breeding was one of the best-known activities, resulting in an annual export of 1400 horses a year to the United States. Horticulture was also important, amounting to an export trade of $500,000 worth of products to this country each year.

Besides those principal enterprises, Belgium is rich in some of the natural resources. The coal mines are deep and were operated to yield about 23,500,000 tons a year. A new and important coal region was discovered a few years ago and steps had been taken toward working it. It is presumed that many of those pits are now operated under German rule.

In 1911, twenty-five steel works, employing 18,000 workmen, produced 2,200,000 tons of iron and steel and 1,650,000 tons of finished steel products were turned out by the rolling mills. The earliest developments of the steel industry were first perfected in Liège and its vicinity. Near Liège, too, the zinc industry was a flourishing one, producing about one-quarter of the world's output of that commodity. Machine shops, locomotive works and similar industries were well developed.

Flanders was especially given over to the textile industry where there were about 1,200,000 spindles at work. Some wool and jute were also produced in that region. The glass industry—both ordinary and plate glass—was world-known. In harbor facilities, Antwerp was one of the first commercial ports of Europe, renowned for its world trade.

In closing, Professor Steels spoke feelingly of the military achievements of his country: "From the first days of August 1914 our army headed by our King has been in the field, and is still in the trenches doing its bit to stem the German onslaught. King Albert and Queen Elizabeth have lived with their soldiers during these four last years, sharing every day their dangers and their sufferings."

Tributes to the Late Frederick R. Hutton

As a fitting close to the Business Meeting, the President spoke briefly of the late Frederick R. Hutton, Honorary Secretary of the Society, who, more than any other member, had been closely associated with the activities of the Society. He said he had appointed a committee to prepare a memorial of Dr. Hutton, which would be presented at the next Annual Meeting in December.

Past-President Worcester R. Warner added a few words of appreciation, saying: "Professor Hutton is the one in the estimation of the older members who did more than any one else for the upbuilding of this Society, for making us acquainted with each other, for making the meetings pleasant for us as well as happy and agreeable in every way. When he first became our Secretary the membership was not made up of the type of men I see before me today. There were very few college men among the early membership of this Society, and that made it all the more difficult for the Secretary, who was a scholar and a master of English, to get along and endure our poor English. He used to translate my papers and my reports into English, and I believe it was an important part of his work to see that we made as creditable a record and report as possible. I used to thank him for it, which I have no doubt others of you here have done, and I told him years ago I wondered at the patience he had with us. And so we all remember him with the greatest pleasure and reverence. I mentioned to some of our members a little while ago the excellent resolution which he prepared expressing our thanks to the British Institution when they entertained us some eight years ago. I wish the members would read it;[1] it reads like Emerson or some of the other masters of English; and there were in those early days comparatively few masters of English in this Society."

William Kent also added a few words in which he referred to a remark made by Professor Hutton in reference to Mr. Holloway, one of the early Presidents of the Society, to the effect that his memory of Mr. Holloway was particularly of the treatment he received from him when a young man visiting the Lake Erie Engineering Works in Cleveland; that Holloway endeared himself to all the young men by treating them so kindly, giving them every facility to see his works and to talk with him and to have a good time with him. "That was Hutton's opinion of Holloway; that is my opinion of Hutton. Hutton did the same thing. Hutton's fond memory of Holloway was the treatment he received from Holloway. Our memory of Hutton is the treatment we received from Hutton. We know what joy it was to Hutton to have the memory of those who had been good to him; may it be an inspiration to the younger men who knew Hutton more recently to remember that that is the kind of man he was and that is the kind of men they should be—whose joy it is to help their fellow men."

NEW ENGLAND DAY SESSIONS

When the program for the Spring Meeting was arranged by the Committee on Meetings, it was planned to have the sessions on one day comprise papers contributed by engineers in Worcester and other New England cities, and this program was carried out with the following contributions relating to New England industries:

The Small Industry in a Democracy, George H. Haynes.

The Textile Industry in Relation to the War, J. E. Rousmaniere.

Converting a Factory for Munitions Manufacture, John S. Holbrook.

Some Economic Aspects of Fire Protection Problems and Hazards in War Times, J. Donald Pryor and Frank V. Sackett.

Oil Fuel in New England Power Plants, Henry W. Ballou.

This session developed naturally from that of the evening before, at which Mr. Washburn spoke on the Industries of Worcester, so many of which began in a small way. Following this was the address on Wednesday morning by Prof. George H. Haynes, treating of the relations of the small industry to a democracy; and in turn were the papers on certain of the specific industries and problems that are now being considered by New England manufacturers.

The papers by Messrs. Pryor and Sackett and by Mr. Ballou appeared in The Journal for June, and in this number are abstracts of the addresses by Professor Haynes and Messrs. Rousmaniere and Holbrook.

At the opening of the meeting, Dr. Hollis brought a message to the membership on the need for the conservation of our resources and the coal situation, which is also reported.

ADDRESS OF DR. IRA N. HOLLIS

I have one message that I want to send back to all parts of the United States, to every Section and to every engineer who can be reached through this meeting. While we are sitting here talking about things that we hope will be to the benefit of our country, our boys are quietly going to register themselves for service. While we are sitting here, too, some of our sailors are losing their lives on the sea and our army is shedding its blood on the other side. We ought to carry back home a certain consecration to duty for those boys. After all, what is it they have gone to fight for? We call it for democracy—to make the world safe for democracy; but there is something far more fundamental than democracy in this world and that is the Ten Commandments. Our boys are going to the other side to bring back to us the influence of that most appealing figure in all history, far greater than the victors of nations, far more potent than emperors and crowned kings and the glories of democracy,—the influence of Him who died on the cross.

The important problem before us, at the present time, I contend, is essentially a fuel problem. In Massachusetts, we bid fair in the course of the next year to be at least 6,000,000

[1] Trans. vol. 32, 1910, p. 626.

tons short of the necessary supply of coal to carry on our industries. The only difference of opinion on the subject is whether it will be 6,000,000 or 10,000,000 tons. Mr. Storrow called together a number of engineers in Boston, representing all the different societies, and through their influence a committee of five or six was named to take charge in Massachusetts of the work of effecting this 6,000,000-ton reduction in the demand for coal. The committee appointed, it may be said, was made up of men entirely from this Society.

It is no small task to present this case in every place in the state, but I have agreed to do that, or to call on members of our Society who live in New England to help in doing it. The great appeal to men who live in New England is a moral appeal. It has never failed yet. Behind the conservation of coal is a larger question. I call it one of the great moralities before the American people—to be frugal in the resources that God Almighty has put here for us to use in the future. That is what we ought to think of when we go into the fuel question.

During the past year one of the great firms here in Worcester formed a conservation committee, made up of employees, who had the power to enforce a certain policy to effect economies upon the entire company. It amounted to establishing a fuel board in that plant and is what we ought to bring about in every concern in the state, so that the men will work together willingly to save fuel. They discovered, after having gone through the month of December on the old system, that during the months of January and February they saved 40 per cent of their coal by economies outside of the boiler and engine rooms. They did not direct their attention to reducing the amount of coal for a certain quantity of steam, but to the use of the steam power after it was handed over to mills that had no responsibility for producing it. Forty per cent saved, when it was within their power to have saved it any time in the last twenty years!

I want to place forcibly before you the absolute importance of taking up economies and savings within the establishments where they are to be effected. After all, this is largely a question of good common sense, as are the bulk of the problems in our profession. In any establishment it is a matter of good-will and coöperation shared by everybody from the apprentice to the highest officer in the place, so that every individual has the feeling that he, too, is making some contribution.

If we can only put that into our factories and into our homes and into this country, if you can only take that back home with you, our boys on the other side are safe and they will do their task with the smallest loss. I feel more strongly than anything else that the Almighty has decided this long, long ago: those win who deserve to win. In God's name let us deserve to win. [Great applause.]

THE SMALL INDUSTRY IN A DEMOCRACY

By GEORGE H. HAYNES,[1] WORCESTER, MASS.

THE purpose of this paper is to raise question as to some of the industrial implications of democracy,—democracy which in government is set before us as the goal worth all this outpouring of blood and of treasure, this world anguish.

A generation ago, Gen. Francis A. Walker, then the dominating figure among American economists, declared: "For one, though believing thoroughly, so far as politics are concerned, in a government of the people, by the people, for the people, I see nothing which indicates that, within any near future, industry is to become less despotic than it now is. The power of the master in production, 'the captain of industry,' has steadily increased throughout the present century."

Though describing industry as having become "despotic," in his Political Economy (1887) which for a decade became the standard text for American college students, General Walker did not think it essential to give a single paragraph to the corporation as a form of business organization, nor a page to the modern monopoly problem, and he made no mention of such a thing as a "trust." In the 30 years that have since passed, concentration and consolidation have gone forward at an unprecedented rate. The new era in industry may be admirably illustrated by examples from the tale told last evening by Mr. Washburn. Thus, the enterprise started by Ichabod Washburn becomes the Washburn and Moen Company. It next is absorbed by the American Steel and Wire Company, with many plants in Worcester and elsewhere. And presently that company becomes one of the many concerns, aggregating nearly 150 plants, consolidated into the United States Steel Corporation, with a capital stock of $1,100,000,000. The net earnings of this greatest of American industrial corporations were $295,000,000 for the past calendar year, and it carries on its payroll some 200,000 employees.

There are those who see nothing of challenging inconsistency presented by the development of such an *imperium in imperio*, of such an autocratically controlled industrial army—the largest among many—in America, the leader of the world toward the goal of democracy in government. They see no incongruity in the fact that we compel the children of this host of workers to attend our public schools, and we urge the newcomers to become American citizens—at any rate, we are going to urge them to do so, from now on!—and we thrust the ballot into their hands, so that in our accepted democratic theory the vote of the newly naturalized Syrian or Polander or Croatian counts for as much as does the vote of Judge Gary himself in determining who shall be the chief executive of Gary, Indiana, or the chief executive of the state of Pennsylvania, or the chief executive of the United States of America. Yet that workman's vote or voice is not to be counted at all in determining matters as intimately concerning his own life as the conditions of his daily work or the amount of his daily wage. These matters are determined for him by the management constituted by the control of 51 per cent of the stock of the New Jersey corporation. Stock ownership by the workmen, to be sure, is encouraged by the United States Steel Corporation, as by many another far-sighted and progressive concern; yet it is safe to say that in not one large corporation in a hundred does the stock vote of the workmen amount to enough to qualify at all the essentially autocratic management of the enterprise.

Nor is the situation greatly bettered, so far as consistency with political democracy is concerned, if the workmen be organized so that collectively they may drive a hard bargain to enforce their own demands. It used to be said that Russia was governed by a despotism tempered by fear of assassination. In democratic America, today, there is many a great industry which is controlled by an autocracy tempered by

[1] Professor of Economics and Political Science, Worcester Polytechnic Institute.

fear of revolution among its workmen in the form of a strike or sabotage.

And yet how many of us have reached the point where we believe that democracy in industry is coming, and ought to come? A striking forecast has recently come from the man who was the first president of the United States Steel Corporation, who later became the head of the company that runs the largest armament plant in the world, yet who, at the present moment—his willing service commandeered by the Government—is at the head of our Emergency Fleet construction. Mr. Charles M. Schwab is reported as saying: "The time is near at hand when the men of the working class—the men without property—will control the destinies of the world. The Bolsheviki sentiment must be taken into consideration, and in the very near future we must look to the worker for a solution of the great economic questions now being considered. I am not one carelessly to turn over my belongings for the uplift of the nation, but I am one who has come to a belief that the worker will rule, and the sooner we realize this, the better it will be for our country and the world at large."

The essence of democracy, in its industrial implications, is not to be found in equality of size, or wealth, or strength. Such equality is neither desirable nor possible. The motto of democracy in industry should be that of Carnot's army of the French Revolution: "*Carrière ouverte aux talents.*"

We recognize that in a democracy the individual, however humble his station, has a right to life, liberty and the pursuit of happiness, a right to the protection of his health and safety, and to educational opportunities which shall give him a fair chance to develop according to his ability. And the war is teaching us, more plainly than we ever saw it before, that, on the other side, in a democracy the State has a right to expect from its citizens equality of sacrifice, in the sense that sacrifice shall be gaged according to their several abilities to bear burdens.

In a democracy, the industry—small as well as great—has its rights, entitled to careful safeguarding; and it has likewise its duties and special services, upon the rendering of which the very destiny of the State may depend.

Democracy is best held sane and secure against attack, if the field of enterprise is kept open for men with a capacity for leadership. At present in the United States there is little to be feared from the I. W. W. or Bolsheviki. But there is grave danger for the future if no heed is now paid to the causes producing these movements, and if the field of enterprise shall seem closed to all but those of wealth or "pull."

In the field of industry as in the field of government and on the field of battle, democracy is on trial. Every forward-looking man anticipates that the industrial testing of democracy after this war will be more severe than ever before. In its relations to industry democracy must develop efficiency equal to that of autocracy, else it is doomed to defeat. But efficiency in industry, as in war, is not alone a matter of training or equipment or centralized control,—it is a matter of the spirit, of morale. Events of the past few weeks have proved that the morale of liberty-loving citizen soldiery may offset in no small degree the superior training possessed by professional fighters. So whatever conduces to better morale in industry may more than counterbalance some other highly valued elements of efficiency. In two respects, as I shall attempt to show later, the small industry distinctively and strongly does conduce to better morale: (1) in the enthusiasm which it evokes in the ambitious young employer who is managing an enterprise which is his own; and (2) in the team play which is worked out between employer and workman.

Of course, democracy must find methods not inconsistent with its own spirit to get the greatest industrial enterprises accomplished. Democracy does not imply that in the twentieth century the dial is to be turned back and that giant industries are to be split up into small units, or that a limit is to be prescribed beyond which an industry must not expand.

Democracy does imply that industries, great and small, shall be given scope to develop their capabilities up to the point where their further expansion would hamper that of others, or would prove injurious to the public interest. A generation of fumbling efforts to work out the state's proper relation to industrial control has brought into recognition some things which 40 years ago were strangely blurred.

In the first place, we recognize far more clearly than when the Sherman Anti-Trust Law and the Interstate Commerce Law were enacted, that many industries are inherently monopolistic, and that any effort to force competition in them is doomed to failure and can result only in increased cost and lessened efficiency of service. In this broad field, public interest is best to be subserved either by private operation under thoroughgoing regulation, or by government ownership and operation. Right now, under stress of war, weighty experiments are being tried out, which will throw much light on the monopoly problem.

In the second place, it is now recognized that in the so-called "trust movement," where no element of genuine monopoly has been present, a large factor has been the desire to secure the economies of large-scale production. This is a sound and constructive motive, and democracy is concerned to have such economies attained, to the extent that does not interfere with some higher or more essential purpose.

In the third place, it is obvious that certain enterprises must be conducted on a giant scale, if at all. A copper-smelting plant, a sugar refinery, a powder plant, locomotive works, as such enterprises are now conducted, may well involve an initial investment running up into the millions. The scale most conducive to economical production is not to be predetermined by any rigid or general rule. It must be worked out in each industry and in each community according to the conditions which conduce to greatest efficiency. Each enterprise should have a fair chance for a start and for normal growth, according to the effectiveness which it develops.

Democracy craves variety and individuality in industrial development. It needs the small industry not less than the large. The point which I wish to emphasize is, not so much that in a democracy the individual enterpriser needs the help and protection of the state, as that the state needs the widely distributed initiative and enthusiasm of ambitious young enterprisers.

Democracy needs to avail itself of the varied industrial talent and aptitudes of the many, and not merely of the genius of the few. There is another and a more important concern here involved than that of getting a maximum output produced at minimum cost. It is the calling forth of widely diffused and varied industrial leadership. "The magic of private property turns sand into gold." It means much for the strength and stability of a democracy, if the man with capacity for industrial leadership finds scope for developing his aptitudes as his own master, in the enterprise of his own starting, and not as a foreman or as a member of the staff of some giant corporation. Right here lies a cardinal difference between industrial democracy as we would see it develop in the United States and the type of socialism which many fear. Is it not possible to keep open the door of opportunity and enable the young man to discover and develop his own aptitude, without at the same

time making him the servant of the state, subject to a repression no less galling because imposed at the behest of a majority?

In recent years there has developed a new and discriminating appreciation of certain advantages of the small plant in industries which are not inherently monopolistic or in which the economies of large-scale production are not a dominant consideration. Perhaps foremost among these advantages is that which relates to the element of *quality*. America has wrought her most distinctive miracles in quantity production. Ford automobiles, to take the most notable example, are turned out by the million. But during the past year we have had our illusions removed as to the speed with which the highest type of fighting aeroplanes can be produced. Where the craftsman skill and precision are needed, more trustworthy products can be secured in the small shop than in the mammoth plant. A second advantage is found in the direct and intimate relation between office and shop in the small plant. Here the workers are still *men*,—yes, individuals, even, in the thought and under the eye of the superintendent or employer, while he is a distinct and knowable personality. This has not a few important results. In the small shop decisions are transmitted from the proprietor-manager straight to the workmen, and are carried into effect at once. Said one of our Institute graduates, a few days ago: "During the past six months we have nearly doubled our output, but we've added only one man to our office force. That puts us all under a good deal of strain." "Why not put more men on your office staff?" I inquired. His reply was: "That would mean just so much more red-tape and complication. When I first went with the firm (less than ten years ago), there were in the office just Mr. A. (the inventor-proprietor), Mr. B., his partner, and one other man. *Then* things used to hum! But the more men you get in, the more cards and reports have to be made out, merely to insure *the same degree* of efficiency."

Leadership "carries" better in the small industry. The proprietor's personality and enthusiasm can lay hold upon 25 or 50 men, whereas to a force of 500 he would be simply "the boss." *Esprit de corps* and morale are of natural growth in the small shop; they are hard to develop and maintain where there is no human contact between the employer and the workmen, and where the workmen are not personally known to one another. In the small shop there can be brought home to the individual workman the direct interest which he has in maintaining both the quantity and the quality of the product; he can be brought to see clearly how his own work is discredited and his own wage lowered in consequence of the soldiering or waste of material by any member of the working force. It goes without saying that the mutual understanding between employer and employees in a small industry is a strong influence in lessening the frequency and the seriousness of labor controversies.

In fact, the advantages of the small shop are so obvious that in these days of giant corporations some of the most interesting and promising experiments in industrial management are in the attempts to reorganize production "on the small-shop basis," assigning to a superintendent and small force of men the making of a particular part or the completion of a certain series of processes in the turning out of the finished product.[1]

If it be granted that the small industry in many fields of production has distinct advantages, and that the easy and natural progress from able and ambitious workman to proprietor is accordant with the spirit of democracy and tends to safeguard it from developing industrial Bourbonism on the one hand, or industrial Bolshevikism on the other, the question presents itself: What chance has the small industry in the democracy of today? Is it getting a better or a poorer chance than a generation ago? To what extent and in what ways should a democracy, in its own interest, seek to insure that chance?

Here the first step, thoroughly in accord with the democratic principle, is to see to it that the field of opportunity is not narrowed by encroachments of monopoly not controlled in the public interest. Despite the contemptuous sniffing with which not a few self-styled "hard-headed business men" have referred to the "New Freedom" programme, I venture to believe that the spirit embodied in the Clayton Anti-Trust Law and the Federal Trade Commission Law is constructive and deserving of approval. Those laws attempt reasonable definition, where the Sherman Anti-Trust Law introduced sweeping prohibition which hastened the very development it was intended to curb. Experience has shown and doubtless will continue to show defects in these laws needing correction. But they merit a better spirit of coöperation than in many quarters they have received. The present moment in the world's history is a time more appropriate for sincere and thoroughgoing study of the ethics of business than for disdainful ridicule of any efforts to restrain unfair competition.

But many a small industry fails to "make good" not because of unfair practices on the part of rivals, nor from any lack of inventiveness, resourcefulness or managerial ability on the part of its enterpriser, but because he encountered exceptional difficulties in securing some one of the elements requisite to its success. If—as I believe—it is essential to the safety and stability of democracy itself that its life be constantly renewed by the upgrowth of small industries, by the direct progress of ambitious young workmen into the ranks of proprietors, what steps should a democracy take to remove obstacles to such progress and to insure to the small industry a reasonable chance to work out it own salvation?

"Paternalism!" someone exclaims, at the mere raising of that question. But to my mind "paternalism" conveys the idea of coddling a weakling, to make things easy for the pampered child. It seems misapplied when used with reference to government action for the assuring of equitable industrial conditions essential to the safety of democracy. Nevertheless, it must be acknowledged that that way danger lies. The history of the protective tariff affords enough illustrations of the possibility that government action, ostensibly in the public interest, may be so designed and carried into effect as in some instances to benefit the few at great cost to the many. That there is some liability to abuse is not to be denied. However, the motive here advanced is not that of fostering any particular enterprise but rather the giving to small industries a fair chance, in order that by their growth they may safeguard democracy by lessening the danger of the development of a basis for class consciousness.

I—Power

All industries here in view are users of power. The obvious implication of democracy—though it has secured but tardy recognition—is that nature's sources of power should be made generally serviceable to the community as a whole, and should not be exploited primarily for the profit of the favored few. This idea underlies the recent movement by

[1] See the Small Shop System, by Peter F. O'Shea. An interview with Mr. F. O. Wells, president of the Greenfield Tap and Die Corporation. This article is soon to appear in *Factory*.

the National Government and by several of the states for the survey of water powers and for their conservation in the interest of all the people.

Most of the modern electric-power enterprises have been built up and are controlled by private concerns; a large proportion of them, scattered the country over, are in the hands of a comparatively few corporations which specialize in such enterprises. They are, thus, in position to bring to bear the highest engineering skill upon the solution of all technical problems, and they possess certain marked advantages in relation to maintenance and management. Here democracy is confronted by the tremendous problem of the government's relation to such enterprises,—of government ownership, with its diverse political and economic implications. A number of cities have been trying experiments under varied enough conditions to make their results of considerable interest and significance. Without exception, so far as I have observed, they report a substantial reduction in the rate made by the private corporations—it was 10 per cent in Seattle—dating from the first serious agitation for a municipal plant.

It cannot be stated too strongly that a conclusive comparison of the service rendered a community by a municipal plant and by a private corporation in competition with it can be made only by an expert, on the basis of painstaking investigation. The power rates of municipal plants are attractively low. But it must be borne in mind that those rates are in a sense not economic but "political,"—rates lower than could be made by any corporation which had to pay taxes, or which could not have its deficits made up from public appropriations. Depreciation charges are likely to be figured differently in the accounting of municipal as compared with private corporations. There may be ample justification for the policy of the city's charging less than cost for electric power, just as for many years the Post Office Department was run with a view not to its paying expenses but to its rendering the maximum service in the development of the country. But if power rates are to be fixed on that basis, the policy ought to be frankly avowed. The question as to the comparative efficiency of service to be expected from a municipal plant as compared with that of a private corporation involves many considerations which cannot be reviewed in this brief paper.

Pacific Coast cities have been pioneers in selling electric power for manufacturing purposes. A comparison of their rates would involve a maze of complications entirely inappropriate in a paper of this character. A quotation from the power rate card of a single city may serve to indicate on what easy terms the starter of a small industry may there secure his power. In Los Angeles, California, the use of the aqueduct has made possible commercial power rates running from 4 cents per kw-hr. for the first 100 kw-hr. in any one month down to 1.05 cents for from 3000 to 6000 kw-hr. Pasadena generates power by a steam plant using fuel oil, and sells her customers electric power at just one-third what it cost at the time when the city plant was projected. In Seattle the rate has been reduced to about one-quarter of what it was under the old régime, and the city's hydroelectric works are being greatly extended. In Tacoma, the city has been selling power since 1897, but made no special effort along this line till 1912, when the rate was reduced from a uniform 3-cent rate to a sliding scale on which the price for kw-hr. according to the load factor runs from 2¼ cents (where the load factor is 10) to 0.35 cents (where the load factor is 100). And these rates are reduced by one-third where the customer agrees to take the power at certain hours and to cut off all or a large percentage of his power during the low-water period. Since 1912 there has been a marked increase in the use of electric power. Forty-two different types of industry appear upon the list of small users of power; they include machine shops, rubber factories, shipbuilding plants, meat packers, smelters, lumber manufacturers, etc. No one who reads the list can doubt that the Tacoma motor-rental system is serving effectively to diversify the city's industries, and to make it easy for an ambitious young workman to start an enterprise of his own.

A most timely document is the Report on Electric Power Supply in Great Britain (made public in December, 1917) by the Coal Conservation Sub-Committee of the British Ministry of Reconstruction. What lends especial interest to this report is the fact that, by way of enforcing the necessity for a most serious consideration of the recommendations which they present, they repeatedly refer to the disadvantages which the British manufacturer is sure to encounter in after-the-war competition with better-equipped American enterprises. For example:

> In the United States the amount of power per worker is 56 per cent more than in the United Kingdom—if we eliminate workers in trades where the use of power is limited, or even impossible, we shall probably find that in the U. S. A. the use of power, where it *can* be used, is nearly double what it is here. On the other hand, not only are the standard rates of wages higher in the U. S. A. but living conditions are better. There is little doubt that in the U. S. A. the average purchasing power of the individual is above what it is in this country, and that this is largely due to the more extensive use of power, which increases the individual's earning capacity. The best cure for low wages is more motive power. Or, from the manufacturer's point of view, the only offset against the increasing cost of labor is the more extensive use of motive power. Thus, the solution of the workman's problem, and also that of his employer, is the same, viz., the greatest possible use of power. Hence the growing importance of having available an adequate and cheap supply of power produced with the greatest economy of fuel. (p. 7.) The present coal consumption would, if used economically, produce at least three times the present amount of power.

The Committee makes the following recommendations: (pp. 1 and 17)

> The present inefficient system of over 600 districts should be superseded by a comprehensive system, in which Great Britain is divided into some sixteen districts, in each of which there should be one authority dealing with all the generation and *main* distribution.
>
> Sites suitable for electric generating purposes should at once be chosen where water is plentiful and transport facilities good or fuel close at hand.
>
> Each district of electrical supply under a single authority should be a large area, with the greatest possible variety of electrical requirements and including populous centers of industrial activity.
>
> Power available from surplus gas or waste heat should be turned into electrical energy on the spot in local plants which would feed into the main distribution system.

At a time when for many months it has been necessary to subject this country's fuel supply to rigid control, on a day when many of the gas and electric light companies in New England have but a week's supply ahead, when Worcester manufacturers are facing the prospect of having to close their shops or curtail production for months, and when the bins of probably half the householders of this city are empty of coal and when no assurance can be had of more than two-thirds of a winter's supply, I have ventured to refer to this radical proposal, put forth by an eminent and responsible group of investigators, for the conservation of England's coal supply, and for the most efficient development of power therefrom, in the interest of all her people.

II Capital

How shall a starting industry secure capital? In the days of Worcester's early industrial growth, the necessary capital units were small, and might be drawn from modest savings, or secured in considerable measure from personal acquaintances. But now the situation is vastly changed. The new industry is likely to need a greater amount of capital at the start, and its founder's acquaintances are less likely than three generations ago to have the requisite funds.

At the present time, some New England banks are paying considerable salaries to their representatives who go about in the community helping farmers decide how to invest borrowed capital most successfully in the development of their home farms, with the result that three parties gain: the bank, in securing a safe investment for its funds; the farmer, in getting capital, together with expert advice as to its intelligent use in his own farm problem; and the community, in securing a greatly increased production of food crops. Similar interest and coöperation may be shown by banks in the case of the starters of other small industries. Some modification of coöperative banking, as worked out in Germany and Switzerland, may enable men of character and enterprise to borrow upon their pooled credit, for the starting of a promising industry.

IV Labor

At the present time the "help" question is one of the most disheartening elements in the manufacturer's problem. Trade schools and vocational guidance are some of democracy's newer devices for affording the boy some training in fundamentals and for discovering to him and to his parents what his real aptitudes are. Public employment agencies may serve to bring employer and employee together and help distribute the labor force to the points where it is most needed. But the fundamental evil of the present situation lies far deeper. Ex-President Tucker, of Dartmouth College, declares that "the social curse of industrialism as it now exists lies in its effect upon the disposition and temper of industrial workers." He points out that by putting the worker under the dominance of the machine, by subjecting him to various conditions not of his own choosing, and by depriving him of the stimulus and incentive to private ownership, industrialism has alienated the man from his job; it has taken from him "the zest for work, than which nothing is more necessary to social progress."

One of America's most eminent engineers, Mr. Charles P. Steinmetz, has said that in every industrial enterprise there are three principal elements that need attention,—the financial, the technical and the human. He added that the I. W. W. put in their appearance where the human factor is neglected and to the employer who disregards that human factor his admonition is: "The I. W. W. will get you, if you don't watch out!"

Right here is one of the great advantages of the small industry and a prime element of its importance to a democracy. In the small shop, relations between employer and workmen still remain personal, human. The great corporations of the present day are striving earnestly to solve this problem of the human element. They are calling to their aid the psychologist and the sociologist; they engage trained experts as employment managers, and organize elaborate welfare departments. But no scientific organization for "hiring and firing" and no wholesale welfare work can duplicate the results in efficiency and *esprit de corps* of the working team which can be achieved by the employer in the small industry.

In a paper recently presented before this Society, Mr. Richard B. Gregg has discussed "What it costs to hire and fire." He intimated that an annual labor turnover of 20 per cent was not exceptional, and cited cases where for several successive years it had run as high as 45 per cent, while in one department of a certain cotton mill it had last year gone over 500 per cent. The losses which such incessant shifting involve to the employer, to the workman and his family and to the community are appalling. Yet every person here knows employers in small industries who through years have kept a loyal working force, relatively permanent and having an interest and a keen pride in "their" shop, and the quantity and quality of "their" product. It was such employers and such workmen as these who gave to this Worcester community its immensely strong and diversified industrial development, so hard to maintain under the changed conditions of today.

V Research

In one respect the small industry has been at an unnecessarily great disadvantage. The day of hit-or-miss or rule-of-thumb methods is clearly past. Yet the small industry cannot conduct scientific investigations in elaborately equipped and expensively manned research laboratories of its own. Here is a field where government, federal or state, may provide coöperation along lines similar to those of the U. S. Department of Agriculture and of the state experiment stations. The Bureau of Standards is already doing something in the way of research work for private concerns. The laboratories of this Institute, as of scores of engineering schools and universities, have facilities which may help solve the technical problems of many a small industry, at a fraction of the cost which would be involved if the manufacturer should attempt to have this work done in his own plant.

VI Publicity and Marketing

One of the greatest disadvantages under which the small industry labors is the difficulty in getting its product continuously and effectively before the public. Private enterprise has not failed to note this need and to provide well-designed facilities to meet it. For example, the Bush Terminal Company, not content with providing the splendid buildings in connection with which manufacturing space, power, light, heat, railway and shipping facilities are furnished to its tenants, has spent \$2,000,000 to erect an "International Exhibit Building" at the very heart of the day-and-night activity of New York City, on West Forty-second Street. It is where every dealer would wish to have his show room, but could not afford to do so alone. This is genuine, scientific coöperative service on the part of a far-sighted corporation, and some small industries may find great advantage in availing themselves of this opportunity.

Considerable saving and enhanced efficiency could be secured if manufacturers in related lines would coöperate in their sales work. The automobile shows offer a spasmodic and spectacular example of what may be worked out in more simple and modest fashion in many lines of industry. The coöperative fruit-selling agencies of the Pacific Coast states and the produce-marketing organizations in other parts of the country present familiar illustrations of coöperative selling. Nor is this a matter unworthy of governmental interest and aid. The medieval fairs brought business and prosperity to the towns which held them. Even in war-stricken France, the past year, certain expositions have been maintained. Our own country affords illustrations of municipal industrial museums suggestive of a development which might be greatly extended, the

ers providing ample and suitable halls and facilities for the display of the high-grade products distinctive of its industry,—doing this not as a matter of favoritism and patronage, but taking it upon itself to advance thereby the interests of the whole city as an industrial unit, in the spirit frequently shown by a progressive chamber of commerce.

An attempt has here been made to analyze some of democracy's implications in the industrial field, and to emphasize some aspects of the American industrial system which bid fair to subject our form of government to severe strain. Emphasis has been laid upon the small industry's consistency with the spirit of democracy, and its tendency to strengthen democratic institutions, and some ways have been suggested whereby through public or private coöperation the small industry, in the interest of democracy, may be given a better chance of success.

At any time these matters might have been considered of some academic interest; but right now they seem to me of a new and vital significance. I believe that it is an accurate forecast that in the future the historian will find the chief significance of this World War not in the dynastic and territorial changes which at present seem to us to be of such prodigious moment, but rather in the world-wide social and economic upheaval and revolution, for which the war is now preparing the way, and of which Russia affords a portentous example. Even before the outbreak of the war, in America as well as in Europe there were abundant signs that convulsion was impending.

The coming of peace will bring a period of tremendous readjustment. Back from the front will come scores of thousands of young officers, and millions of young soldiers, to be reassimilated into our economic and political life. That process will be vastly different from the readjustment which followed the Civil War. Back to our industrial centers these young men are to come, with a changed outlook upon life. Men who before the war had been plodding wage earners, hardly stepping outside their deep-worn rut from one year's end to another, and with no suspicion that life had anything else in store for them, have now seen other lands, other customs. They have had a great illumination. They have taken part in the greatest enterprise in the history of the human race. They have learned team play, and the immense effectiveness of disciplined coöperation. They have found within themselves unsuspected power to dare and to do and to lead. Let no one fancy that the return to the ranks of industry of these hosts of young crusaders, who have gone through hell to make the world a decent place to live in, will not add a tremendous ferment to the social and economic unrest. They are going to demand that democracy in government find its counterpart in democracy in industry; that life yield them something more than the day's wage,—that it give them something of the zest of adventure, of opportunity for advancement, of chance for independent leadership. Where shall these ambitions and restless energies find an outlet?

In the strain to which our institutions are sure to be subjected in the years that lie immediately before us, the small industry may render service of incalculable importance to American democracy. It offers scope for ambitious young men to rise from the ranks to positions of leadership. It keeps relations human between employer and workmen. It gives the lie to the class-conscious radical's assertion that America is divided into two hostile camps, the bourgeois and the proletariat. When the Allies shall have succeeded in making the world safe for democracy, the small industry may have no small part in making democracy safe for the world.

THE TEXTILE INDUSTRY IN RELATION TO THE WAR

BY J. E. ROUSMANIERE, NEW YORK, N. Y.

I AM concerned with the selling of cotton goods. Before the war the firm with which I am connected sold to the Government a large amount of goods for the Army and Navy. We have, of course, sold them a much larger amount since the war has been on, and since I first went to Washington at the request of one of the representatives of the Government, to serve on a committee, I have given a rather large part of my time to helping the Government, so far as I could, to obtain the textiles of which they were in need, particularly cotton textiles, with which I am most familiar.

Those who have not looked into the matter carefully will be surprised at the need there is of textiles in all departments of the war-making machinery of the Government. In fact, it has been a theory of mine—which has not worked out in practice—that by reason of the lack of cotton and wool and rubber Germany's war-making ability would be restricted. But she is making war now probably better than she has in the past, and yet with the enormous use that is made of those three articles here, and on the theory that Germany has not received any for the past two years, it would seem as if she must get to the end of her rope.

Among the textiles used in war are cotton woven goods, woolen woven goods, cotton knit goods, woolen knit goods and same silk goods. There are four grades of woolen goods: overcoating, 32-oz.; suiting, 20-oz.; blanket, and woolen shirt. There are also various weights of cotton duck used for tentage and for wagon covers and the like. The cloth is used by the Government usually in the dyed state, but owing to the great need of haste they have been using large quantities in the gray state until the dyeing capacity of the country could be adjusted. There are also uniform cloths, fiber-dyed—that is, dyed in the cotton and then spun and woven, as used by the marine corps, or spun and then dyed, as used by the Army. There is also a silk material used in making cartridge bags, which, unlike cotton, does not leave any residue in the gun.

When the war began the Government did not have any stock of goods. There had been trouble with Mexico the summer before and practically all the stock of goods in the country had been taken by the Army and had been made up and used. The first time we went to Washington the Assistant Quartermaster General told us that he wanted 47,000,000 yd. of 12-oz. duck for tentage within nine months. There were three or four manufacturers present who made such goods, and we all agreed that 20,000,000 yd. could not be made in a year, much less 47,000,000 yd. in nine months. But the industry bestirred itself and is now supposed to be making 90,000,000 yd. per year, and has bettered the production which the Assistant Quartermaster General asked for a year ago last March. We all had commercial orders at that time to keep our looms busy, but in every case the man whose commercial business was interfered with has accepted the decision of the Government, and so far as my personal experience goes, the whole textile industry, both in the manufacturing and in the consuming end, has acknowledged the fact that the Government must be taken care of before anything else is done.

The same question has arisen within the last two months. When the drive across the water began and it was seen that the Army must be increased very rapidly, the buying that

[1] J. Spencer Turner Company.

had been done on the established program at that time was found to be insufficient, and about the middle of April instructions came to us from the Government that we must deliver no more goods on our commercial orders of the class that is used in uniforms or for linings until the first of June, and for five or six weeks there were no goods delivered on commercial orders—the Government took them all.

In order that you may understand some of the needs of the Government for textiles, let me repeat a few of them, taken somewhat at random: The amount of woolen cloth needed for uniforms, for blankets and for overcoats for 3,000,000 men is enormous. A part of the wool used comes from Australia. Our Government went to the British Government, who had bought the entire clip in Australia, and obtained from them some of the wool, which in turn was doled out to the manufacturers who are to make woolen uniform cloth. One contract placed with one firm on woolen cloth at one time amounted to $57,000,000.

Then there are the cotton uniforms that are worn in summer; and the cotton uniform cloth required for 3,000,000 men is an enormous amount. Let me suggest some new demands which had not arisen before. One new use for wool that came up suddenly was occasioned by the demand for woolen puttees. United States soldiers had never worn puttees before and they do not wear them much now in this country, but it was found that the weather in the trenches, particularly in the winter, made the use of leggings impossible—that the men's legs became so cold that they could not stand it and they needed something warm to wrap around them.

Immediately on war being declared the gas-mask question came up and the Government had to supply them for all the troops going across the water. It requires a very closely woven piece of fabric for the face cloth that contains the bull's-eyes, and heavy canvas for the pouch holding the aluminium container in which the chemical is placed and through which the air is sucked in through the rubber tube. These goods had to be gotten together quickly and mills had to go on to fabrics which they had never made before, but on the whole it has been done remarkably well. Now they also provide gas masks for horses.

One question that came before the committee early in the war grew out of the fact that the hospital corps required 500,000 suits of pajamas, necessitating about 3,000,000 yd. of goods. The Army hospital corps had always used pajamas, but in amounts requiring not over 100,000 yd. a year; and it so happened that they had adopted a standard which was a practical manufacturing proposition for only one mill. But the mill could not make 3,000,000 yd. as quickly as the Army needed it, and therefore a new pajama cloth had to be arranged for—a sort of chambray weave.

The Government has just purchased in the market 70,000,000 yd. of denim for overalls and jumpers and other purposes for the men in order to save their uniforms while they are working. The men who went abroad first were equipped with blue denims, but Pershing cabled back that blue denims were too conspicuous for the hostile aviators and therefore the Government had to change to the less conspicuous brown goods.

All of these problems have been solved by the industry and I think it is entitled to a very great deal of credit for the way in which it has adjusted its methods to the making of new cloths at short notice.

The amount of sheets and pillow cases needed for the hospitals was also large. The Government has lately placed an order for 240,000,000 yd. of bandage cloth for the Navy, for the Army, and for the Red Cross, consolidating the purchase.

The Navy also buys a very large amount of bleached twills for white uniforms. This is much the same cloth as the Army uniform cloth, but made a little wider and then bleached.

The use of heavy ducks by the Government is very large. I remember last fall at one time the General Staff in Washington received a requisition for 13,000,000 yd. of No. 4 duck, a very heavy material weighing almost a pound to a yard, and 22 in. wide, for use in tarpaulins. Another need of duck has lately arisen in the Emergency Fleet Corporation, which has just placed a large order which is needed promptly in order to complete the boats now being built at various shipyards.

Probably the greatest change was in the aeroplanes. Aeroplane wings had hitherto been made of linen, and while the practice was different in Italy, it had been the theory both in France and England that cotton cloth would not do for wings. Cotton has a tendency to expand and contract with the dryness and the dampness of the atmosphere, and it was also felt that cotton wings when shot by a shell would tear, whereas linen has very great tenacity and does not tear. But they experimented in many ways and developed a cloth made from specially treated cotton yarns. It is now said by the aeroplane service in Washington that that cotton cloth is standing up quite as well as the former linen. But it took a good deal of experimenting to convince the personnel that it would do as well as linen. However, so far as I know the battle planes are still equipped with linen cloth, a little of which we get through the British Government, but the practice planes and the slower planes are equipped with the cotton fabric.

Beyond these very large needs are those for covers for the 3-in. and the 6-in. and larger guns, which require a good deal of duck, taking it as a whole. And in addition a new belt had to be manufactured—a new apparatus to carry hand grenades—something that had not been used much by the Army before. Then there is the matter of truck covers; for one of the first orders of trucks over a million yards of goods was needed.

A large part of all these goods have been made in New England. The heavy ducks have been made in the South, but as many of the heavy duck mills in the South are owned and controlled in New England, they may be considered New England enterprises. Various of the mills in New Bedford are making the aeroplane and the balloon cloth. Fall River and other places are making the bandage cloth. The army duck is being made largely in Lowell and Manchester. The uniform cloth is being made very largely in Manchester, one concern turning out 500,000 yd. each week. The woolen cloths are made all over New England. And New England, taking into account its munition factories and its textile enterprises and others, seems to be doing its fair share and possibly more than territorially would be allotted to it in supplying the needs of the Government for carrying on the war.

As I said before, I feel that the textile industry as a whole has responded splendidly to the demands made by the Government. And I have no doubt but that these very industries have called on you for advice as to how they can make over their plants to manufacture the fabrics which the Government most needs, and increase their production—which is attempted in every plant in the country so far as labor conditions will permit. And I know that when such requests are made of you by the textile industry you will do everything that you can to help them meet what appears to be at first sight the overwhelming needs of the Government to supply its armed forces in all its branches. [Applause.]

CONVERTING A FACTORY FOR MUNITIONS MANUFACTURE

BY JOHN S. HOLBROOK,[1] PROVIDENCE, R. I.

THE Gorham Manufacturing Company, probably the largest silversmiths in the country, if not in the world, has been identified particularly with the sterling-silver trade. It has also made a considerable amount of silver-plated ware and of late years has produced a large quantity of bronze statuary, structural and ornamental bronze, besides various ecclesiastical wares such as pulpits, altar rails, chalices, etc., at its Elmwood plant in Providence, R. I. The step from this sort of work to the manufacture of metal goods for war munitions is consequently not as great as at first it might appear when we speak of silversmiths as munitions makers, for our men are trained in the handling of metals and in the use of machinery adapted to their manufacture whether drafting, spinning, stamping, or casting, and we therefore were not handicapped as a strange concern might have been in the knowledge of metal handling.

Very shortly after the war broke out the Allied governments came to this country for munitions and we began to receive inquiries. Our superintendent at that time was Capt. O. V. Kean, a graduate of West Point and thoroughly familiar with ordnance work and the ordnance schools, and he naturally became interested in these inquiries.

The first negotiations entered into were with the British Government for 50,000,000 brass cups for small arms and the same number of cupro-nickel cups for Serbia, these being made in knuckle-joint presses which we already had on hand in our machine shop. The cupro-nickel cups were contracted for on April 14, 1915, and were delivered on time.

On May 11, 1915, we contracted for 50,000,000 brass cups to go with the cupro-nickel, but found our presses were too light to handle the heavier gage, which necessitated the purchase of new presses.

At the same time the French Government appeared in the market for cartridge cases for the 75-mm. gun, considered by many the most efficient weapon of the war. This was an entirely new proposition and involved a large expenditure both for new buildings and equipment, but after careful consideration the directors of the company felt that the contract was profitable and that as a matter of patriotic assistance to the Allied governments, with whom our sympathies even then were very strong, we should take the contract. They therefore authorized the building and equipment of a new one-story brick brass-case shop, 360 ft. 6 in. by 122 ft. 8 in., which has cost approximately $500,000.

The first contract with the French Government was for 500,000 of these 75-mm. cartridge cases, which upon completion was followed immediately by an order for 975,000 more. These orders were filled so satisfactorily that when we entered the war the French Government went out of their way to compliment our work to the United States Government.

The French Government contracts were followed by one from the Russian Government for 1,000,000 brass cases for 75-mm. high-explosive ammunition, and another from the Swiss Government for 200,000 75-mm. brass cartridge cases of a still different type. Later the Netherlands appeared in the market and gave us a contract for 1,000,000 lb. of brass disks for their small-arms cartridges, as well as for 340,000 lb. of cupro-nickel cups. Also the Danish and British Governments each placed orders for about 225,000 lb. of the latter, and smaller orders were filled for the Norwegian and Portuguese Governments. It should be stated that each of these contracts required a different cup, slightly different in gage, height, thickness of bottom, etc., and that special metal had to be carried for each contract.

These various contracts had fitted us with a broader experience and we had built up a reputation and were ready to begin serious work for the United States Government when we entered the war. At the same time we have been able to do some work for the Allied governments in addition to our United States Government work.

The first U. S. Army contract came March 30, 1917, even before war was declared, and was for small cups, 6,600,000 each of the brass and of the gilding metal, the latter being for the U. S. Army bullet jackets. In May, 1917, a contract was closed with the Maxims Munitions Corporation for 275,000,000 each of brass and cupro-nickel cups for Italy. The first order for cases was placed May 1, 1917, for the U. S. Navy 3-in. landing gun—again a different case from anything we had made before and requiring an entirely new outfit of tools but not machinery.

Immediately on the outbreak of the war our plant was placed at the command of the Government both as to its special war machinery and as to the silver plant. The Navy contract was followed by one in August for a large number of 3-in. cases for the U. S. Army—again a different case from that for the Navy landing gun, and French 75-mm. cases, the Army having decided to adopt that gun.

The Government then began to inquire what we could do on grenades, and after some negotiations we took no less than four separate orders for grenades, and at the request of the Government built an assembling and loading plant at a cost of considerably over $250,000, at East Providence. This plant is designed for an output of 100,000 loaded grenades per day. Ground was broken in December, 1917, and work started in the plant six weeks later.

Our contract for the Navy landing-gun case was so successfully filled that the Government asked us to make a large number of the large 4-in. 50-caliber cases. Another plant was required for this work, as it is done almost entirely by hydraulic presses, and after some negotiations the old plant of the Providence Machine Company on Eddy Street and Allen's Avenue was purchased, new buildings erected, the old buildings repaired, and the machinery installed, and they are just beginning production. The plant's ultimate capacity will be 2500 per day.

In December, 1917, the Army placed an additional order for the 75-mm. cases with the proviso that if we finished them by August 1, 1918, we should continue and make an additional million. More than one million have been delivered and we expect to complete the balance well in advance of the date specified.

Early in 1918 the Government took up with us the question of our assembling and machining the Stokes trench bomb. This involved a further outlay for machinery, but there was space enough in the Allen's Avenue plant and we accepted an order for these, deliveries of which have already begun. We anticipate turning out 1500 per day on our automatic machines and may considerably exceed this.

The machinery directly engaged on our munitions work and bought for that purpose has a capacity of between 25 and 30 millions of dollars' worth of output per year on the basis on which we now work, which is that the Government furnishes

[1] Vice-president, Gorham Manufacturing Company.

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the raw material and we the labor and assembling. Contracts actually in hand total something over a third of this amount—between 8 and 10 millions of dollars. This, however, does not take into consideration any machinery in the silver plant, and finding that we had capacity over and above our usual business, we have taken a considerable number of orders for miscellaneous equipment of various kinds. The disposition of the directors of the company is to place the plant as largely as possible on work which is directly useful to the Government and assist in every way in the successful prosecution of the war.

Special Equipment

With regard to the tools which the Gorham Manufacturing Company has found necessary in order to arrive at the stage of production which it has reached in this work, the following particulars may be of interest: The machinery and tools of the silver plant have in the main been totally inadequate and impractical for the munitions work. Certain knuckle-joint presses which we had been using in the machine shop of the silver plant were used for bullet cups, as mentioned in an earlier paragraph, but the brass small-arms cartridge cups came from stock so heavy that it broke down our presses and we had to order special presses from the E. W. Bliss Company.

The equipment for the brass-case shop consists approximately of 4 cupping presses, 2 indenting presses, 15 rack-and-pinion presses, 4 heading presses, 4 tapering presses and 33 Bullard lathes. There are also marking presses for stamping the heads of the cases with their identifying marks and lot numbers. The cupping presses (E. W. Bliss Co., No. $77\frac{1}{2}$) are large presses for making the first cupping from the disk and are very powerful. The indenting presses were originally put in for work on the Russian and Swiss cases. As these are no longer made the presses are now used for cupping. The rack-and-pinion presses (E. W. Bliss Co., No. $66\frac{1}{2}$) are presses which make the second, third and fourth draws of the French cases.

The annealing ovens consist of three large annealing furnaces and a number of mouth and body annealers. Most of the latter have been built by us and are so arranged that the case is turned around in a frame and at the end of a certain number of minutes is presented at the opening, where it is withdrawn by a man with a pair of pincers.

For the grenade plant we purchased 14 acres of land in East Providence from the Rumford Chemical Company and erected one-story frame buildings covered with asbestos shingles, all of a temporary character. These buildings consist of two assembly rooms connected with the loading plant by a covered passage, power house, loading plant, detonator assembly room, shipping and storage sheds, office building, and of course the usual accessory buildings such as toilets, rest room, etc., together with two magazines. We have also arranged with the New Haven road for a spur track into the property.

The plant at Eddy Street and Allen's Avenue is built on land having an area of about 100,000 sq. ft. Here it was found necessary to erect one new building as there was none with sufficient height to take the huge hydraulic presses, some of which require 40 ft. of headroom. These presses were obtained in various places and are of the following capacities:

2—250-ton, 1st draw	3— 150-ton, 5th draw
2—250-ton, 2d draw	4— 210-ton, 6th draw
2—250-ton, 3d draw	1— 90-ton, taper
3—200-ton, 4th draw	2— 100-ton, header

There are also such small presses for stamping, etc., as may be necessary, and ten lathes. All the presses mentioned above, with the exception of one, which was used in the Russian indenting and which was moved from the Elmwood plant, are hydraulic.

To manufacture the trench bombs we were also forced to buy new equipment, consisting mainly of automatic machinery. This included three large automatic lathes for the machining of the head of the bomb, and automatic machinery for making the boosters and other parts.

The Question of Employees

In connection with the East Providence plant it may be stated that we have large storage magazines buried in the woods two or three miles away from the plants, where a large part of the nitrated starch is carried. This material is transferred as required to smaller magazines at the plants and only a few hours' supply is carried on the premises. From the smaller magazines it is brought underground by a pneumatic conveyor.

As to employees, we have 25 to 30 trades represented in the silver shop and some of these employees are at work on war materials, a few having been transferred as the opportunity presented itself through the slowing down of the silver shop. Most of them, however, are at work in the silver shop in their regular rooms, working on such war materials as bomb sights, powder cans, ramrods, etc. Our highly skilled men, such as die sinkers, designers, etc., we have not been able to transfer to this war work. The chasers have been kept busy on their regular silver work as have also the designers. The die sinkers have been of help in making tools, but most of the tools are made in the machine shop.

At the present time there are over 3200 employees on the payroll, which means about \$60,000 per week. The employees as a rule have stayed with the company and those transferred to the munitions work have been successfully trained under expert foremen acquainted with that kind of work. We found it necessary to add to the organization a number of expert men who had had previous experience in munitions manufacture and they are responsible for the training and upbuilding of the force.

The force of women employed has considerably more than doubled and it will be more than trebled by the time this paper is presented. The women employed in the Elmwood and Eddy Street plants are largely inspectors on brass cases and on parts of trench bombs and do not aggregate 100 altogether, whereas the number of women in the silver plant normally is in excess of 150. In the East Providence plant, or grenade plant, the women are in the majority, there being over 300 at present, which number will be increased to 500 to 600 when the plant is running at its full capacity. These girls are taken from the surrounding towns and are entirely untrained in the sort of work they are required to do. They assemble and load hand grenades, except as to certain processes which are entrusted to men. They are carefully selected and each one entering our employ has to be vouched for by at least two reputable citizens. We cannot afford to take any chances in a plant of this kind. The help is carefully picked and the inefficient ones rejected, this being shown by the large labor turnover—100 to 150 per week at the present time.

From the foregoing statements it will be seen that the problem of the Gorham Manufacturing Company has not been so much the transferring of present plant capacity and man power as it has been the building up of the new organization

to handle the work. The organization has been efficiently built up and its importance may be gaged by the fact that while the number of employees before the war was normally 1600 to 1800 at the Providence plant, it is at present about double that number, and all these new people have had to be brought in and trained. We have secured the help of able men, most of them acquainted with the production in their particular lines, some of them merely good machinists and mechanics. Of course this applies to the munitions only. We have found in the silver plant and bronze shop that our own foundrymen are able to handle any casting job which comes to us, and the munitions jobs which we have taken are far less complicated than the elaborate statuary moldings with which our molders are acquainted. The bronze-shop force, under the supervision of their foreman, has proved capable of handling such work as has come to them—ramrods, powder cans, thumb nuts, etc. An interesting part of this work is the work that is being done for the Government by means of our special process for depositing—on range finders and the like. We have had one or two contracts where very fine graduations were required and where the Government has found this process of great value for the reason that it might be depended upon to reproduce important parts absolutely without shrinkage.

FIRST GENERAL SESSION

THE first general session was held on Wednesday afternoon, June 5, in the Mechanical Engineering Building of the Worcester Polytechnic Institute. Vice-President Greene presided. The session was particularly well attended, and the discussion was keen, the first paper, entitled The Public Interest as the Bed Rock of Professional Practice, by Morris L. Cooke, ex-Manager of the Society, exciting so much interest that its discussion extended to half the proceedings of the session. This was to be anticipated from the nature of Mr. Cooke's paper, which, as the author frankly stated, was written for the purpose of determining what has been, and apparently continues to be, the attitude of engineering organizations toward society as expressed in their rules of conduct. Mr. Cooke's paper was one of the most important "policy" papers ever presented to the Society, and one which every member should take the time to read and discuss.

Mr. Cooke called attention to the inconsistency between the attitude of the engineers of the country toward the war—an attitude of spontaneous sacrifice—and their canons of professional practice as enunciated in the codes of ethics of their organizations. He thought this was a time to take stock and examine critically the orders under which society and its constituent elements are operated. Hence there can be no better time for a review of the regulations governing the professional practice of engineers. In this paper he sought to develop the engineer's concept of his public relationships and responsibilities as contrasted with such relatively minor obligations as those to the profession of engineering, to a client, to fellow-engineers, and to himself.

It seemed to him that the successful prosecution of the war was largely a question of our ability to keep it where President Wilson had placed it, on high moral ground. In a democracy this is not the work of one man, but of all the people. It is not our work purely as individuals, but it is our work in all our relationships, whether they be those of town life, church life, professional life, or what not. In these days of real peril, can we do less than write into our code that whatever our thought and practice may have been in the past, from this day forth it is unprofessional for an engineer to safeguard any private interest at the sacrifice of public welfare?

The chairman opened the paper for discussion, and Secretary Rice read a number of written contributions. In the first of these, by Charles M. Horton, the writer advocated rewriting our code by all means, but writing it in the spirit of what we shall do, and not what we shall not do. He thought the Society should "go big" at this thing and the members stand behind it to a man.

All the discussions which followed were in favor of Mr. Cooke's suggestion. All felt that engineers as useful and highly respected citizens should rewrite their codes in the spirit of the times, except one, Mr. Robert J. Hearne, who thought that if the present code were read as a whole, there was nothing in it that was directly antagonistic to the consideration of the public welfare by an engineer.

Secretary Rice opened the oral discussion by stating that he had been making the subject of this paper a religion in his administration of his office in the Society. He wanted to claim for engineers that they as individuals and idealists had contributed to the state of opinion in this country as to the object of this war, and the President has sensed these ideals of the nation and has phrased them.

He pleaded for a reconsecration of ourselves to the newer ideals, which he could express by no better phraseology at the moment than that recently expressed at the dedication of the Dayton Engineers' Club: "For the dissemination of truth and the promotion of civic righteousness."

L. P. Alford thought that a reframing of our code of ethics ought to be associated with a reframing of the statement of the aims and objects of the Society as expressed in the Constitution, and he presented a suitable resolution, which was carried.

Prof. W. W. Bird presented the second paper, on A Foundry Cost and Accounting System. This paper was developed as the result of experiments carried on in the commercial foundry at the Worcester Polytechnic Institute.

Professor Bird explained that the system was not a cost system, but was simply a signal system which could be kept up by the regular clerical force and which would give fairly accurate results of the profits from the foundry.

The system was based on the principle that the three most important items of cost are Core Labor, Molding Labor and Pounds of Castings Produced, and that each of the other items of cost was a function of one of these. Ledger accounts were opened for the three items, and by careful inventories at the beginning and end of each year the exact annual cost for each item was carried out.

Most of the criticisms of the system were to the effect that while it had been shown to apply to work of a very varied character, still the operations were fairly continuous. The discussers doubted whether the system would work so well for a foundry operated on different kinds of products.

Irving H. Cowdrey then presented a paper entitled Moisture Reabsorption of Air-Dried Douglas Fir and Hard Pine and the Effect on the Compressive Strengths. Though the interest in this paper was not so general, it was recognized that it embodied the results of an important research, which the

author presented in a remarkably clear and able manner. No discussion ensued.

The next paper was by Lieut. John L. Alden, entitled A High-Speed Air and Gas Washer. On account of the absence of the author, the paper was presented by title only. Three contributed discussions were read, by F. R. Still, W. H. Carrier and Henry P. Gale, respectively.

Briefly, the paper described a new type of washer, in which the entering dust-laden air is thoroughly wetted by the mist of the spray chamber, which removes much of the coarser dirt, and then is conducted through a helical conduit, where a large proportion of the remaining dust is thrown against the wet curved side of the washer, flowing off to the drain with the spent wash water. Due to high washing efficiency, only from 1 to 2 gal. of water are required per 1000 cu. ft. of air. Moreover, the apparatus is small, compact and of light weight, a 10,000-cu. ft. washer being but 5 ft. long and 5 ft. in diameter and weighing less than 400 lb.

That devices designed along the lines of the paper cannot be used in public buildings because of the noise they make was the criticism of Mr. Still, while Mr. Carrier considered that the principle described was not new, and varied hardly at all from the cyclone type of separator, provided with spray nozzles, which has long been used. Mr. Carrier considered the type as especially adapted for relatively small air quantities handled at high-fan pressures and where the air contains a great deal of coarse foreign material.

The last paper of the morning was presented to a small audience, but it nevertheless brought out interesting discussion and commanded attention. It was entitled An Investigation of the Uses of Steam in the Canning Factory, and was presented by Julian C. Smallwood. The paper was a unique one, in that it indicated the new types of mechanical-engineering problems confronting the special industries in war time. Heretofore there was not much mechanical engineering in canning—the essential consideration was the raw material, and no attention was paid to economy of operation in the process used. Now every attention was necessary. Members of the Society might take a lesson from this paper of Mr. Smallwood as illustrating new fields of application of their professional knowledge.

The paper described the various steam-using units in the canning factory, and suggested methods of increasing their efficiency, eliminating all avoidable wastes and utilizing all other wastes of heat as by-products.

Mr. W. D. Bigelow, of the National Canners' Association, supplemented the paper with a most interesting picture of some of the canners' problems, and pointed out the need for a publication which will give canners in general terms the essential facts of steam engineering as applied to the canning industry.

A. L. Webber spoke at length on his experiences in the sugar industry, especially with foaming materials. He gave some useful information on the velocity of circulation through evaporators.

L. B. McMillan called attention to simple ways in which the losses in canning apparatus could be reduced. B. H. Foster suggested the use of superheated steam to increase economy, and the author thought this was a possibility. Mr. Foster also thought that any attention which could be given to the conservation of fuel in canning plants at this time was commendable and worth the cost.

SAFETY EDUCATION SESSION

On Wednesday afternoon the session on Safety Education was held in the Salisbury Laboratories of the Polytechnic Institute, Vice-President C. H. Benjamin presiding. In opening the session, the chairman reviewed briefly the activities of the committees having charge of this educational work.

As a result of the interest of the officers of the National Safety Council and of the Workmen's Compensation Bureau, two committees were formed, the Committee of Eastern Universities, of which Prof. D. S. Kimball of Cornell University is chairman, and the Committee of Western Universities, of which Prof. Benjamin himself is chairman. He stated that the object of the committees was to stimulate educational work along safety lines and to interest the colleges and universities in it so that certain courses of instruction might be given in those institutions, and that the purpose of the present meeting was to contribute to that end. It was proposed further to furnish material, first in the form of lectures to be given by men eminent in the profession; second, in the nature of printed matter and of motion pictures, lantern slides, models, etc., for illustrative purposes, and thirdly, and most important, to formulate a brief system of education appropriate for this work.

Two papers were prepared for this session, one by L. A. De Blois on the Safety Engineer and one by George H. Follows on Safety and Welfare Work in the Engineer's Education.

Mr. De Blois' paper defines the field of the safety engineer and sets forth his goal as the reduction or elimination of accidents; it deals also with safety in construction, equipment and through supervision and education. Mr. Follows' paper takes up the question of safety as related to the engineer's education and outlines the commercial engineering course in the Carnegie Institute of Technology.

THE SAFETY ENGINEER

By L. A. De Blois,[1] Wilmington, Del.

Seven years ago I visited the Gary Plant of the Illinois Steel Company, in the interests of reducing the number and severity of the industrial accidents occurring in the plants of the Du Pont Company. The United States Steel Corporation, of which the Gary Plant was a subsidiary, had even then established an enviable reputation for its work in accident prevention. The report of this visit, which is now a very painful one for me to read, briefly disposed of the subject by stating that accomplishments at Gary could be roughly divided into two classes: mechanical safeguarding, which was excellent, and safety advertising, which the writer believed was undertaken to convince the general public that the steel industry, with a reputation for innumerable serious accidents, was not so black as it had been painted.

As I reflect on these earlier impressions and realize that over a year passed before I fully appreciated the injustice I had done the work at Gary, I wonder how many engineers and executives think today as I thought then—that safety engineering is merely a matter of safeguarding and advertisement. Yet, if I were asked for an opinion, I would say without hesitation that the foreman and skilled laborer in our modern

[1] Safety Engineer, E. I. du Pont de Nemours and Company.

industries have a somewhat clearer conception of and entertain a more cordial feeling toward the safety movement than many engineers and executives. It is partly for this reason that I am anxious today to persuade those who have heretofore considered the "safety first" movement as a fad or a frill that safety engineering is true engineering, that freedom from accident hazards should be a fundamental requisite in the design of structures and machines and a rigid necessity in plant operation, and that the greatest obstacle in the path of such attainment exists in a certain apathy to the safety movement among engineers in general and in a very definite and lamentable scarcity of trained safety engineers technically fitted to carry forward the work.

Field of Safety Engineer Defined

Let us attempt to define the field of the safety engineer's activities. His goal is, of course, the reduction or elimination of accidents. Analysis of industrial accidents shows that from 15 to 25 per cent are unavoidable. In the Du Pont Company, which I am happy to represent, these are the cases which we attribute to "Risk of Employment," "Unknown Physical Deficiency," and "Act of God," and they may be passed by with the brief statement that the number is gradually decreasing as the general knowledge of accident prevention broadens. Of the remainder, or avoidable accidents, between 10 and 20 per cent are caused by unsafe mechanical or structural conditions and are therefore possible of correction. This leaves 80 to 90 per cent attributable to human defects, that is, to the shortcomings of the individual—ignorance, carelessness, irresponsibility, indifference, disobedience, recklessness, horseplay and inexperience of the injured or fellow-employee—and to defects of system such as lack of proper supervision, discipline, etc., in the organization.

Obviously, the safety engineer may not confine his attentions solely to the elimination of those accidents for which his employer or company could be judged responsible under the common law of master and servant; he seeks to eliminate all accidents regardless of responsibility. In 1916 there were approximately 22,000 persons killed in industrial accidents in this country alone and 500,000 injured to the extent of losing over four weeks from work. Such wastage of man-power and production is in the aggregate enormous and constitutes a monetary loss of serious proportions. Unfortunately, its dollars-and-cents equivalent cannot be readily estimated. Workmen's compensation acts, which have largely rendered unnecessary recourse to suits at common law, practically ignore the question of relative responsibility and place approximately one-half the burden of accident compensation for all accidents on the shoulders of the employer. In establishing a rate of compensation, however, these acts make no attempt to evaluate life and limb but, based somewhat on the average net judgments for damages in suits at common law, aim rather to fix on the industries a fair proportion of the financial burden. It is not reasonable, therefore, to assume that the cost of accidents to the people of any state is represented by the total annual payments for compensation. Losses incident to injury or death are in one sense no more compensable than losses by fire are "covered" by insurance. In both cases there has been withdrawn from the nation's reservoir man power, or property representing man power, which can never be replaced.

A remarkable thing about the preceding analysis of industrial accidents is that it seems to apply equally well to any industry. The Du Pont Company, for instance, engaged in the manufacture of the most dangerous materials used in both industry and war, discovers about the same assignment of responsibility for accidents as does the cement industry. Mining, railroads, and other industries have the same experience. Moreover, the non-fatal and fatal accident rates on the Du Pont Company's plants do not themselves differ greatly from the rates of other and so-called "non-hazardous" industries. Both premises lead us directly to the logical, though somewhat surprising, conclusion that neither the nature of the industry nor the character of the materials produced or handled has as much effect on the cause, frequency and severity of accidents as the safe design and equipment of plants, the provision of a proper organization and constant supervision and the education of the working force into habits of caution and careful practices.

Have we not in this way defined the field of the safety engineer's activities and accredited him to all the provinces of design, equipment, organization, supervision and education? His influence must surely spread into each of them if consistent accident prevention is to be attained. But in reality they cover practically the whole vast territory of industrial projection, construction and operation.

Safety in Construction

There may be some who would at first object radically to the intrusion of the safety engineer's ideas in all these matters, especially since, as the exponent of "safety first," he is sometimes accused of interference with production. Let us examine this from the practical side. In the design of structures no engineer neglects the safety factor—which has become one of the tools of his trade—but who has not encountered stairs poorly designed, or probably not designed at all but left to the experience of the carpenter, the handrails of which, put there for emergency, must be used continually if an accident is to be avoided? We are all acquainted with new plants where aisles are dangerously narrow, where there is insufficient headroom, where machinery is inaccessible for repairs and valves are difficult to get at for manipulation or repacking. The safety engineer who sees these conditions and recognizes that accidents will inevitably occur may be met with the objection that they have not yet caused accidents and that expensive alterations are not justified and would hold up operations. These matters could have been corrected at less expense in the original design, and probably would have been if any one with experience had considered them from this angle.

Safety in Equipment

As for equipment, there are types of machine tools that are dangerous and others that are less so and equally efficient—the cylindrical-head jointer, for instance; and there is machinery that could have been better safeguarded by the manufacturer if complete guarding had been specified or if the pressure of demand by the trade had forced him to recognize that he must supply adequate guards or suffer through unequal competition.

In the field of general mechanical safeguarding there has been marked progress in recent years and some excellent standards have been formulated, among them those of the A.S.M.E. But the more difficult problems encountered are those arising from local application and arrangement of machinery, often peculiar to the industry in question, and others due to conditions abnormal to regular operation. As a fundamental we may as well admit that no machinery can be made foolproof in

its regular operation, and we must furthermore admit that conditions occur during adjustment, oiling, cleaning, repairs, replacement, etc., under which standard safeguards may be useless or may even introduce hazard. Evidently the solution of the problem of how to make the equipment as safe as possible under all conditions cannot be reached through mere general acquaintance with machinery of the class in question, nor by a casual inspection of the plant in normal operation. The problem will yield only to analysis after a painstaking study of all phases of operation and of conditions such as poor lighting, inaccessibility and congestion which are contributory to accident.

Safety Through Supervising and Educating the Workers

I have already stated that the majority of accidents are due to the shortcomings of human nature, to personal tendencies and traits in the individuals liable to injury, and to deficiencies in the organization which employs, instructs, holds in restraint and disciplines them. Here the safety engineer is upon different ground and must employ his knowledge of psychology and the principles of industrial organization. His greatest aids will be diplomacy, perseverance, tact and patience with the slow response to his insistent efforts to change the mental viewpoint. But there is in this branch of the work a principle so important that its neglect will bring failure in place of success; it is a clear recognition of the fact that the safety engineer can no more effect general accident reduction by his own direct efforts alone than the doctor can make a healthy community by curing the sick.

Through general education we may awaken a sense of personal responsibility in the man and emphasize the fact that it is necessary to "be careful," but this injunction is of little value if the actual presence of danger is not realized. Failing these, we must rely on the detection of dangerous practices among the men. The safety inspector or safety engineer should be able to tell whether a certain practice is dangerous when he sees it, but he cannot watch all the practices of a thousand workingmen, or even a hundred. The one class of men who can perform this function most efficiently are the foremen, but some one must instruct the foremen as to what is dangerous. This is the function of the safety engineer or inspector. However, an executive authority immediately above the foreman must first convince him, and continue to convince him, that he is required to properly supervise for safety. The plant manager must place himself clearly on record to the effect that safety is as important in the day's work as production or quality, for it is from him that the organization takes its tone. From the directing officials of the company must come moral and financial support. Thus the whole organization is involved.

I trust that in the foregoing I have shown that safety engineering with its interests in design, equipment, organization, supervision and education should have a place in every field of industrial enterprise and that it bears as well a very definite and important relation to all other branches of engineering. This relation is so close and its need so urgent that I am convinced that some instruction in the fundamentals of safety engineering should be given a place in the training of every young engineer.

Value of the Safety Inspector

I do not wish to be understood as underrating the safety inspector. There are many among them who are successfully filling worthy and responsible positions. There are many more who bear about the same relation to the safety engineer as the stationary engineer does to the mechanical engineer. Many are capable of making thorough inspections and recommending standard safeguards but are debarred by personal limitations from going very much farther. Yet in many plants nothing further is demanded. "We have a safety inspector and a safety committee"—the safety inspector of the "practical" type and the safety committee recruited from men in the shop who by some strange metamorphosis are expected to become suddenly expert in detecting hazards previously unrecognized. The real truth of the matter is that the safety committee proves very useful in detecting obvious conditions that the foremen and management ought to have observed and remedied long ago and the experience gained by the committeemen is good for them and opens their eyes to many common hazards.

Real Work for Real Engineers

The National Safety Council is the representative organization of the country dealing with safety. Since its foundation in 1912, its activities have extended until its membership now represents the employers of over 6,000,000 men. The safety of this vast army of workers should be in the hands of trained men, but there are few to fill the vacancies that exist today and the new positions that will be created tomorrow. It is not right that the onward march of the safety movement should be halted to permit its officers to be recruited and trained.

If there was ever need for a national campaign to reduce death and disablement from industrial accidents, that need is today. They tell us that at least three workers are necessary at home to supply one man at the front. By workers is meant producers—not hospital patients—and the war will bring us enough reconstruction problems in the employment of war cripples and returned soldiers without the problem of employing the many men crippled in our industries. Let us realize, then, that "safety" is not child's play, not a matter for "practical" men, not a passing fad, but real work for real engineers, and that the sooner we accept this viewpoint and shed our coats to the undertaking the less cause shall we have, when light comes, to regret the days of complacent inaction.

As Mr. Follows was not present at the meeting, Professor Benjamin called on Prof. J. A. Polson to read the paper in his absence, of which the following is an abstract:

SAFETY AND WELFARE WORK IN THE ENGINEER'S EDUCATION

By GEORGE H. FOLLOWS[1]

On March 2 of this year, at the American Museum of Safety, New York, under the auspices of the Committee on Safety Education of the National Safety Council, there was held a conference on safety education in technical schools and universities, with Mr. Albert W. Whitney, general manager of the National Workmen's Compensation Service Bureau, presiding. On March 20 a similar meeting was held in Chicago, with Mr. Whitney again the chair. At each of the meetings, a special committee was appointed to suggest ways and means of introducing definite courses of instruction in safety and welfare work in our engineering schools.

At the meeting in New York it was suggested that a corps

[1] Carnegie Institute of Technology, Pittsburgh.

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of lecturer be chosen from among engineers of prominence in this field to visit the schools and give a series of safety talks to faculties, students and others. This suggestion was unanimously approved, but it was at the same time realized that although such a series, limited perhaps to three or four lectures at any one school, would undoubtedly arouse interest in the subject, it would not in itself constitute a definite course of instruction. To preach safety is one thing; to give efficient training in safety and welfare engineering is another. While keen interest was shown in the safety movement, the fear was rather generally expressed that it might be difficult to "find room" in any of the regular engineering courses for adequate treatment of the subject.

I was much impressed by what Mr. C. P. Tolman, chairman of the Manufacturing Committee of the National Lead Co., said at the New York meeting. In a most interesting and inspiring address he prophesied that within a very few years engineering schools would find it necessary to grant a special degree in safety and welfare engineering. He spoke of the wide field of usefulness of the safety engineer, of his value alike to employer and employee.

Practically every day since that meeting, I have been at work on a problem that the Carnegie Institute of Technology has been interested in for the past 11 years, the solution of which seems to provide the natural place for safety and welfare work in the engineering school. Our problem has been the course in commercial engineering.

I believe that in this course in commercial engineering there has been found the logical place for safety and welfare work; and this in my opinion is the crux of the problem, the realization that there is today a positive and increasing demand for a new type of engineer, and that the course of training which he must have naturally includes safety and welfare work.

The Carnegie Institute of Technology has chosen the name "Commercial" for this new type of engineer. At the outset let me say that his training must not be confused with that given in business colleges and schools of commerce; this in spite of the fact that some of the subjects handled will be found in these courses in business and commerce. The training of the commercial engineer must be based upon engineering science, economics, and psychology. Since 1907 Carnegie Tech has been giving definite courses of instruction and student work in economic production and works management, and a large proportion of the senior class in the several engineering fields has been scheduled for parts of these studies, which, however, have been specifically developed for the benefit of those graduating in commercial engineering.

If it is permissible to divide the entire range of engineering work into two main parts, the one technical, the other commercial, then the commercial engineer is the man who is trained to use or apply in a variety of ways but always efficiently what the technical engineer provides. And he is a distinct species, not a mechanical, electrical or any other kind of engineer who has in addition some other kind of general training, superficial in character, but a distinct species, whose entire college education and training are based upon the fundamentals of commercial engineering itself.

The field is broadly that of conservation, not only of materials and equipment, but of the time, the effort, the life, health and happiness of the men and women employed. There is a large and rapidly growing need for men who have been definitely trained in the direct solving of problems in this field.

Below is given the four-year schedule in commercial engineering as recently adopted by the faculty of Carnegie Tech. There was some opposition to the introduction of this as a schedule of studies leading to a bachelor of science degree in engineering, but it was finally adopted. As Mr. Whitney puts it: "Problems of industrial management are coming to be recognized as the great problems of the day." Who shall say that they may not be called engineering problems? If the designing of a milling machine is an engineering problem, surely the problems that confront, say, the efficiency man, or the safety and welfare man, are worthy of the same name! We must not forget what the word engineering means. We have no right to limit the use of it to material devices, no matter how ingenious they may be.

SCHEDULE OF COURSE IN COMMERCIAL ENGINEERING AT CARNEGIE INSTITUTE OF TECHNOLOGY

FRESHMEN

	F.	W.	S.
Mathematics	5-0	5-0	5-0
Chemistry	2-4	1-4	2-2
English	3-0	3-0	3-0
French	3-0	3-0	3-0
Drawing	1-3	0-3	0-3
Shop Processes		0-1	0-1

SOPHOMORES

	F.	W.	S.
Mathematics	4-0	4-0	4-0
Physics	5-3		
Mechanics		4-0	3-0
French	3-0	3-0	
Economics	2-2	2-2	2-2
Psychology		1-2	2-0
Statistics		2-6	2-3
Accounting			0-4

JUNIORS

	F.	W.	S.
Materials	1-6		
Measurements	1-4		
Mechanical Laboratory		0-3	0-6
Prime Movers	2-0	2-0	
Machinery Analyses		1-3	2-3
Production Processes	1.0	1-0	2 0
Electricity and Magnetism			3-0
Commercial English			3-0
Commercial Illustrating	1-2	1-2	
Advanced Economics	1-0	1-0	1-0
Factory Costs	1-3	2-6	
Accounting	1-3	1-3	1-3
Commercial Law and Contracts		3-0	3-0

SENIORS

	F.	W.	S.
Electrical Applications	2-3	2-3	2-3
Spanish	3-0	3-0	3-0
The Printery	1-3	1-3	
Banking and Insurance	2-3	2-3	
Transportation			2-3
Works Management	3-0		
Safety and Welfare Work		2-0	2-2
Economic Production	1-3	1-3	1-3
Buying and Selling	2-3	2-3	2-0
Industrial Corporations			3-2
Applied Psychology		2-0	1-2

In this schedule, F., W. and S. mean fall, winter and spring. The school year is divided into four quarters, with the three terms of regular scheduled work. The two-part figures, as 2-3, mean two hours of lecture or recitation and three hours of laboratory work per week.

During the past three months I have had repeated interviews with several well-known captains of industry in large engineering corporations, and they have been unanimous in

saying that today the field in commercial engineering offers greater opportunities to the young college graduate than any other single field of engineering work. One of these men put it in this way: "At present we have to take a mechanical or some other kind of engineer and instruct and train him along entirely new lines, lines of work of which he does not possess even the rudimentary fundamentals. It is a different kind of training altogether from that of the designer or strictly technical man. Men trained in the way you have outlined will be of immediate and great value to us." It is a significant fact that several of the large industrial corporations have already offered to employ our entire output of graduates in this new course.

A few years ago we experimented with what we called commercial options; and so we had electrical, civil, chemical, and mechanical commercials. We discovered that this hyphenating was inefficient. The idea itself was not unattractive to the orthodox engineering faculty, namely: that a man must be some kind of orthodox engineer first, and then if he chose he could be converted into a commercial engineer of sorts. In other words, he was to be a real engineer with the addition of commercial training.

It would be unreasonable at this time to go further into the details of the general course in commercial engineering. What I set out to show was that the course provides the logical place for safety and welfare work, and so it was necessary to give this Society a definite idea of the nature of the place that the Carnegie Institute of Technology has arranged to provide.

The commercial engineer will have to do with the solving of a great variety of problems, but there is one factor that is common to all, and that is the human factor, as dealt with through a study of psychology and its definite application in the scientific study of men, their work and their welfare.

The accompanying schedule shows that safety and welfare work has its allotted time for specific treatment, but many phases will be discussed in connection with other scheduled subjects, as psychology, economics, statistics, machinery analyses, production processes, works management, insurance, and commercial law and contracts.

It is impossible as yet to give even a synopsis of the specific course in safety and welfare work that will be given at Carnegie Tech. This will be developed during the next twelve months. There is an abundance of literature to draw upon, but the administering of specific instruction can only be developed in connection with classroom and laboratory work.

Before opening the general discussion, Professor Benjamin called on Mr. Albert W. Whitney [1] as the man largely responsible for the organization of the committees and the arrangements for the meeting.

A pamphlet had been distributed at the meeting, entitled The Teaching of Safety in Technical Schools and Universities, containing suggestions as to the incorporation of safety education in engineering curricula; subjects and speakers for safety lectures; safety exhibits, and bibliography of safety and accident prevention, etc. Mr. Whitney explained the purpose and contents of the pamphlet, saying that coincidentally with the entrance of this country into the war the arsenals and navy yards (through the assistance of the National Safety Council and the American Museum of Safety), and later the United States Shipping Board, were put upon a safety basis with well-developed safety organizations. This was not done primarily for humanitarian reasons; it was done for efficiency. It meant a saving in money, greater production, fewer wasted lives.

[1] General Manager, National Workmen's Compensation Service Bureau, New York.

The safety problem is fundamentally psychological. What needs most to be done is to make men think in terms of safety. Just as the war is introducing the idea of thrift into the nation, so the idea of thrift in the saving of lives and limbs must be learned. Safety must take its place in the consciousness of people as part of the program of conservation, and conservation as part of the program of efficiency. In no way can this result be produced in industry more effectively than by education of the coming generation of engineers.

DISCUSSION

Prof. E. F. Miller said that he had served for the State of Massachusetts in the draft of safety rules under the direction of the Board of Labor and Industry. The rules were general in nature and outlined the general methods of safeguarding —ladders, shafting, toe guards around pits, keyways, set screws, etc. There were representatives on the advisory committee of practically all of the large industries of Massachusetts, besides two insurance men. The manufacturers were inclined to feel that the insurance men were asking for so much protection that the output of the machines would be reduced, due to safeguarding. This led to an investigation in the woolen industry by the committee, and in one of the best-guarded mills of the country dangerous conditions were found, particularly in respect to belting. This disclosure brought about a more favorable attitude on the part of the manufacturer.

He said that the enforcement of these rules was left generally to the option of the Board of Labor and Industry, who would give a firm reasonable time to make the changes; but if not made, they had the power to shut down the plant. Professor Miller had served the state in an advisory capacity in cases of occupational diseases, etc., where it had been beyond the ordinary state inspector's ability to tell what to do to remedy the troubles. Some of the conditions which he found were so bad as to be almost unbelievable.

At the Massachusetts Institute of Technology instruction in safety subjects was given in connection with the course in factory construction. The protection of gears and pieces which were likely to catch a man's clothing were considered in the course in design. He felt that the reason why there had been opposition against the safety engineer was that many of the insurance inspectors who looked over risks had been so extreme in their recommendations that the manufacturers would not meet them halfway.

E. E. Clock emphasized the importance of safety devices for steam engines. To use an analogy, he said that a boiler has a safety valve and a damper regulator. The latter acts in the capacity of a governor, but it would not be safe to depend on this alone. The safety valve is essential. In the same way a steam engine is controlled by its governor, but people do not seem to realize that an automatic stop for ultimate safety is also essential.

Prof. James A. Moyer spoke on a course of study prepared for the Department of University Extension of the Board of Education in Massachusetts by experts selected by the New England Council of Industrial Safety. This course, which is adapted to correspondence methods also, is to be revised during the summer months and printed in September of this year, when it will be available for use in the state.

G. W. COON, explained that the course consisted of twelve lectures and was given to a class in Springfield, under the auspices of the New England Council of Industrial Safety, consisting of about forty-three members, drawn from the ranks of mechanics, millwrights and university graduates. There had been time for but eight of the lectures to be given, but the remaining four were to be given in the fall. The course was very successful.

CHARLES F. OAKES[1] believed that the trend of the whole discussion was toward standardization. The remarks on safety in mechanical construction were in line with a subject on which the Bureau of Standards had been working for the past four years, the standardization of safety practices. The Bureau's work in the past had been in a somewhat specialized field, electrical safety, but the success which had attended this work had moved them to broaden their scope to include industrial safety practices. This work had been initiated in the recent safety movement in Federal industrial establishments, and the movement, inaugurated in Federal arsenals and Navy Yards, had its inception at the instance of the Council of National Defense, with the assistance of the National Safety Council and the American Museum of Safety; the main idea of this was to check the number of accidents occurring in Federal plants by formulating a set of safety standards for equipment and construction. These had been submitted to the Bureau of Standards, who, working in conjunction with a committee of the Safety Engineers, had revised them, and it was expected that they would soon be adopted by the War and Navy Departments. There was little doubt, said Mr. Oakes, that a standardization of industrial safety along mechanical lines should be effected in much the same manner that the electrical industry was being safeguarded through the agency of the National Electrical Safety Code. This movement had been started in a number of states with little thought of nation-wide standardization, however, by the State Industrial Commissions. In order to coördinate the work of the states, the Bureau of Standards had been suggested as the best medium of accomplishment. In the preparation of the electrical code about two thousand conferees had been consulted and the services of over thirty technical organizations had been called upon. It had had a wide distribution, and was now incorporated in thirty two colleges in the United States. It was the intention of the Bureau of Standards, after the work had progressed to a degree sufficient to warrant it, to offer the services of its staff for lecture work among the universities as was now being done from time to time in the case of the National Electrical Safety Code.

MR. M. W. FRANKLIN[2] said that the time was not yet ripe for turning out specialists in safety engineering at the universities. A large percentage of our industries, aside from our highly-organized, large industries, had had no safety engineers. He believed, however, that the work which Mr. Whitney's committee had been carrying on in the development of specific courses in safety engineering was the most important thing yet attempted in the training of safety engineers, and would produce very concrete and immediate results. Mr. Whitney had had the forethought and the very sound judgment to choose people to assist in the work who had actual, concrete, definite experience. A course in safety engineering was necessarily so varied, so widely spread out and of such a broad nature that no one person was in a position to outline such a course. It had required the coöperation of very different persons with very different experiences to successfully formulate such a system.

Mr. De Blois, in closing, said that the Du Pont Powder Company, with between 60,000 and 75,000 employees, and whose numbers were constantly growing, would not consider the erection of a plant without first having an experienced safety engineer engaged on the work. Five years ago it was a difficult task to get a manager to realize that he needed a safety engineer. If he did get one, he didn't know what to do with him except to turn down his recommendations, but today the situation was entirely different. The company had found that it was easier to take a perfectly green engineer from the field, who had had no safety engineering whatsoever, and make a safety engineer out of him, than it was to take a man who had had five or six, or maybe ten, years' safety experience in general industries. They had secured candidates through advertising in the daily press, and from 300 applicants ten were selected for a six months' course of training. He believed that if there were available men from universities and technical schools, with the fundamentals of safety engineering and the ability to handle men, the problems which the industries were now having to face would be materially lessened.

WEDNESDAY EVENING SESSION

ADDRESSES were planned for this evening on The Procurement Program of the Government in order to present to the Society ways in which its members could best cooperate. Owing to conditions incident to the war, however, three of the speakers who had accepted were unable to attend, two of them sending their regrets on the day of the meeting. In spite of the sudden change in program, the session was entirely successful and of interest to the large audience in attendance.

PROCUREMENT OF SUPPLIES FOR THE NAVY

PAYMASTER C. E. PARSONS, U. S. N., who was one of the speakers originally invited, said that his principal reason for coming was to indicate to the members of the Society, and to the industries which they represent, the friendly feeling that the Navy entertains toward them. The big, paramount question now is that of getting material. While it has not been necessary to go outside of the Navy's own organization to provide for its increase in size, it has been necessary for both the Army and Navy to call to their aid the brains of the country in connection with material and the procurement of supplies.

Discussing some of the aspects of the procurement program, he said in part: There has been manifested the greatest interest on the part of the industries in this country toward supplying the Navy's needs. However, it is felt that even yet a greater interest can be taken, and that the Navy's business is sufficiently interesting to warrant all manufacturers attempting to get some of its contracts. Its dealings are conducted fairly and squarely, and one of its principal policies has been not only to do things right, but to do them in a way to indicate to every one that they are right.

[1] Bureau of Standards, Washington, D. C.

[2] Consulting Engineer, E. F. Fulton Co., Philadelphia, Pa.

There is no fairer basis for awarding contracts than that of competitive bidding. The Navy has held to that from the very beginning, except, of course, in those industries where the supply is not great enough to meet the demand and where it has been necessary to allocate supplies among the manufacturers, and necessary also for the Government to fix prices.

Standard specifications have been adopted, of which there are now about 1400, as a basis for equal opportunity for everyone. These are used by the railroads and by big corporations throughout the country, and even throughout the world. At the beginning of the war, owing to the changed conditions and the necessity for making prompt, immediate purchase of supplies, classified mailing lists were started. Before the war it was only necessary to advertise the Navy's requirements in order to enlist the interest of contractors and manufacturers; but now it is necessary to get into closer personal touch with them and bring to their immediate attention those things that they are in a position to supply. In order to bid on the business, therefore, it is essential that manufacturers should be on its mailing lists. It is desired that reliable firms should ask to have their names placed on these lists, and in turn it is attempted to make the lists of such a character that it is worth while for any manufacturer to have his name upon them. Brokers have been eliminated—the Navy has maintained a fight under great odds against the brokers, and has done everything possible to eliminate them in their dealings.

There have been reports among the industries relative to Government red tape, the very binding contracts, and the inspections which are so exacting, but in all cases it is believed that if any one will investigate the question fair-mindedly, he will find that these conditions are absolutely required, and particularly so for the protection of the legitimate and the honest dealer. The specifications are drawn up by the technical bureaus of the Navy Department, and these bureaus are entirely open-minded about changes in specifications. If any manufacturer thinks the material that is purchased or the specifications that we used are not proper and could be improved upon, he has only to advise the department of the fact and an investigation will be made, and in nearly every case the specifications are changed if a change is warranted. Under the present stress it may not always be possible to do this, but this is the policy of the department.

The contracts are big and the specifications voluminous, and carry provisions which often appear to the average individual when he looks them over as excessively in detail. As a matter of fact, nearly all the provisions have been brought about by efforts on the part of unfair contractors to take advantage of technicalities, which have made it necessary to set forth plainly, without a question of doubt, the provisions under which contracts are made.

As to the inspection of supplies, if an exacting inspection were not maintained and some one was permitted to furnish supplies below the standard, it would be unjust to the man who was bidding and expected to furnish just exactly what was called for, and fairly and squarely carry out his contract. Rigid inspection is essential for the protection of the honest dealer.

Very much has been said relative to Government red tape as the reason why industry has not interested itself more in the Government's requirements for supplies. As a matter of fact, red tape is simply organization and system, which must exist in an organization of the size of the Navy. But he said, "I will warrant that any chief of bureau in the Navy Department, or any official in the Navy Department, can be seen and consulted with less loss of time and with less difficulty than almost any president of a big corporation or firm. As a matter of fact, the doors are wide open, and we welcome people to come down and look us over.

"Particularly do we maintain that publicity is essential in connection with the handling of contracts. Bids are opened publicly, and people interested can be present when bids are opened and see the bids of any of their competitors. They can be assured that the awards are made fairly and squarely and that nothing is concealed."

The speaker referred to the growing tendency for Government regulation of matters connected with industry through the Fuel Administration, the War Industries Board and other agencies, and said that it was desirable for firms to have contracts either for the Army or Navy.

"We have found," he said, "even up to the present time, and it is going to be more and more so in the future, that we can be of great assistance to contractors if they have Navy contracts. We can procure fuel for them which otherwise they possibly could not get. We can arrange for transportation for the supplies which probably otherwise they could not get. We also attempt to pay promptly, and during the month of May we found that our average time for payment was only seven days after the supplies had been furnished and accepted."

In conclusion, the speaker stated that business had been placed on the east coast to such an extent, in the region north of the Potomac and east of the Alleghanies, that it would be almost impossible for more to be handled except where it was a continuation of that which contractors already had. The railroad facilities are inadequate to handle further business, and the Fuel Administration is unable to furnish the fuel for any further activities. All we can hope to do now, if we take their judgment as correct, is to maintain the present rate of production. It is necessary, therefore, to develop our great facilities in the West or in the South, in order that we may get supplies and carry on the war to a successful end.

INTERIM REMARKS

THE address by Paymaster Parsons ended the procurement part of the program, so far as Government supplies were concerned, but in respect to the procurement of speakers for the evening the work was only well begun. When word had been received that the other Government representatives could not attend, Dr. Irving G. Clark of Worcester, who had recently returned from service at the front, very generously accepted an invitation to address the meeting on his impressions and experiences abroad. Dr. Clark could not come until later in the evening and the President therefore called on some of the Society's able members to assist.

Professor Breckinridge enlivened the audience with some stories on the lighter side of university life. One of these related to a dinner which he attended, of the alumni and alumnae of a large western university, held in honor of a newly elected president of the university. Everyone was attired in evening dress except one man who sat at his right—but we will let the professor tell it:

"I didn't know who this fellow was—nice fellow, just as nice as any fellow with evening clothes on. Laughter. When the newly chosen president was called upon, to my surprise this fellow got up, and the first thing he said was: 'I perhaps ought to apologize to the ladies for appearing in these clothes, but it was this or nothing.' [Laughter.] Now, that was entirely accidental. They laughed over in this corner, and in this corner, then this corner. He tried to explain, but they

couldn't let him explain. After he got all through he sat down. 'Well,' he said, 'I did put my foot in it, didn't I? The fact was, I expected to get home and get into those other clothes, but I lost my train.' I said to him, 'I have four jokes. I bet they won't laugh at any of them as much as they did at yours.'" [Laughter.]

At the meeting on Wednesday evening Professor Breckinridge told the other four jokes, but space requires that we refer instead to a more serious note which he sounded in concluding—a clear call to the young, prospective engineers of the country. He said: "We have heard what the Navy wants in material and about certain priority of shipment and priority of fuel which may be arranged for those who are making the things that the Navy needs. But I want to call attention to one thing that needs the attention of every industry. My experience is no different from that of many professors of engineering in all of our universities. It is that we need raw material for our universities and technical schools. Never was there a time when the teacher of engineering and the teacher of science was asked day after day, in telegram after telegram, 'Where can we get a man to do this and to do that?' to say nothing of the industries that are pleading with the technical schools to send them men. There are no men. There will be no men. There ought to be some priority scheme that will put raw material into the universities, otherwise we shall have troublesome times ahead."

Past-President Worcester R. Warner followed—his remarks are reported in full. He said: "When Professor Breckinridge mentioned universities, and the study of engineering subjects, it occurred to me how important it is to start from the right standpoint. This is illustrated by a happening at a certain university, which, being a western institution, was coeducational. It was in the class of mathematics and astronomy. The class had 'Time' for its subject that morning and the professor explained the reasons for the different kinds of time—mean solar time, sidereal time and the equation of time and all the problems incident to the study of time, in astronomy. It seemed that the entire subject was covered, and, in closing, he turned to one of his students in the class and said, 'Miss Brown, what time are you most familiar with?'—thinking that she would say, as you all would, 'mean solar time,' such as we keep in our clocks and watches; but a young man right behind Miss Brown whispered loudly, so that all could hear, 'Dinner time.' [Laughter.] Of course, all the students laughed. The professor laughed, too. He didn't correct them in the slightest degree, but he said, 'Ladies and gentlemen, that all depends on the standpoint from which you look at a subject. To Newton the fall of an apple meant the great law of universal gravitation, but it meant a very different thing to the pig that came along and picked it up. [Laughter and applause.]"

Chairman George I. Rockwood, of the local committee, then made a few announcements, when Dr. Clark arrived and gave a most interesting talk, a synopsis of which is printed below:

TALK BY DR. IRVING G. CLARK

DR. CLARK spoke on conditions that he saw in France during his three years' work there with the Red Cross. Life in France, where one experiences all the realities of a country at war, presents many changes which are hard for the pre-war traveler to reconcile. Women handle the train service—which is excellent—baggage transfer, the industries, farming, hospitals, etc. The large number of soldiers in Paris and great variety of uniforms make the streets most interesting. Few people understand the significance of the many different colors and insignia, for there are Belgian, English, Canadian, French and American, and all the subdivisions and colonials of these nations are represented. The life of the city is brilliant when it is quiet on the battle fronts, but much changed. The cafés that were open formerly up to two and three o'clock in the morning, now begin to close at 9.20 and are absolutely vacated by 9.30. The theatres still run until eleven, but after that Paris is a very quiet city.

There are fewer shops and prices are very high. Food is so expensive that an ordinary meal ranges from \$1.20 to \$6 in price.

Air raids are announced by sirens like the warning New York City recently planned. Every light is instantly darkened, indoors and out, except the blue light over the *alerte* signs which show cellar refuges to which all the people in the streets immediately run. These blue lights are less visible from above than the lights of usual color. Then starts the noise of the anti-aircraft guns putting up their barrage fire. The little flashes of light from the shrapnel appear, and the lights from French planes rising in defense. Soon the roar of the falling torpedoes is heard, and all interest centers in the speculation as to whether the next one will be nearer or farther away than the last.

Dr. Clark admitted that his feelings were always uncomfortable during an air raid, for he always had to be out at this time in order to reach Red Cross headquarters. Every one seems to feel easier when under cover, even though the cover is entirely inadequate.

The concussion from a torpedo which exploded about a mile away was sufficient to spin around three times a heavy plate-glass door and to knock people out of their chairs. The weight of the bomb generally carries it through two floors, where it explodes, completely demolishing those two floors. The building below that usually stands. All windows for blocks around are blown out, and the decorated paper pasted in to replace the glass presents an extraordinary sight.

The French are unable to joke about the air raids as they do about the "Big Bertha." The defense from aeroplanes is now much more effective than at first so that the enemy planes do not reach the city very often. Some new method of protection seems to have been used which apparently is a military secret, and very successful.

Air raids last from 40 minutes to 3½ hours, and at the close a welcome bugle announces that the danger is over.

The French make a little party of the periods spent in the cellar refuges, where they play cards, have music and enjoy meeting the new people who are obliged to seek shelter in that locality.

Dr. Clark spoke enthusiastically of the methodical way in which an immense amount of hospital work is turned off. The team work is splendid, no hurrying, but brisk, steady work. He found the morale of the men in the hospitals wonderful, and referred particularly to the work of two American physicians as an example of the loyalty and devotion which everywhere exists. They were operating in a French hospital, but under the direction of the American Red Cross. When the Germans were advancing the French were ordered to evacuate, but some of the patients were so badly wounded they could not be moved. The Americans, not being subject to French orders, decided to remain. Refugees and wounded came pouring in and the two American surgeons operated all day and all night and part of the next day until it was established that the French line was holding and the French were ordered back.

EMERGENCY TECHNICAL WAR TRAINING

The War a Matter of Matériel and Technically Trained Specialists. The Problem is That of "Re-educating an Entire Nation for a New Kind of War"

THE session devoted to Emergency Technical War Training, held on Thursday morning, June 6, in the lecture room of the Electrical Engineering Laboratories of Worcester Polytechnic Institute, was one of far-reaching importance. Inasmuch as the great need for technically trained men is constantly becoming more and more acute, it is vital that a comprehensive scheme for such training be speedily put into practice. The fact that considerable has already been done in this direction merely tends to emphasize how much has to be accomplished. For this reason Major James E. Cassidy, of the 301st Engineers, and an official observer at the French front in 1916, was invited to open the program by outlining the enormous scope of military activities dependent upon technically trained men. Professor Arthur L. Williston then spoke on the problem from the point of view of a director of vocational training. Lieutenant André Morize, detailed to the Department of Military Science at Harvard University, summed up the remarks made by the previous speakers in an inspiring address.

Following, Mrs. Frank B. Gilbreth, in the absence of her husband, Major Gilbreth, made a plea for an increased enrollment in technical schools and colleges. Motion pictures were then shown descriptive of the Browning machine gun, its operation and method of clearing, etc.

Mr. John R. Freeman, Past-President of the Society, took advantage of the presence of the motion-picture apparatus to show by this means a method he had employed in demolishing a smokestack, and the accuracy with which the stack was made to fall was demonstrated in a most interesting manner.

Vice-President Charles H. Benjamin presided, and a very attentive and enthusiastic group of members and guests profited by the remarks of the speakers. The following report is an abstract of the proceedings.

CONDITIONS AND REQUIREMENTS OF WARFARE

By MAJOR JAMES E. CASSIDY[1]

THE complexity of modern warfare has brought the engineer into a position that was never before occupied in the course of war. At the outbreak of the present struggle neither the Allied nor the Teutonic armies really realized what the war was coming to as regards the methods of fighting. Practically all previous methods of fighting have been relegated to the scrap heap to a certain extent. We saw for the first few weeks of the war a war of movement, where bodies of troops were engaged in maneuvering for positions and fighting in the open. Following the battle of the Marne, however, where the Germans were thrown back to the Aisne River, the war lapsed into a war of positions.

When the war of movement ceased and the war of positions began, then it became a matter of *matériel*, a term that the French coined to cover all the equipment and the appurtenances of war. The development of the war of position rapidly made the artillery—the mechanics of war—a very prominent feature, and also started the use of the airplane. Up to this time the airplane was considered nearly as dangerous to our own men as to the opposing forces. As an example of the trend of warfare, the grewsome works at Namur, Liège, Antwerp, Maubeuge, etc., were built to withstand a 6-in. artillery fire, which was considered the heaviest artillery that an army in the field could carry to any advantage. However, when the infantry failed to take Liège by storm they brought up Austrian 9- and 11-in. howitzers. There has been a great deal of newspaper comment on the work that the "Busy Bertha" and the 42-cm. howitzer were supposed to have done. As a matter of fact, it was not those guns that were used, but a size between those and the 6-in. guns, and the 9 and 11-in. howitzers that are believed to have destroyed the forts mentioned.

The War a Matter of Matériel

One of the best axioms or most emphatic axioms of this war is that men cannot combat matériel. You must destroy matériel with matériel before men can advance, before positions can be taken. The side that produces the greatest destruction of matériel is the side that is going to win the war.

To a certain extent up to the present time there has been more or less of a deadlock. The airplane situation is practically in that condition. For certain short periods one side has been able to overcome the matériel of the other, but on the whole there has been almost a stand-off. For this reason the war of movement has entirely ceased; the war of positions is on.

In former wars, if one combatant could maneuver around and capture the capital city of the other and get a good slice of his territory, peace was declared. In this war territory means practically nothing. The function of the army of today that wins consists of three things: the destruction of men, matériel and morale. The destruction of matériel is the prime factor in the destruction of men, and the destruction of men means the destruction of morale. We have seen it in various fightings; for instance, where the Germans hurled their masses on the French positions and were simply slaughtered. The same thing occurred in the first and second battles of Ypres in 1914. The same thing has been occurring in France and Belgium in the last few weeks of fighting. The price the Germans have paid for a few square miles of territory has been entirely out of proportion to the advantage gained. Their reserves and the disposition of their forces are necessarily limited, and when their reserves are wasted they have nothing further to draw upon. Their only hope, as a wild gambler's chance, was to do something big, but the British, French, Portuguese, Americans, and other men that have taken part in this fight have tended to destroy that one gambler's chance, and as time progresses it will be completely destroyed. The slaughter of men—the Germans fighting *en masse*—the slaughter of men who are forced to move forward under the murderous fire of machine guns and rapid-fire artillery, undoubtedly has its effect on the morale of the soldiers and is bound to tell in time.

The part that we can play in this war and will play is a very great one. By superhuman efforts on each side there is now a certain amount of deadlock in the situation. In the air the Allies have maintained a small supremacy. They have the speed and the maneuvering ability and, on the average,

[1] 301st Engineers, Camp Devens, Ayer, Mass.

they have the better class of fighters—they are airplane fighters. But on the whole it has been to a certain extent a stand-off. We are coming in with fresh forces and unlimited reserves, and while we were laggards for three or four years we have made great strides the last fourteen months.

In a lecture yesterday morning, Colonel Paul Azan, chief French military attaché in this country, mentioned the need for a lighter mobile field gun than is at present in use. We have the 75, which is practically the 3-in. gun; then the next step down the line is the 37-mm. gun, which is a very effective gun but only fires a 1-lb. shell. If the mechanical engineers in this country can produce a gun somewhere between those two, say, one of $2\frac{3}{4}$-in. caliber and much lighter in weight, they will be doing an enormous service toward ending the war. Colonel Azan has gone all over this country in connection with military work and says that he never fails to speak of this when he is addressing any body of men, whether soldiers or whether civilian societies, in the hope that some one will take the idea and work on it.

THE PART PLAYED BY ENGINEERS IN THE WAR

The question, then, outside of the production of matériel for the armies, comes down to the part the engineer is playing in this war. Well, it is no small one. The corps of engineers in this country at the outbreak of the war consisted of 200 officers and 2100 enlisted men. Our organization today consists of 252 regiments and about 108,000 men and 7000 officers. For fourteen months that is not bad, and our proportion is increasing all along. In the time at my disposal I can merely mention the different activities in our Army that have been turned over to the engineers.

For instance, we have the work of mining and sapping; the various classes of bridge work—pontoon and other classes used in the field; and the mining of deep gallery shelters, a very important feature on the fighting fronts of today in the war of positions. For several miles from the front lines all the soldiers live in deep gallery shelters. With the modern high-angle artillery fire one is not perfectly safe in a deep gallery shelter unless he has from 25 to 30 ft. of roof over his head. Major Rousseau of the French engineers, in commenting on that point, stated that often a mistake was made in constructing a machine-gun shelter with only 4 or 5 ft. of earth overhead, and said that a piece of sheet iron would serve equally as well, because neither would turn even the smallest shells.

The work of demolition and the defense against the poisonous gas used by the Germans has been turned over to our engineer service. Then we have the searchlight service and camouflage paint service. We have not progressed so very far in tanks yet, but have a tank corps organized and tanks under construction or under contract. We have a railway transportation regiment which has been turned into a corps, and the gas and flame offensive service. Then we have the map section of the engineers and quarry regiments to quarry and crush stone for road work. One of the primary things of the war today is getting up supplies; and the building of railroads and ordinary highways has involved figures that are staggering to the ordinary individual. Then there are tunnel companies for various kinds of tunnel work, mostly back in the zone of the interior.

CANTONMENT CONSTRUCTION ABROAD

With reference to cantonment construction abroad, I would say that most of our troops are billeted in France. For instance, a certain village will have every house and every barn marked with the number of men it will accommodate and the town major has a complete list of every house, knows exactly where he can have his headquarters and knows how many a certain building will shelter. I believe the usual basis of figuring that billeting is about seven soldiers to one civilian inhabitant. In our training areas back behind the lines, however, we build cantonments differently from what we do in this country. Here we have simply let contracts for the erection of buildings; for use abroad we have furnished portable, or rather, sectional, houses. The original design was for houses 20 ft. wide and 237 ft. long. The doors were put on a panel, the windows were put in and the roof was in sections. The only thing not built up here was the floors. The work was parceled out to 15 mills and enough of these buildings were completed in 60 days to house 500,000 troops. So far as I know, that system has been continued.

The large army of today not only needs plenty of food supplies and ammunition but it needs water as well. So we find the Germans poisoning wells and dropping in bodies of animals and men or anything to destroy the value of the water for immediate use, making it necessary for the engineers to plan for a water supply to follow the armies, run pipe lines up, dig wells, and take steps for purifying water. Then we have our general construction units which do all sorts of general construction work back in the zone of the interior. We have the general repair shops and supplies. We have railway-construction regiments. There is one particular regiment—the 23d Engineers—that is organized for highway work and will ultimately have under its direction an immense force of German prisoners.

I happened to have one of the battalions of this regiment under my charge for tactical instruction at Washington barracks last December, and an amusing incident occurred in connection with the Second Liberty Loan. One of the enlisted men went around to men in his regiment asking for subscriptions to the Liberty Loan, and he came to one man, a private, and asked him if he didn't want to subscribe. He said he believed he did. "How much shall I put you down for?" said the solicitor. "I will take $100,000 worth," said the private. The soldier thought that was a great joke and rather laughed, but the private told him, "If you don't think that that is all right you can wire ——," naming a certain bank in Pittsburgh. The soldier reported the conversation to his superior officer, and the officer said, "All right, just wire this bank for curiosity." The answer came back, saying that if this man wanted to take $5,000,000 worth of Liberty Bonds he was perfectly good for them. [Laughter.] That is a little illustration of the cosmopolitan composition of this regiment. In it there are men serving as privates who have had 10 or 15 years' engineering experience, consulting engineers, some of them. You will find there almost every class.

Then our railway engineering corps is very elaborate. We have the standard-gage construction and operation men. We have the 60-cm. units and the 40-cm. The 40-cm. are light railways that are built up in the trench lines, leading up to the front lines, and the 60-cm. are back of them. The 40-cm. lines are entirely for small cars moved by hand. The 60-cm. cars are partly horse-drawn and partly drawn by small locomotives, either gas or steam. We have sent over a great number of cars and engines. Our equipment in this country is very much heavier than the standard equipment in Europe, and where we can use our engines and cars without going

through tunnels, we send our equipment. Then to keep up this railway work we have our railway shop regiments, of which there are quite a number. Then of course we have field fortification and fortification in general, and recently aerial photography has been turned over to the engineers. It seems that when they run into anything that nobody else wants particularly they immediately put it on the engineers!

Taking of Messines Ridge by Engineers

Any one of these different items is a story within itself. In regard to some of them I probably could spend an hour talking on one particular feature, but I want to mention a few things that have come under the scope of the engineers, for instance, in taking Messines Ridge. There has not been a great deal published on the actual details of taking Messines Ridge, but for 16 months previous to the taking of this ridge by the British and Canadians they were very busy tunneling this hill. It was a point the French and British had fought over in the early days of the war; in fact it had been retaken once or twice for short periods as the tide of battle swung back and forth. It was a ridge that overlooked the British lines and was rather a thorn in the side. For 14 months before this attack was made the British were busily engaged tunneling this hill, running mine galleries. There were 24 of these mine galleries and their average length was over two miles. These galleries were about 4 ft. by 6 ft. and as the earth had to be carried out and disposed of so that the Germans would not know any more about what was being done than possible, it was quite a tedious task. The Germans knew that the British were mining this hill, although they could not tell where. Owing to the geological conditions of this particular terrain there was a stratum of clay above the British tunnels acting as a muffler, and while the Germans could tell by the sounds that there was mining going on, they were not successful in doing any countermining. The idea is that when any one is running a mine gallery up to your trenches, you should countermine and blow him out with what is known as a counterflame, that is, a small shaft that runs into his mine. The British played a little joke on the Germans. The Germans were holding Messines Ridge as lightly as possible, knowing that tunneling was going on, but not being able to locate the mine galleries. These mine galleries were eventually finished and branched out in different directions under the German lines, and a million pounds of aminol was placed in them. This aminol, which is very much of the same nature as our TNT, was put into rubber bags and these bags were placed about four months before they were detonated. The British played their little trick by placing their mines and then waiting for an opportune time, because the Germans, after the British stopped digging, got over their scare. It is rather trying on the nerves to know that some one is mining under you and you are unable to find him—it shakes the morale of the best troops. So there was a period of about four months that they waited after the mines were laid and the Germans had gotten over their nervousness and Messines Ridge was held very strongly. Then one morning, at exactly four o'clock—and I might say in this connection that very great care is always taken in any sort of movement to see that all watches are absolutely synchronous; every watch must be exactly with the others, there must not be thirty seconds' difference—the million pounds of aminol was exploded and every gun on the British side started firing. The whole top of Messines Ridge was practically blown off, and the country seemed to rock for about ten minutes. The British troops moved forward without very many casualties. The Germans were simply stunned by the artillery fire and the explosion of those mines. Following the explosion of the mines a novelty was introduced in the way of machine-gun barrage, the Royal Engineers having placed machine guns about 1800 yd. behind the British positions.

The Italians performed a similar feat in the Col di Luna in the Dolomite Alps. Those peaks are very jagged and the Austrians held a post on a small peak that the Italians could not get at. On January 16, 1916, they had prepared to go after this peak and they moved in compressed-air and other necessary machinery under the shelter of a ledge, some 4000 ft. below the Austrians who were up on the top of this peak. They started their tunnel, ran it up at an angle of 45 deg. for about 4000 ft. to get under the Austrian position and spread out in a sort of fan shape and placed 95 tons of aminol under this position. On July 16 they exploded the charge and there was nothing left of the Austrian position, not even the top of the peak. The whole top of the mountain was removed.

These are but isolated incidents out of thousands. I am sorry I have not the time to describe the engineer's progress from the time he arrives at a port in France and show what he does up through the lines and up through the entire country. This it was my original idea to do, but I have just mentioned these few little instances.

SPECIALIZED TRAINING OF TECHNICIANS

By ARTHUR L. WILLISTON

I APPEAR here on this program this morning in a dual capacity: First, as the chairman of a committee of our own Society which was appointed shortly after the January meeting to see if through the agencies of the Society work might be stimulated to increase the number of men in the United States who had some kind of specialized ability of one sort or another that might be useful in connection with this gigantic task in dealing with the matériel which Major Cassidy has just told you about; and, secondly, I am here as representative of the Committee on Education and Special Training created within the War Department by special order of the President through Secretary Baker on February 10, which created within the War Department this special organization charged with very wide responsibility and duties in connection with the development of specialized technical skill in the shortest possible length of time—intensive war training of technical or artisan character.

The War's Demand on the Engineer

Major Cassidy has pointed out with emphasis and clearness the remarkable way in which this war differs from all other wars and the supreme way in which matériel of extraordinarily varied and complicated character enters into it from start to finish—absolutely through every part of the work. We on this side of the water are more or less thrilled by the wonderful exploits of airplane, of submarine, of wireless and one and another of the very recent and startling advances in applied science. We often fail to realize, I think, the extent to which gigantic engineering problems calling for exactly the same kind of intelligence and accurate planning and skilful application and unusual skill or technical abilities enter into the handling of all the mass of matériel. The question is not one of dealing necessarily with these unusual

factors so much as it is the kinds of big engineering propositions that this country used to think of in connection with our great industries. It is a problem of transferring, transplanting a certain number of thousands of tons of iron and thousands of tons of steel or gas or inflammable material or some other necessary factor in the situation from one place to another with precision, on time, with the least possible effort and with the maximum effectiveness—the same kind of problem that the United States Steel Company has to meet in Pittsburgh. And it calls in an extraordinary degree not only for the engineer who plans at the top but for the whole personnel, all the way down the line from commanding general to rear-rank private, for the same kind of organization, the same kind of ability to do the particular job at the right time in the right way that great industries in America or great engineering enterprises of one sort and another call for.

Urgent Need of Additional Shipping

The difficulty in transporting troops on account of lack of ships from this side of the Atlantic to France increases tremendously the need for giving every possible particle of training that can be given on this side of the water so that the men may be prepared to be effective at the earliest hour after they arrive on French soil. We fail to realize some of these things, I think, to understand that the preparations for increasing the Hog Island plant last winter were going on at the rate of approximately four times the maximum rate of construction of the Panama Canal at any time, and that similar increases in shipbuilding plants throughout the country totaled possibly thirty times the Panama Canal so far as one can contrast one method of construction with another.

The Special Obligation of the Society

I am saying this simply because I wish to get The American Society of Mechanical Engineers and its entire membership to appreciate that we need not engineers alone but we need a supply of technicians, of new kinds of artisans all along the line. And there is not in existence the supply. President Wilson might have said when he described this war, "It was a problem of reëducating an entire nation for a new kind of war." No body of men in America can understand the nature of the problem so well as the members of The American Society of Mechanical Engineers, I think. And on them, because of that ability to appreciate, is a special obligation to come forward and exert in every possible way a public sentiment which will help this work forward as nothing else can.

THE NEED FOR SPECIALISTS IN THE PRESENT WAR

By LIEUTENANT ANDRÉ MORIZE[1]

As Major Cassidy, a few moments ago pointed out, the warfare of today presents a new character, being a war of fortified positions. This means that we have to abandon completely the words and the idea of field warfare or open warfare. These words have not meant anything since the battle of the Marne, since September 1914, when the two armies began to dig themselves in and to organize the long lines of fortified positions which run from the North Sea down to the Swiss border. It does not mean that the fighting will be confined to the trenches, but it means that after all the battles the armies will find themselves again in fortified positions, organized lines of trenches, defensive organizations, and that the fighting on the open ground will be limited always to the pursuit of the hostile forces from one fortified position to the next fortified position. And when it shall happen that the army which is attacking does not find the hostile army fixed on an organized position, after a few days, the war will be over in less than a week.

The Need for Technical Training

What does that mean now? After the first blow the Germans were able to get through the first line, through the second line, possibly through the third line of Allied positions, but now they find again the French and British and American troops established on fortified positions hastily dug during the first day but improved day after day, hour after hour. And now they have to start again in the same manner, march to the new position—the attack of a fortified position, and it is absolutely wrong to oppose the two terms of trench warfare and open warfare. It is very important for the right direction of training to realize the new characteristics of the war of positions. And the point I wish now to emphasize is that, given the new character of the war of today, the men—more than the men, the officers—are perfectly useless if they have not had a complete technical training. Why? First, because the war now is a war of specialists. And all the men engaged in the present war must be specialists because the old conditions of the fighting are all gone, and to reach the enemy sheltered in fortified positions, using heavy artillery and new weapons such as gases and flames—as well for the attack as for the defense, it is necessary to have men with special training and technical training.

The rifle and the bayonet, the weapons of the old-time fighter, are still useful, and it is wrong to believe that the French and the British are going to abandon them more or less—not at all. Our men are trained in the use of the rifle and the bayonet, but the rifle is useful only in special cases when we can fight on open ground between two positions, and the rifle and the bayonet are absolutely powerless against men sheltered in deep trenches and in dugouts. So our men, the plain infantrymen, must be trained in the use of all the new weapons—grenades, bombs, smoke bombs, incendiary bombs—and in the use of the trench mortars. Besides the infantrymen we have the men trained for gas warfare, for liquid-flame warfare, and finally we have all the new kinds of weapons which under the name of "tanks" are nothing but assault artillery, artillery used in close coöperation with infantry, advancing with the attacking lines and sometimes preceding them.

The War One of Specialists

I cannot give more details about these different lines, but it will be seen that the war is now fought entirely by specialists and that these specialists must get a technical training. It is impossible to improvise in a few days a man for a gas attack. It is impossible to improvise in a few days the man to use bombs and hand grenades in a satisfactory way. We need men and officers with technical training.

A second reason which makes technical training more and more necessary is the fact that the present war is a war of close coöperation between the different arms of the service. If we think of all former wars it is easy to realize that

[1] French Military Mission, Northern District; detailed to Department of Military Science and Tactics, Harvard University

infantry had to play the most important part—and sometimes alone—helped by artillery, but it was possible to think of infantry fighting, pure infantry fighting. Aviation was unknown. Engineers had to play but a small part. The supply service, the railroad service, were useful, but not as necessary as they are now. If we now think of the conditions of a large battle—one in which all the resources of the two armies are engaged—it is easy to see that the battle is the common task of all the branches of the service, as any one of the different branches, infantry, artillery, aviation, working alone is helpless. Even for an operation like the capture of a few miles of hostile positions all the arms of the service must work at the same time, and now all the branches of the service need men with technical and complete training.

Training in Use of New Weapons Necessary

In the infantry all the men must be more or less specialized in one of the new weapons now used—grenades, trench mortars, machine rifles, machine guns, etc. In the artillery the conditions of the work are now quite different from what they once were. The old idea of the artilleryman was a man with a technical knowledge of the gun and its different parts, and familiar with its tactical use. But now artillery work means, first, the technical knowledge of the science of adjusting fire with the long-range guns and with the difficult task of adjusting fire at small targets, sometimes very well camouflaged; second, technical knowledge of the science of locating, of spotting the hostile battery. That is a complete organization now. We have two such large organizations that started in the French army under the names of *sections de repérage par le son* and *sections de repérage par les lueurs*. These mean spotting the hostile batteries, first, by observing the sound, and, second, spotting them by the flash of the battle. They are complete scientific organizations with special officers, and they play a very important part in all the operations now. When it is realized that it is impossible to launch an offensive today without first silencing and neutralizing all the hostile batteries, it is easy to realize the importance of the rôle played by the men who have to locate the hostile batteries by their technical knowledge.

Third, technical knowledge of topography. The topographic work is a part of the artillery work because, given the long range of the guns, the use of the ground to conceal the batteries behind the hills and the contour of the ground, most of the adjusting work is done entirely with the map; and so the necessity of making, drawing and reading maps—technical knowledge for artillery work.

Fourth, the batteries are exposed to hostile fire, so the first condition to be able to destroy the hostile position is to have a good protection for our own batteries, and the technical knowledge necessary to build the batteries and emplacements—to know exactly the conditions of resistance of materials, to know how to use the ground, and the different kinds of supplies to protect the batteries as much as possible—technical knowledge necessary for such a job.

Question of Artillery Transportation Most Important

Very probably the most important point now is the question of transportation of artillery. If the Germans, as Major Cassidy pointed out, have been able to advance so fast in the last few weeks it is because they have been able to find new methods of transportation for artillery. All the preceding drives have been more or less limited to the range of the long guns—six, seven or eight miles. The depth of the German advance is now much greater and wider only because they have been able, thanks to their technical ability, to find more efficient means of transportation for artillery. The question of the transportation of artillery material, and especially of heavy guns and heavy ammunition, is one of the most important problems of today. So you see that relating to artillery alone at least five points require technical knowledge.

I will not speak about aviation; aviation is nothing but a technical branch of the service. But just one word about the connection between all the different branches of the service. Each of them needs a technical training. But to connect them, to have them work together, to realize what we call the *liaison* between the different arms of the service, we need more than ever men with technical knowledge. Liaison between the different arms, between infantry, artillery and aviation—the liaison between the different units and the high command—means organization of telegraphs, of telephones, of wireless, of ground telephone, ground telegraph and visual signaling, searchlights, etc. For all these different means of liaison we need men with technical ability and technical training.

And finally, Major Cassidy emphasized the point that the present war is a war of matériel and of supply. It means the question of production in this country, the question of transportation of troops, men, food, supplies, equipment and everything; and the question of distribution of the supply of the ammunition at the front. It means, as he said, the organization of an extensive network of railroads, regular and field, depots, stations, etc. So you see a war of positions, a war of specialists, a war of coöperation between the different arms of the service, a war of matériel and of supply. From all these different points of view the war is now of such kind that all the men engaged must have a complete technical education and training. And not only the men engaged in the special technical lines, but even the most modest infantry officer; a second lieutenant now, leading the platoon, must be able to know about liaison of the telegraph, telephone, about the digging of a dugout, about the organization of a drainage, etc. Technical education is accordingly of first importance and it is the duty of all to help those directly engaged in military training to make the country realize these new characteristics of the war. The war will not be won by men with rifles and bayonets. It will be won by the effort the whole country will make in order to meet the requirements of the new kind of warfare we have—the war of matériel, the war of supply, and the war of technical knowledge.

JOHN R. FREEMAN, during the session, had projected on the screen a short film showing a method he had used in demolishing an abandoned factory chimney. The chimney was a radial brick stack 160 ft. in height. The work was accomplished in the short space of four hours' time. The method shown consisted in digging a hole in one side of the chimney, in which a cobhouse blocking of hard pine was then loosely built. The weight at first was all taken at the point where digging was started, and the question of having the chimney fall in the direction desired was one of tearing bricks out from each side of the starting point an equal distance at a time. The wood blocking was then saturated with oil and set on fire, and when sufficiently consumed, the chimney fell on the side from which the bricks had been removed.

In falling, the chimney came within two feet of centering on the spot selected in advance, demonstrating the precision with which the method can be worked.

SECOND GENERAL SESSION

THE second General Session was held on Thursday morning, June 6, in the Mechanical Engineering Building of the Worcester Polytechnic Institute, and, considering that the session was held simultaneously with two other attractive sessions, it was well attended and a lively interest was manifested in the five papers presented for discussion.' President Main presided for the first half of the session, when he turned the meeting over to Vice-President Greene, who concluded it.

The six papers, in the order of presentation, were: Efficiency of Gear Drives, by C. M. Allen and F. W. Roys; A Self-Adjusting Spring Thrust Bearing, by H. G. Reist; Air Propulsion, by Morgan Brooks; Electric Heating in Molds, by Harold E. White; The Elastic Indentation of Steel Balls Under Pressure, by C. A. Briggs, W. C. Chapin and H. G. Heil; and Stresses in Machines When Starting and Stopping, by F. Hymans (by title only).

Although the subjects of the papers were so varied, participation in the oral discussion was general, and the proceedings of the session, with the large number of written discussions contributed, were somewhat voluminous.

Professor Allen presented the first paper, which described an apparatus, set up in the laboratory of the Institute and on view before the session, for measuring the efficiency of gear drives by measuring directly the power loss through them. An electric motor is so hung in a cradle that both its armature and field are free to turn. The armature shaft is connected directly to the pinion gear shaft and the driven shaft directly to an Alden absorption dynamometer. The reaction of the motor field is balanced by the action of the absorption dynamometer through a simple lever. The arms of the lever are accurately proportioned to the ratio of the gears.

The paper illustrated methods of calculation and gave data of efficiency tests of both worm- and bevel-gear drives.

President Main, H. G. Reist, Prof. W. H. Kenerson, Prof. A. A. Adler, R. G. Nye and Prof. W. W. Bird discussed the paper. The trend of the discussion was that the results given should be somewhat discounted, to which Professor Allen replied that the paper had been written simply for the purpose of presenting a method by which any one could test gears and get results without much trouble; he thought that some other agency than the Institute should be prevailed upon to carry out reliable experiments, having the method provided.

Mr. Reist's paper, presented by the author, illustrated spring-thrust bearings for vertical water-wheel driven generators, to carry a load of 300,000 lb. at 100 r.p.m., cited allowable unit pressures, and described the construction of the bearings. In these bearings one of the surfaces is made to yield at any point by using a comparatively thin plate supported by a large number of springs. The pressure usually allowed is 300 to 400 lb. per sq. in., the design permitting a very thin oil film without metallic contact.

Professor Adler opened up a discussion by calling attention to some of the steps in the history of bearing theory, which he promised to write up in mathematical shape later. He then asked the author some questions regarding film lubrication and also alignment.

C. A. Briggs said he had seen the bearing under test at Schenectady and it had impressed him favorably.

Professor Adler continued with questions, mostly for information, and Mr. Reist answered them in turn.

Professor Brooks then presented his paper, describing experiments to show that the screw theory for propellers should be replaced by the theory of reflection or batting action. By means of two electric fans and an anemometer he demonstrated how air can be driven by a propeller at a velocity nearly twice as great as the product of the pitch and the revolutions. He said he knew the idea would be received with skepticism, but he would welcome suggestions regarding its explanation and proof.

As was anticipated, both the written and oral discussions were lively, some discussers receiving the paper with enthusiasm and some contradicting the author's conclusions entirely. The terms "sustentation," "superspeed," "vortex," "stream line," etc., were frequently cited; and, in fact, before the discussion was over all the nine theories of propeller action had been brought up.

Those contributing to the discussion were N. W. Akimoff, H. G. Reist, W. C. Durfee, C. W. Howell, G. D. Bothezat, H. F. Hagen and C. A. Briggs, and justice can only be done to their remarks by printing them in full later.

Mr. Briggs then read his paper on indentation, which described experiments carried out at the Bureau of Standards showing that the indentation of balls pressing against flat surfaces was not directly proportional to the pressure but to the two-thirds power of the pressure. These experiments were developed in connection with the adjustment and standardization of precision apparatus incidental to the manufacture of munitions gages.

The discussion of this paper was light, questioning the author on the materials, shapes of surfaces and pressures which he used and those which his results could be extended to apply to.

Mr. Harold E. White presented the next paper, which he said was a practical paper, illustrating a mechanical engineer's method of utilizing induced electric currents and hysteresis losses in solid iron to heat molds, the method being one which electrical engineers instinctively turn away from, as they usually laminate every magnetic circuit they possibly can.

Though the interest in the topic was not large, the paper was well received, and the author was asked a number of questions by Mr. W. H. Marshall which excited the interest of those present.

Mr. Marshall's main requests were in regard to the practicability of melting glass in molds heated as the author described. Mr. White thought this, on the whole, impracticable.

The last paper scheduled was a mathematical paper by Mr. F. Hymans, giving a new method for the correct evaluation of the forces acting on machine parts during start or stop. The method was illustrated by application to a vertical geared hydraulic hoisting machine.

There were no oral discussions of this paper, but written discussions were sent in by N. W. Akimoff and Prof. S. E. Slocum. These will be printed in full later.

Mr. Akimoff eulogized the paper, saying that no true engineer could help feeling a better man for having studied it. It was not difficult and was very clearly written. He entered a plea for more members of the Society to interest themselves in the finer points of this character.

Professor Slocum was of the opinion that the author's application would apparently afford a considerable refinement in the calculation of stresses of machine parts. He thought the author's use of the unfamiliar normal coördinates, while it served to show the generality of the method, complicated the solution somewhat, but he did not offer this as a criticism.

There being no further discussion, the meeting adjourned.

EMPLOYEES SERVICE SESSION

Thursday Afternoon Meeting at the Norton Company's Plant for the Discussion of Industrial Housing and Other Requirements for the Welfare of Employees

A PROFESSIONAL session of exceeding interest, at which employment methods, labor turnover, and welfare measures for promoting and conserving the health of employees were among the subjects considered, was held in the administration building of the Norton Companies' plants at 2.15 p. m., Thursday, June 6, Past-President James Hartness acting as chairman. Four papers were presented at this session, the first two dealing with the important subject of housing conditions.

The Workman's Home and Its Influence upon Production in the Factory and Labor Turnover, Leslie H. Allen.

Indian Hill: An Industrial Village Created by the Norton Company, Clifford S. Anderson.

Employment Methods as Followed by the Norton Companies, E. H. Fish.

Vestibule Schools, J. C. Spence.

Mr. Allen's paper was published in the June issue of The Journal; the texts of the others immediately follow in slightly condensed form.

INDIAN HILL: A MODEL INDUSTRIAL VILLAGE

By CLIFFORD S. ANDERSON,[1] WORCESTER, MASS.

UP to the present, the Norton Company has not been called upon to meet and solve the industrial housing problem as it is generally understood. Many concerns which have been located in the smaller towns, in order to provide homes for their workmen have had to practically create a local village. Other industrial plants situated in large cities have felt it imperative to bring about an improvement of home conditions for employees previously living in slums. We have fortunately been situated on the outskirts of an industrial city to which laborers are constantly attracted. It is a city which up to the present time has no slums. As a matter of fact, our lower-paid employees are able to secure living accommodations that are safe and light and well ventilated, and as clean as the occupants are inclined to maintain them, at a price commensurate with their income, more readily than any group of our workmen. Accordingly, we have not set out to approach the problem from the bottom but rather from the top. Our aim has been to make it easy for our foremen and more progressive workmen to obtain for themselves homes of taste and convenience, likely to make the employee happy and contented with his personal work, to improve his taste, stimulate his ambition, lead him to assume without terror some of the responsibilities which fall upon men of all stations in life, and to furnish for the other employees tangible evidence of the thoroughly satisfactory and worth-while things of life which may be secured by diligence and industry, and so stimulate in them a desire to make themselves more useful, to improve their conditions of living, and to so win for themselves and for their families a bigger share of the truly good things of life.

The Norton Company has embarked on this work, not solely with the idea of indulging in philanthropy, but from the point of view of enlightened self-interest, considering the return in loyalty and intelligent labor, and the probably increasing values which are likely to result from the development of the Indian Hill community. We have given our workmen nothing but an opportunity. The land cost them all that it cost us. The houses erected thereon cost them all that they cost us. We have simply furnished them the opportunity to buy a home not only on easy payments but at cost, an opportunity which is not elsewhere extended to them. The Indian Hill community is a corporation, the stock of which is held by the Norton Company, and was brought into being merely to handle more easily the work of creating an industrial village. The policy of its board of directors, which is identical with the directorate of the Norton Company, is to administer its affairs without profit and without loss; all of its activities are purely business, its purpose, to insure to our workmen the opportunity of an attractive home at cost, without exacting a penny for the profit of others, and to insure to the stockholders, in other words, the Norton Company, the business-like execution of this mission without a penny of loss.

When the village was originally opened in 1915, there were, of course, many who rushed in to avail themselves of the new opportunity, but there are residents on the hill who have been invited to come there by the company, families whom we felt would be leaders in the community, and contribute to the success of the village life. We have not hesitated to suggest to certain employees that they undertake a considerable financial responsibility in securing a home in this way, for we have found from experience that the appreciation of these opportunities up to a certain point is in direct proportion to the sacrifices that are required in order to enjoy them. Yet I do not think that in any case periodical payments are being made upon a house in excess of 25 per cent of the income of the residents.

In starting out upon our program we were fortunate in having right at the very doors of our works an ideal site—a beautiful hillside overlooking the waters of Indian Lake, with an opportunity for gentle grades and slopes for the roads which have been availed of to the greatest extent by the architect, Mr. Grosvenor Atterbury, of New York, whose services we sought because of his similar work in connection with the Russell Sage Foundation and their housing problem. The idea was to establish here homes which should be substantial, resistant to fire, would not require a large cost of maintenance and which would combine taste with efficient relation to the need of the class of workmen who were likely to reside therein.

In the very first instance the company decided that the relation of employer and employee was sufficiently intricate so that we did not want to assume also that rather difficult relation of landlord and tenant. Consequently none of our houses are rented; all are sold. We were fortunate in securing the land at a low price and offered it to our workmen at the actual cost per foot, including the improvements, and built the houses for them through our own hired contractor. There are five or six different styles of houses so that that unwholesome uniformity that used to dominate an industrial village is presently lacking.

The question came at once, how should we finance our scheme? We decided that we would sell direct, giving a full

[1] The Norton Company.

title to the buyer, taking back a mortgage. We require of the purchaser an initial payment of 10 per cent of the cost of the house. He gives us in addition a time note for 12 years and a demand note. These are secured by a mortgage to the company. We require of him also that he take out a certain number of shares in a coöperative bank, and the local banks, at the rate of interest which has been adopted, have brought about the following state of affairs: that a payment of a dollar a month results in a return of $200 in 12 years. Consequently at the end of 12 years he has, without making any direct payment to us, saved a sum sufficient to pay off the time note, and that sum, with the initial payment, brings him to a point where he may then look to a bank in the city and have a first-class bank mortgage and own his house under the same conditions that prevail among those in more fortunate circumstances. In many instances the owners of these houses are occupying them and virtually securing the ownership thereof at monthly payments which do not exceed the amount which they were previously paying as rent for tenements in which they never had any lasting interest.

We built first in 1915 twenty-seven of these houses and thirty more in 1916. The prices in 1915 ranged from $2850 to $4000; in 1916, from $3600 to $5200.

The cost of these houses was 16 cents per cu. ft. in 1915, and 19 cents in 1916. Mr. Atterbury informs us, however, that the same house we have been constructing was constructed in 1916 in Tennessee for 10 cents per cu. ft.

It is too soon for us to tell what we find registered in increased loyalty and increased work in the factory due to this one project alone. We feel sure that the effect will be to attach the workmen to our company. On the other hand, we have been careful not to chain them to the soil. The possessor of an Indian Hill house may leave our employ and still retain his home. The purchasers of our houses are also free to sell, this provision only being made, that having a bona fide offer in writing from another they shall be prepared to offer the house to us at the same price, so that if we do not approve of the new village occupant we may take the house over and seek new residents for ourselves.

The increasing village life has been interesting. The owners of these houses have formed their own improvement society and have recently made appropriations for the beautification of their village. We feel sure that the work has been started successfully and we look forward to greater influence in the future.

EMPLOYMENT METHODS AS FOLLOWED BY THE NORTON COMPANIES

By E. H. FISH,[1] WORCESTER, MASS.

WITH the growth of any business there comes inevitably a time when the management feels its separation from the men who are actually engaged in production. Such a time is apt to come soon after the number employed pass the thousand mark; then it becomes necessary to find some organized means of keeping the management and the workmen in touch with each other and in harmonious relations.

It has been customary in the last few years to use the labor turnover as an index of the degree to which the management is successful in keeping in close touch with its employees. At present the labor turnover of manufacturing establishments throughout the country will average in the vicinity of 400 per cent. This, however, takes in all kinds of shops under all varieties of management. The shops which have made conscious efforts to establish better relations are able almost invariably to show a much lower rate of turnover. It has sometimes been said that the only thing our employees want is money. If this were so then the lowest rate of turnover would be in the shipyards and munition plants where the highest wages ever known are being paid. The contrary is true, however, as they are running up to or over the average rate for the country in almost all cases. No one factor can be depended on to diminish this percentage, but all of them working together will surely, as in our own case, cut the labor turnover in quarters if not even more.

One of our activities along this line comes under the head of Employment. This means not merely the selection of the best men from a rather discouraging supply, their physical examination, the placing of them in positions best suited for their physical and mental power, but following them up while they are with us and especially as to the reasons for which they leave us when they do go.

The study of the reasons why men leave is one which almost every concern will find very productive of results, as it often indicates that there is quite a variance between the reasons which are advanced by the foremen and those given by the workmen themselves. If there were only one thing which could be done to better relations between the management and its employees, probably this one of keeping track of the reasons why the men leave would be productive of greater results than anything else. Possibly one of the things which this study is most likely to show is that hours of labor have much less interest to workmen than is sometimes thought: for example, in spite of the fact that on one side of the street we have 200 machinists working on 8-hour shifts, there has been no evidence of a desire on the part of nearly a thousand men on the other side working 10 hours, to secure transfers. In fact the total number of men leaving the Norton Grinding Company to secure shorter hours in the past year is only two.

The second department dealing with employees is the Hospital, and we find it very important that the Employment Department and other employee relations shall keep in the very closest touch with it and its records and advice so that all of these departments practically become one in their purpose and results.

The third department, that of Safety Engineering, has followed out the usual custom of providing mechanical safeguards until now the plant is so well covered that accidents seldom occur which can be traced to lack of mechanical guards. The large problem before the Safety Engineering Department today is that of the education of men in safe practices, by means of bulletins, lectures, moving pictures and other educational means.

Another department quite essential to better relations is that of training. This will be discussed by another speaker so that I need only refer to the fact that we find the labor turnover among men who have been given intensive training much lower than among those who have been thrown into their jobs without preparation for them. No one type of training can be prescribed offhand for all shops and all conditions. In many instances, especially such processes as can be taught in a short time and where increased value comes from dexterity, it is probably better to do the training on the job through foremen especially fitted for that work but without special equipment or separation from the usual work of the shop. On the other hand, where work requires thought,

[1] Employment Manager, Norton Grinding Co.

care and skill as differentiated from dexterity, the vestibule school has been found most acceptable. For work which can be taught on the job but where there is a body of related knowledge which can best be given in the classroom, the continuation school so strongly advocated by the National Association of Coöperation Schools has its value. All of these activities are going on here in this Company and all doing good work.

Other problems which must be faced for the benefit of the employees as well as the profit of the company, include transportation, especially for shops situated as so many are at a distance from centers of population so that means have to be provided for the workmen to get back and forth at a time when the transportation companies are rushed and least desirous of adding to their burdens. This problem has met a partial solution here by the running of two workmen's trains from the center of the city into our yards and by means of a trolley terminal nearby.

The problem of feeding is always with us and is one of the most unsatisfactory of solution of all problems. The line of least resistance is to secure some outside contractor to whom a concession can be given allowing him to feed and profit from the feeding of our employees. Where only one meal per day is served it is difficult to find a contractor who will agree to give real food such as we would wish our employees to eat and expect to make a profit from its sale. We have found it desirable to maintain a lunch room for our office employees which serves a luncheon, and also to maintain various dining rooms for workmen where ordinarily soup, pie, coffee and in warm weather ice cream are sold to the men with which they can supplement the cold food which they bring from home.

In addition to this we have found a great demand for the sale of milk and ginger ale which we have met by the establishment of milk stations in some buildings and milk wagons in others. There is no doubt but that the milk has a greater nutritive value and is the best from the employer's point of view. On the other hand, there are many workmen, especially those working in hot and dusty places, who feel the need of something like ginger ale to clear their throats and send them back to work refreshed.

Wash rooms are another thing which appeal to the men very strongly, and we have accordingly installed an arrangement making it possible for every man to use running water which has not come into contact with any other person. Our lockers are all of full height, which allows a man to wear as good clothes as he chooses and hang them in a way that makes them look acceptable when he takes them out.

You will also be interested in our gardens which are not exclusively a war measure as they have been conducted for several years, always with an increasing number of farmers. These gardens are each about 50 ft. by 75 ft., and are rented at the nominal charge of $1.50 per year to partially cover the cost of plowing and harrowing. This has had a large effect on our labor turnover. Last year, for example, when we had 600 gardens only three gardeners left our employ between the time of planting and harvesting. Under ordinary conditions we have a labor turnover of about 80 per cent. and during practically six months' time it can be seen that out of any given number of men a great many more would normally have left than did actually leave.

All these factors, together with our athletic association, minstrel shows, etc., help to build up a social interest which has a large holding power but which is not the result of any one activity.

VESTIBULE SCHOOLS

J. C. SPENCE, WORCESTER, MASS.

The munition firms of the United States failed to deliver British, French and Russian contracts on time in 1915 and 1916 simply because there were not enough tool makers in this country to make the jigs and gages for the manufacture of rifles and munitions alone, to say nothing of the increased demand for every other product of our factories, such as machine tools, engines, automobiles, rolling mills and so on, almost without end.

One of the consequences of this sudden demand for men was a ruthless attempt on the part of most of the war-order plants to obtain tool makers and machinists at any cost, and regardless of which going industries were hurt.

The ensuing confusion was augmented by the fact that the American Federation of Labor seized upon this time to send its labor agitators broadcast, with the result that practically no manufacturing center of any consequence, on the eastern seaboard, at least, escaped having very bitter strikes.

The manufacturers of the country were almost wholly unprepared to handle the situation, in so far as shortage of skilled labor was concerned. They had never before been faced by exactly this same problem. They had had keen competition for help several years previous during the very rapid expansion of the automobile business, but nothing that approached this new state of affairs.

Practically the only remedy used by the majority of the struck plants, or plants whose help had left for the "Promised Land" of Bridgeport and New Jersey, was to send out representatives to steal skilled help from towns not yet affected by the fever. All, without exception, followed this practice. The manager who says he did not either failed or else he was not aware of the proselyting carried on by his organization.

The Norton Grinding Company realized in 1915 the uselessness of attempting to hire skilled men in a community crowded with business, and started a Training Department. We have not a true Vestibule School, as such a school is an adjunct of the Employment Department, and is used principally as an examination room for applicants. What we have done is very simple and can be duplicated by any factory practically without cost.

To start a Training Department only two things are necessary:

1 A manager who really wants to help the United States to win this war to the extent that he will do his share of the breaking in of the "rookies" of industry.

2 A workman or foreman who has the knowledge, and especially the patience, to keep everlastingly teaching green help.

The first objection raised by most managers is that they have neither the necessary equipment nor the floor space. This is a natural first thought, but is wrong for this reason: In every department, say, in a machine-tool shop there is a certain amount of simple work to be done. This applies even to the tool room. It is the custom to give this simple work to the less skilled men, and to use the older machine tools, thus allowing the more valuable men to do the better work.

This being so, then why not simply take a lot of these machines, some of every variety, and concentrate them in one department? Some rearrangement of the shop may be necessary, but, on the other hand, this is usually a blessing, as most shops profit by frequent well-studied movings.

Start in a small way, and enlarge as you get experience.

[1] Superintendent, Norton Grinding Co.

Sometimes you will find that you have to overcome a deep-rooted resentment on the part of those foremen and workmen who served a long-term apprenticeship against any "presto, change!" method of producing help. Avoid this by starting small and letting it be thoroughly understood that the school is not intended to produce real machinists, but simply to take from the shoulders of the foreman the hard preliminary work of breaking in inexperienced help.

We do not attempt to make specialists in our Training Department. The student is taught a little of all of the common machine-shop operations, for we do not know in which department he will probably work. We simply wait for the opening to occur, and then the head instructor furnishes the student whom he thinks is best fitted for the job, regardless of the length of time served in the Training Department.

The Training Department runs along as a department of the shop, having its own schedule to meet in the production of simple parts and assembled mechanisms. This schedule calls for about one-half of the available labor of the department, the remainder being picked up throughout the plant in the form of odd jobs. It is really surprising, in times like these, how the foremen of a plant welcome an odd-job department. Here they get rid of all of the one-piece bothersome things that make fine jobs for the beginners, as this kind of work usually calls for the use of several different kinds of machines.

The toolroom also turns over much of its roughing work, as, for instance, the making of milling cutters, taps, reamers, arbors, etc., up to the very final operations that require experienced men.

If, by chance, the Training Department runs low in the right kind of work, that is, work that gives training in many branches of the trade, the head instructor has the right to commandeer any job in the main shop, no matter whether or not his department is equipped to do that job in an economical manner. For instance, if it becomes necessary to get some work to train men in the cutting of threads in an engine lathe, we go so far as to take work away from a turret lathe, even though the resulting threads show on our cost sheets to have cost us ten times what they ought to.

We pay an adult who has had previous experience at some kind of work the prevailing wage for common labor. Just now, in this section, this is 35 cents per hour. With our 55-hour week this amounts to $19.25, which is an inducement for many men, especially as there is the additional advantage of being able to make a good start toward learning the machinist's trade.

About a year ago France made it a law that each factory employing 300 people or more should maintain a separate Training Department.

Great Britain at the outbreak of the war tried to supply help through putting new workers on the machines, as we have always been accustomed to do, but soon found that the great numbers of newcomers swamped the old. The technical schools were resorted to, but they were abstract, academic and unacquainted with production requirements. Then school directors were replaced by factory managers, with foremen in charge of departments under these directors.

Finally British and French manufacturers came to see, as we must now see, that the obligation to produce war products in quantities implies another and equal obligation, i. e., the production by systematic training of mechanics who will produce the war requirements.

The manufacturer who would produce war materials must produce the machinists who will operate his plant. We must prepare to give up thousands of skilled men and make the semi-skilled and the inexperienced replace those we lose. There are not enough skilled workers in the country today to produce anywhere near the war products that we will need.

It is the immediate duty of every essential industry to take hold of the problem of remedying this condition. For the sake of helping our Government, we should have the foresight to do voluntarily what we will probably be finally forced to do by law or necessity. This war is going to last plenty long enough for every essential industry to get back a hundredfold any investment made in such an enterprise.

CORRESPONDENCE

Contributions to the Correspondence Departments of The Journal by members of The American Society of Mechanical Engineers are solicited by the Publication Committee. Contributions particularly welcomed are suggestions on Society Affairs, discussions of papers published in The Journal, or brief articles of current interest to mechanical engineers.

More Research Papers Desirable for A.S.M.E. Transactions

To the Editor:

The writer heartily concurs in the plea of Mr. Sanford A. Moss for more "high-brow" papers for record in our Transactions.

Although a decided improvement in the character of American research papers is noticeable of late years, apparently but few of our engineering publications care to consider papers treating technical problems on a mathematical basis.

In Europe the more important research papers attract considerable attention on part of the engineering profession, and the discussions which accompany them are not only of benefit to the author but also serve ultimately to establish a school of engineers highly proficient in some particular field of endeavor. A similar atmosphere in this country would no doubt lead to greater technical interest on the part of our engineers, and at the same time be decidedly helpful in advancing our research technique and bringing it fully abreast of the standard prevailing in Europe.

Meritorious research papers often represent the results of years of investigation and contain an abundance of interesting material that is invaluable to the engineering specialist. Such papers are well worth careful study, as they form a storehouse of original information to which recourse may be had repeatedly as various practical engineering problems present themselves for solution.

The lack of more intense interest in research papers appears to be due to the apprehension with which many of our engineers approach the more intricate mathematical papers, in which concentrated quantitative form one paragraph will often

require page upon page of descriptive matter to be as explicit.

While a few of our larger commercial establishments have fostered research work for their own benefit, the resulting material is generally not accessible to the public. Our public institutions, both state and national, have also made substantial contributions to engineering research work, but these efforts in themselves are hardly numerous enough to effect the rapid advance in scientific progress desired.

It is therefore up to the profession generally to offer greater encouragement to the trained individual investigator who from sheer love of science is ready to devote himself painstakingly to advance the particular phase of research work in which he is especially proficient. The integration of effort on the part of many such workers will surely lead to a far more rapid advancement in the art of scientific research. To bring this work fully abreast of the times, by all means foster the congenial atmosphere that is conducive to the further development of the research abilities of those so inclined.

Louis Illmer.

Boston, Mass.

Conservation of Coal

To the Editor:

More knowledge regarding the perfect combustion of coal should be acquired by all those who have to shovel it into the mouths of power or heating boilers or furnaces in large institutions and blocks of buildings using many tons each day.

Evening classes should accordingly be maintained by city councils in the schoolhouses, with expert instructors to lecture and demonstrate regarding proper methods of firing to get the best results out of the fuel and produce perfect combustion. Students at such classes should be shown samples of the various grades of coal, the heat value of each being explained, as well as the quantity of air it requires for perfect combustion, etc.

We require men to have an engineer's certificate before we allow them to take charge of a steam boiler, but I have yet to learn that an examination for such embraces the principles of obtaining the best results out of the coal burned to generate the steam. Often men are seen laying a heavy charge of fuel on a bed of incandescent coal too thick to allow the gases from such to be thoroughly mixed with the amount of oxygen supplied. A surplus of air is also frequently noticed with some firemen, who leave the feed doors open longer than they should. It is obvious that this air passing over new fuel is cold and cannot be mixed with the combustible gases; consequently the volatile portions of the hydrocarbons do no useful work. This lowering of the temperature of gases in the combustion chamber and flues is bad enough from the smoke-nuisance and coal-saving point of view, but to my mind a greater evil exists, and that is the unequal expansion and contraction of the boiler shell by such sudden changes of temperature. For a fireman who carries a thicker fire than necessary and then keeps his feed door open to reduce steam pressure is shortening the life of his boiler. A further waste of coal results when the boilers and steam-pipe surfaces are not insulated with asbestos.

If evening classes were established, the men should be informed of the percentage of waste of coal caused through various thicknesses of boiler scale and of flue scale, and, in fact, of all matters relating to getting the best results out of the coal.

The idea prevails that so long as a man is strong and can handle a shovel or firing tools, further knowledge is not required. If an applicant can show that he has fired a steam boiler before, it is taken for granted that he knows his business, regardless of the fact that he may not be acquainted with the rudimentary principles of combustion. If after attending the classes spoken of these men could answer the necessary questions they should be given a fireman's certificate, and as an inducement for them to practise what has been explained to them, they should receive a bonus or percentage on the amount of coal saved. Indeed, I would go further and suggest that all such men should be licensed by the Boards of Trade or similar responsible bodies of our cities if coal is to be conserved in the interests of ourselves and those who come after us.

James S. Kingston.[1]

Ottawa, Ont.

[1] Heating and Ventilating Engineer, Chief Architect's Branch, Public Works Department.

WORK OF THE BOILER CODE COMMITTEE

The Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York City.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval, after which it is issued to the inquirer and simultaneously published in The Journal, in order that any one interested may readily secure the latest information concerning the interpretation.

Below are given the interpretations of the Committee in Cases Nos. 190-193, inclusive, as formulated at the meeting of May 16, and approved by the Council on June 4, 1918. In this report, as previously, the names of inquirers have been omitted.

Case No. 190

Inquiry: Can the vertical joint of the inside furnace plate of a Manning boiler be welded by the autogenous process, under the proposed revision of Par. 186 of the Boiler Code as published in the March issue of The Journal? In the Manning boiler the collapsing pressure on the inside furnace sheet is fully supported by staybolts and this joint is under compression instead of tension.

Reply: It is the opinion of the Committee that if the vertical joint of an internal furnace which is fully supported by staybolts is welded by the autogenous process, it will meet the requirements of the proposed revision of Par. 186.

Case No. 191

Inquiry: Does or does not Par. 190 of the Boiler Code indirectly indicate that, unless definitely specified, and the specification distinctly stating, tension test sample shall be taken from the plate transverse to the direction of rolling, butt straps shall be cut so that their shorter or transverse dimension shall represent the longitudinal direction of the plate as rolled, in order that the greatest tension stress, the circumferential stress, sustained by the metal, shall be in the direction of the fiber produced by rolling?

Reply: It is the opinion of the Committee that the word "plates" in the fourth line of Par. 190 of the Edition of 1914 with Index refers to shell plates only and not to butt straps. It is proposed to insert the word "shell" before "plates" in the revision of Par. 190 in order to clearly indicate the intent of this rule.

Case No. 192

Inquiry: Is it the intention of the Boiler Code Committee to remove the limitation on the length of headers which may be made of malleable iron for use in connection with boilers under Par. 245? The present edition of the Code appears to limit the length of the header, whereas the proposed revision as published in the March issue of The Journal would remove this limit.

Reply: It is the opinion of the Boiler Code Committee that Par. 245 of the present edition of the Boiler Code does not restrict the length of cast iron or malleable iron headers, but that the limitation as to cross sections applies only to the form and size of the internal cross section, perpendicular to the longer axis of the header.

Case No. 193

Inquiry: Does the word "riveted" which is used in the proposed revision to Par. 273 of the Boiler Code to indicate a method of attachment of a "plate or plates" to the body of a safety valve as an alternate to stamping or casting the markings on the body, prevent the use of screws for the attachment of such plates?

Reply: It is the opinion of the Committee that the requirement for riveting is covered provided the plate is attached to the safety valve by screws with the outer ends riveted over so that the plate cannot be removed.

REVISION OF THE BOILER CODE

THE Council of the Society directed that a hearing be conducted in accordance with the recommendation in the Boiler Code that a meeting at which all interested parties may be heard be held at least once in two years to make such revisions as may be found desirable in the Code, and to modify the Code as the state of the art advances. The first of these meetings was held at the Society's headquarters in New York, December 8 and 9, 1916.

The Council also directed that the proposed revisions in the Boiler Code be published in The Journal with the request that they be fully and freely discussed, so as to make it possible for any one to suggest changes befo e the Rules are brought to the final form and presented to the Council for approval. This has been done, and the revisions were presented in the March issue of The Journal, pp. 234-247, in the April issue, p. 316, in the May issue, pp. 398-400, and in the June issue, pp. 468-470, in the form proposed for submission to the Council, except as they may be modified by editing without change of sense.

The revisions finally agreed on are those that have been published in the March, April, May and June issues of The Journal, with the modifications which follow. Although these modifications are in a sense final, the Committee would like any one who has an important criticism or suggestion to offer to submit the same immediately to Mr. C. W. Obert, Secretary of the Boiler Code Committee, 29 West 39th Street, New York, N. Y.

May Journal, p. 398

Letter to the Council:

Add the following to the third paragraph relative to the Conference Committee:

The members of the Conference Committee are notified of and invited to attend all meetings of the Boiler Code Committee, and have rendered most useful assistance in preparing the interpretations as well as in coöperating with the Boiler Code Committee in revising the Code.

March Journal, p. 234

Letter to the Council:

Add to the list of names of those constituting the Boiler Code Committee, which follows the letter to the Council, the following:

Conference Committee

(Names to be inserted here)

March Journal, p. 241
and
June Journal, p. 470

Par. 292:

Cancel the entire revision proposed for Par. 292 and replace by the following:

292 No form of device shall be used for controlling the water supply, or the indications of the height of water in a steam boiler, unless it is approved by the state or municipal authorities enforcing these rules.

March Journal, p. 243
May Journal, p. 400
and
June Journal, p. 470

Par. 354:

Cancel revision proposed for Par. 354 in the March and June Journals, so that this paragraph will read as it originally appeared in the Boiler Code.

March Journal, p. 243

Par. 359:

Modify proposed revision of Par. 359 to read as follows:

359 *Double Grate Down Draft Boilers:* In boilers of this type the grate area shall be taken as the area of the lower grate plus one-quarter of the area of the upper grate.

March Journal, p. 243

Par. 363:

Modify the proposed addition to Par. 363 so that it reads as follows:

Temperature Regulator. A temperature regulator which will prevent the water from rising above 210 deg. fahr., shall be applied to all hot water supply boilers irrespective of the working pressure, and to hot water heating boilers in which the working pressure exceeds 30 lb. per sq. in.

March Journal, p. 244
and
June Journal, p. 470

Par. 374:

Cancel revision proposed for Par. 374 in the March Journal and revise it from the form in which it appears in the present edition of the Code by inserting the following after "in." in second line:

"but not to exceed 160 lb. per sq. in."

Add at the end of Par. 374 the following:

The separate sections when tested to destruction shall withstand a hydrostatic pressure of at least 1200 lb. per sq. in.

PAGE 109—APPENDIX

Insert in the Appendix the following:

Where state or municipal authorities allow the use of automatic water gages, they shall conform to the following requirements:

(Insert here rules 1 to 7 as proposed for Par. 292 on page 241 of the March Journal, and revised on p. 470 of the June Journal.)

SOCIETY AFFAIRS

A Record of the Current Activities of the Society, Its Members, Council, Committees, Sections and Student Branches; and an Account of Professional Affairs of Interest to the Membership

PREPARE to Win! was the essential note struck at the Spring Meeting. No longer is it satisfactory to prepare for war—we must prepare to win.

Among the most helpful sessions to the undertaking of the United States in the present war was that on the Conservation of Fuel, under the auspices of the Committee of the Society of which Prof. L. P. Breckenridge is chairman, and attended by the representative men of the nation.

Another feature essential to winning the war is Emergency Technical War Training. The session on this subject was opened by an address by Prof. Arthur L. Williston, chairman of the Society's committee for this important activity. Others who addressed the meeting were Lieutenant André Morize, of the French Military Commission, and Major James E. Cassidy, of the 301st Engineers, an official observer at the front in 1916.

Notwithstanding the intensive war period and the fact that a year ago our Society met in Cincinnati, a central city, and jointly with another large organization, the Machine Tool Builders' Association, the attendance at the Worcester convention was larger than at any previous Spring Meeting, namely 986, of which 472 were members and 514 guests. Whereas the effort was concentrated on Win the War activities, and nothing was allowed to distract our main attention from these features, nevertheless the moments of relaxation were occupied by the wonderful program arranged by the Worcester Convention, permitting the members of the Society to enjoy the delightful friendships they have with our members and friends in Worcester, and to develop new acquaintanceships.

The beautiful scenery in and around Worcester, and the automobile ride to Concord, Lexington and the Wayside Inn, further added to the pleasures of the Spring Meeting.

In the general meeting before the whole Society Mr. Warner and Prof. Kent gave eloquent tributes to Prof. F. R. Hutton, who passed away just previous to the meeting. Prof. Hutton as Secretary for nearly a quarter of a century through its formative period had developed the personal as well as the professional side of the Society's work. In regarding, therefore, the splendid arrangements provided by the Worcester Committee, the ideal as expressed by Prof. Hutton in his Presidential Address for a convention of the Society was fully attained.

The spirit of rendering service which is now uppermost in the minds of all the people had birth quite as early in the engineering societies as in any other group of America's citizens. This is evidenced by the words used last February in the dedication of the new Engineers' Club in Dayton, Ohio, to the "dissemination of truth and the creation of civic righteousness."

One of the secrets of the complete success of the Worcester convention was the fact that it was our members who in their capacity as most active citizens in the drives of the Red Cross, Liberty Loan and Y. M. C. A. in Worcester, were naturally those that were grouped together on the Local Committee for our Spring Meeting, and, having worked out all the activities of these campaigns to a wonderful degree of success, it was to be expected that our convention should attain the same standard.

At the Council Meeting the report of the Special Committee on Readjustment of the Industries for War Work was approved, and a committee authorized to be appointed by the President. It is expected shortly that not only will there be a committee but that there will be regional representatives coöperating with the other instrumentalities of the nation. Dr. Hollis has with especial happiness expressed the idea that this is not an engineers' war any more than it is a financial war; but it is a war in which engineering is greatly employed, and the opportunity for service by our profession and the Society as an instrument of the profession could not be greater.

General March in his remarks to the graduating class at West Point this month stated:

"You are face to face with the most glorious adventure in the history of the world—a modern crusade, where an entire nation, without thought of territorial aggrandizement or of material gain, has planted its standard upon the soil of France in order that freedom shall be guaranteed to posterity. Go in and win!"

CALVIN W. RICE,
Secretary.

Council Notes

A WELL-ATTENDED meeting of the Council was held in the Hotel Bancroft, Worcester Mass., on June 4, 1918, in connection with the Spring Meeting of the Society. There were present:

Charles T. Main, *President;* Charles H. Benjamin, Arthur M. Greene, Jr., James A. Hartness, Ira N. Hollis, D. S. Jacobus, George A. Orrok, Charles T. Plunkett, W. R. Warner, W. H. Wiley, *Treasurer;* D. R. Yarnall L. P. Alford, *Chairman of Meetings Committee;* Jesse M. Smith, *Chairman of the Committee on Constitution and By-Laws;* Calvin W. Rice, *Secretary*, and W. E. Bullock, *Assistant Secretary.*

National Research Council. The President announced that in response to the invitation of the Engineering Committee of the National Research Council he had appointed Past-President John R. Freeman to sit with them in the discussion of their mechanical engineering problems.

Spring Meeting, 1919. It was voted to hold the next Spring Meeting in Detroit, Michigan, on a date to be mutually arranged by the Committee on Meetings and the Detroit Local Committee.

Committee on Readjustment of Industries for War Work. The report of this Committee suggesting ways in which the Society might serve the country in the matter of readjusting industries for war work was accepted, and the President was authorized in his discretion to appoint a committee to carry out the recommendations.

Boiler Code Committee. Interpretations of the Committee in cases 190 to 193 inclusive were approved with slight changes and ordered printed in THE JOURNAL. *Replies of the Committee* to communications from Mr. J. A. Hance and from the State Industrial Commission were approved.

Enemy Alien Members. A recommendation to drop from the membership all those who do not comply with the "Trad-

ing with the Enemy" Act, and all alien enemies was referred to the Engineering Council for advice as to what action this Society should take to be in accord with the other Founder Societies.

Communications. The Secretary read a letter from the family of Prof. F. R. Hutton, acknowledging the wreath of the Society and the sentiments it conveyed.

A communication from Sir John A. F. Aspinall expressed his thanks to the Council for its congratulations upon his election to the presidency of the Institution of Civil Engineers.

Quorum of the Council. The following By-Law was approved to take effect immediately after the constitutional amendments to be voted on at the Business Meeting the following day were made: "The number of persons constituting a quorum of the Council shall be one-third the number of members of the Council then in office."

Adjournment was taken to reconvene September 20, or at the call of the chair.

CALVIN W. RICE,
Secretary.

Readjustment of Industries for War Work

PRESIDENT MAIN TAKES IMPORTANT STEP SECURING COÖPERATION OF OUR SOCIETY WITH WAR INDUSTRIES BOARD

FOR the purpose of developing new industrial resources to meet the war demands of the Government, and quickly to disclose additional means of increasing production, the War Industries Board has just established a Resources and Conversion Section. Mr. Charles A. Otis, of Cleveland, former president of the Cleveland Chamber of Commerce and a member of the Board of Directors of the Chamber of Commerce of the United States, has been appointed Chief of this Section.

To carry out the plans of the War Industries Board, it has been decided to divide the country into twenty regional groups and to organize each region through the commercial organizations within the region.

In each of these regions all types of industry represented in the membership of the business organizations and in addition all industries which may not be a part of such membership will be invited to coöperate.

The purpose of this regional system is immediately to make a careful survey of every section of the country to determine what industries not now doing war work may be utilized for such work, and also to ascertain what industries already engaged on work for the Government are able to take on additional contracts or increase their production of munitions and war supplies.

Utilizing our Local Sections organization, President Main has appointed the following members of the Society to act as its representatives on each of the Regional Committees of the Resources and Conversion Section of the War Industries Board:

Bridgeport, Conn.	Harry E. Harris
New York City	G. K. Parsons
Philadelphia, Pa.	Lewis F. Moody
Pittsburgh, Pa.	J. M. Graves
Rochester, N. Y.	F. W. Lovejoy
Cleveland, Ohio	F. H. Vose
Detroit, Mich.	G. W. Bissell
Chicago, Ill.	A. D. Bailey
Cincinnati, Ohio	Fred A. Geier
Baltimore, Md.	William W. Varney
Atlanta, Ga.	Oscar Elsas
Birmingham, Ala.	J. H. Klinck
Kansas City, Mo.	J. L. Harrington
St. Louis, Mo.	R. L. Radcliffe
Milwaukee, Wis.	W. M. White
Dallas, Texas	A. C. Scott
San Francisco, Cal.	B. F. Raber
Seattle, Wash.	R. M. Dyer
Boston, Mass.	A. C. Ashton
St. Paul, Minn.	Paul Doty

The President has also created a national committee of our Society on Readjustment of Industries for War Work. Mr. George K. Parsons, the chairman of our committee on this same subject, who was appointed as the outcome of the recent successful meeting of the New York Section on Non-Essential Industries, is chairman of the main committee. The other members of the national committee are F. A. Scheffler and Erik V. Oberg.

The action of President Main is in accordance with the action by the Council at its meeting in Worcester, of carrying out the recommendations of the Committee on Readjustment of Industries for War Work, and the President chooses the above method as the best means of rendering effective service by offering our organization to an agency already established for carrying on the work.

Desirable Constitutional Changes

It has been said that an ideal constitution of a society should "embody organization structural principles only and provide for nothing except members, officers and money." Details should be "left to by-laws." These statements are sound; a society that is not moribund is an elastic thing, and its development should not be hampered by the constitution curtailing future desirable activities.

On the other hand, the interests of a society are the interests of its members and should at all times be conserved and safeguarded by a constitution which limits things which should be limited.

The amendments to our Constitution adopted at the Spring Meeting at Worcester adhere to the principle that a simple constitution is best by reducing the number of constitutional standing committees, or Standing Committees of Administration, from ten to six.

The Standing Committees of Administration are now Membership, Finance, Meetings and Program, Publications and Papers, Local Sections, and Constitution and By-Laws. The former standing committees on House, Library, Research, Public Relations, and Standardization are now transferred to the By-Laws, and more may be added to their number at the discretion of the Council.

Analyzing the effect of these changes on the development of the Society, the six committees in charge of the six major activities now have a representative at all Council meetings to take part in all deliberations. Coördination of these six activities is secured through the contact of these representatives, which occurs under the most advantageous circumstances, simultaneously with the meeting of the governing body of the Society. The new arrangement therefore presents attractive possibilities.

That the members desired the Sections Committee included in the new standing committees of administration is a recognition of the potency of this activity. The Local Sections movement presents practically unlimited possibilities, and every step necessary should be taken which tends toward its full

realization. The Sections Committee has recently taken great strides forward; it has recommended autonomy to the Local Sections, and the autonomy has been approved in principle by the Council and new amendments proposed to the Council.

The changing of the names of the Meetings and Publication Committees to Meetings and Program, and Publication and Papers, is the idea, long since conceived, of the late Professor Hutton, who was a student of the Society's policies and the constitutional provision for them. The new names indicate more clearly the functions of these committees, as they have been in force for some time.

The changes in the methods of the Society's organization are but indications of a desire to harmonize the principles of government and to recognize the will of the membership. They are not even new indications, because ever since the Society was formed, and throughout all its successful development, the interest of the members in these things has been as keen as now. The point is that until recently there has been no opportunity for expression.

That this interest is an ever-present thing is illustrated by an example which it is proper to insert here. For some time past the President has been selecting the regular Nominating Committee for officers in consultation with members selected by groups of the Local Sections. By initiative of the Council itself, which recognized the advantages of the new method, a constitutional amendment was proposed at Worcester which takes this power of appointing the Nominating Committee entirely out of the hands of the President and places it, through the Sections, in the hands of the voting membership.

Report of the Nominating Committee

The following is the report of the Nominating Committee of the American Society of Mechanical Engineers:

The Committee held its first formal meeting at the Hotel Bancroft, Worcester, Massachusetts, on Wednesday, June 5, 1918. The meeting was called to order at 9:30 a. m., and adjourned at 1 p. m. Prof. L. P. Breckenridge was elected chairman.

The following members were present: L. P. Breckenridge, *Chairman*, New Haven, Conn.; Major Thomas E. Durban, Erie, Pa.; William P. Caine, Ensley, Ala.; George R. Wadleigh, St. Louis, Mo. Major C. F. Hirshfeld, Detroit, Mich., was absent but submitted a letter with his nominations.

After carefully considering the names submitted, the following nominations were unanimously approved:

For President:

DEAN MORTIMER E. COOLEY, Ann Arbor, Mich.

For Vice-Presidents:

F. R. LOW, New York City.
HENRY B. SARGENT, New Haven, Conn.
JOHN A. STEVENS, Lowell, Mass.

For Managers:

CHARLES L. NEWCOMB, Holyoke, Mass.
F. O. WELLS, Greenfield, Mass.
DEAN C. R. RICHARDS, Urbana, Ill.

For Treasurer:

WILLIAM H. WILEY, New York City.

As required by the By-Laws, we are submitting with this report the written consent of each nominee to serve if elected.

Respectfully submitted,
(Signed) L. P. BRECKENRIDGE,
Chairman of the Nominating Committee.

Society Service

Our Society is constantly supplying information to its members, as well as to other individuals or other organizations, on technical subjects, through the facilities of the Library and the acquaintance of the Secretary and office staff with the individual members and committees throughout the country. It is usually possible to refer such inquiries to specialists, who have always indicated their willingness to supply information to any reasonable extent; and often, indeed, our members put themselves to a great deal of trouble to help other members who may be in need of definite information which they are able to supply.

A case in point is an inquiry which came from India a few months ago with regard to the equipment of a mechanical-engineering laboratory. Through the courtesy of several professors of engineering who had recently equipped laboratories in this country and through helpful suggestions of various firms the desired information was supplied, as indicated in the accompanying letter:

TO THE EDITOR:

I thank you and the several firms and individual professors who at your instance have been kind enough to send me valuable information regarding the equipment of a suitable Mechanical Engineering Laboratory. I have thanked the several firms and professors separately.

I shall soon submit figures and specifications for the approval of the University. If the items be included in the next official budget, I shall be able to place orders with the firms or their agents, if any, in India.

Yours very truly,
(Signed) S. SETTI.

Malleswaram, Bangalore, India, March 11, 1918.

Dues of Members Being Remitted

Under a provision of By-Law, B 16, exempting from dues any member who has paid dues for 35 years, the following members have been granted such exemption:

Name	Date of Election	Name	Date of Election
Alden, Geo. I.	1880	Hunt, R. W.	1880
Allen, F. B.	1880	Kent, Wm.	1880
Baldwin, Wm. J.	1882	Lanza, Gaetano	1882
Bancroft, J. S.	1880	McEwan, J. H.	1882
Betts, A.	1881	Marx, Henry	1880
Bond, Geo. M.	1881	May, De Courcy	1881
Burdsall, E.	1880	Porter, H. F. J.	1880
Byllesby, H. M.	1882	Sellers, C., Jr.	1882
Clarke, Chas. L.	1882	Smith, A. W.	1880
Cloud, John W.	1880	Smith, G. H.	1881
Cogswell, Wm. B.	1880	Smith, Oberlin	1881
Coon, J. S.	1880	Tallman, F. G.	1881
Cox, J. D.	1881	Thomas, E. W.	1880
Emery, A. H.	1880	Townsend, David	1882
Forsyth, R.	1881	Trump, E. N.	1880
Halsey, F. A.	1882	Warner, W. R.	1880
Herrick, J. A.	1880	Weston, E.	1882
Hollerith, H.	1880	White, J. J.	1880
Howard, C. P.	1880	Wiley, W. H.	1880
Hugo, T. W.	1882	Wood, W.	1880
Worthington, C. C.	1882		

A list is now also being compiled of members who have reached the age of 70 years and have paid dues for 30 years. These are also entitled to the same exemption. This list will be published as soon as possible.

Steam Engineering Training School at Stevens Institute

The Navy Department has designated Stevens Institute of Technology, Hoboken, N. J., as headquarters for the new United States Steam Engineering School for the training of the engineering officers for the U. S. Naval Auxiliary Reserve.

This school is the only one devoted to training engineer officers for steam-engine service, and is a branch of the large training school now located at Pelham Bay Park, N. Y. It is contemplated to make a five-month course for the training of an officer; one month to be devoted to military and ship duties training at Pelham; one month at Stevens to receive the preliminary requirements and duties of an engineer; one month in inspection and repair duties at local shipyards, machine shops and boiler shops; one month at sea in the engine rooms of different types of boats; and one month subsequent training and examination at Stevens.

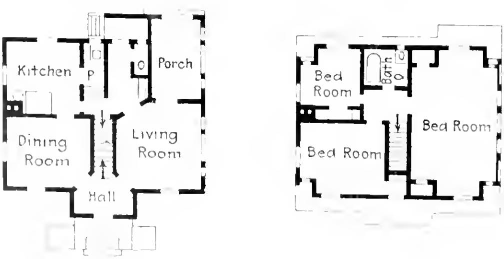
The instructors for the School with the exception of the Civilian Director will be regularly appointed commissioned officers of the United States Naval Auxiliary Reserve and will be selected primarily for their special work.

The school is open to men between twenty-one and thirty, who are physically qualified, of thorough ability and officer-like character, and who have completed the engineering course at any recognized technical school. Any men can enroll with the proper enrolling officer by securing from the draft board a letter of release which in all probability can be obtained for this purpose, provided the men are not included in the current draft quota. A graduate of the School will be commissioned an Ensign in the U. S. Naval Reserve Force.

For additional details application can be made to the Civilian Director, U. S. Navy Engineering School, Stevens Institute, Hoboken, N. J.

Workmen's Model Homes

Those who visited the Indian Hill Community of the Norton Company during the Worcester Meeting were favorably impressed by the architecture of the model houses, designed by Grosvenor Atterbury of New York. For economy of construc-



FIRST FLOOR SECOND FLOOR

Plan of Model Indian Hill House

tion and convenience of arrangement these houses could hardly be surpassed, and it will be of interest to Journal readers to see the floor plans of one of the designs, reproduced herewith.

At the convention of the N ional Association of Purchasing Agents on May 22, 1918, a resolution was passed advocating the standardizing of the 6 x 9 in. size as a primary standard for catalogs, and the $8\frac{1}{2} \times 11$ in. as a secondary standard.

Lessons From Our Medical Friends

In his presidential address before the American Medical Association, Dr. A. D. Bevan cited some striking facts about the Association, which is recognized as the leader in the organized medical profession of this country. Some of these lessons we might take to heart:

"It is now more important than ever that the admirable activities of the Association should be continued and amplified, and that steps should be taken to meet the new problems that will confront the Association after the war . . . But these things can and must wait on the one great problem that confronts us now, *the winning of the war.*"

"At the outbreak of the war, the American Medical Association offered to the United States government its entire organization and machinery to assist in the enormous expansion that became necessary. Through the officers of the county societies, the state societies, and particularly through the columns of The Journal, the needs of the government were placed before the organized profession of the country, and they responded splendidly to the call. So far 25,000 have gone into the Medical Departments of the Army and Navy. No other profession or calling has responded more promptly to the needs of the country than the medical profession. The great bulk of the medical men who have gone into government service were members of the American Medical Association."

"The demands made on the medical profession by the war are so great that it is evident that in order to secure the necessary number of medical men for the government, and at the same time prevent hardships in some communities and institutions, it is necessary to organize the entire profession of the country in a systematic way. It therefore became necessary for the American Medical Association, acting with the Surgeon-General's Office, to take a census of the available medical men in the United States in each state, in each country, in each medical school and in each hospital, and to attempt to secure from each one of these different units at least 20 per cent. of the medical men. This plan will enable the government to secure the necessary number of medical officers for an army of 5,000,000 men or more, and a navy of 1,000,000, without any great hardship to any community or to any institution."

"Profiting by the experience of the great nations that entered the war in 1914, the medical profession of the country, and the government, have very wisely taken steps to prevent the disruption of our medical schools, and I am glad to say that our national government adopted the suggestion made by the Surgeon-General to allow medical students to be commissioned in the enlisted Medical Reserve Corps and have them detailed to complete their medical education and to serve a year in a hospital as interns before they are called into active service."

"The United States is the only great reservoir of medical men in the world. The medical professions of Great Britain and France, of Italy and Belgium, and this is probably more true of enemy countries, have been well-nigh exhausted by this war. They delayed making plans for a continued supply, their medical schools became disrupted, and they are already suffering for medical men in their armies and in their civil life."

The Cincinnati Section Committee on Special Training Courses for Women, which consists of George Langen, J. B. Doan and R. T. Hazelton, has requested the Ohio Mechanics' Institute, Cincinnati, O., to give a course in intensive training in mechanical drawing for women. This course will begin on June 24, and it is entirely probable that other courses for women will follow.

AMONG THE LOCAL SECTIONS

THE Sections' Conference at the Worcester Meeting was attended by the following: D. Robert Yarnall, Alex. D. Bailey, Louis C. Marburg, A. L. Rice, W. Herman Greul, G. W. Galbraith, W. C. Brinton, R. Collamore, C. H. Bierbaum, W. W. Macon, G. K. Parsons, G. R. Woods, R. W. Adams, H. P. Fairfield, H. N. Dawes, J. C. Smallwood, A. C. Ashton, L. P. Breckenridge, J. C. Kingsbury, E. L. Fletcher, H. E. Harris, W. P. Caine, E. H. Lockwood, W. G. Starkweather, E. Smith, C. C. Cariss, E. L. Folsom, Calvin W. Rice and E. Hartford, representing in all thirteen Sections.

Mr. W. Herman Greul, Secretary of the New York Section, told in a very interesting manner of the way in which the meetings of the Section were being developed. Supplementing his statement Mr. W. C. Brinton showed a number of slides which gave graphical statistics as to the growth of the membership over a period of years; as to individual grades and total membership. Data was also given as to the attendance figures at the New York Section meetings, showing those attending according to their respective ages and also as to the period of time they had been members. These figures will be further developed and published in a later edition of The Journal. The activities of each of the Sections represented were described in turn by members of the Section in attendance and much of interest and value was developed.

Mr. D. Robert Yarnall, Chairman of the Committee on Sections, told of the recognition being accorded by the Council to the activities of the Sections, and emphasized the big step forward in making the Society truly democratic, through the presentation at the Business Session of an Amendment to the Constitution whereby the voting membership would elect the Nominating Committee, using the organization of the Sections to carry out the election.

The Secretary of the Society and also the Secretary of the Committee on Sections visited a number of the Sections during the month and reported a keen interest in the affairs of the Society in all sections of the country. The Committee on Sections will give considerable attention during the summer to planning for next year's activities and it will thereby be possible to get a flying start in the fall, with a series of meetings of considerable current interest. Likewise a number of new Sections are contemplated and the members in districts where Sections are not now organized are encouraged to develop interest in a Section in their respective localities. The Committee on Sections will be glad to contribute assistance.

Duluth Engineers at Get-Together Dinner

The engineers of Duluth, Minn., have taken the first steps to form a Duluth Engineers' Club by meeting at a get-together dinner on the evening of May 20th, at the Kitchi Gammi Club, Duluth.

At present Duluth has no club embracing all engineers. About thirty years ago a movement to organize was initiated but was not completed. The city has many other representative clubs and ranks high among other cities of the country for its activities and discussions of public questions. The environment is splendid for the growth of an engineers' organization. There are within reasonable distance of Duluth, over a hundred members of the four large national engineering societies, a number of members of the lesser engineering societies and many non-members. Until the successful formation of the Duluth Association of Civil Engineers about three years ago, these engineers had no common ground of meeting, no means to render their united thought effective on questions concerning the welfare of the profession or to promote the civic activities of their skill.

The Duluth Association of Civil Engineers, however, can and does represent only a small part of the whole body of trained technical men. Something bigger and broader is needed. With this view in the minds of the Civil Engineers, the Duluth Association in March, 1917, appointed a committee of Mr. W. H. Hoyt, Mr. W. B. Patton and Mr. W. H. Woodbury to develop a plan for a Duluth Engineers' Club. This committee has studied the situation carefully and is now ready to help in the development.

Its first important move was the call sent out for the above dinner to all members of the four main national engineering societies who lived within suitable distance of Duluth to attend and take part in the discussion. Some seventy engineers were present and took an active interest in the movement. Favorable responses were received from others who could not be present during the evening. The committee prepared an excellent program of talks and lantern slide pictures.

President F. E. House of the Duluth & Iron Range Railroad and retiring President of the Duluth Association of Members of the American Society of Civil Engineers, acted as toastmaster. In opening the program, he briefly outlined the objects of the meeting, and called on Mr. W. H. Woodbury to outline the plan of the formation of an engineering club. Three objects of the club were given by him; first, professional; second, social; third, civic. Four plans of membership have been considered: first, to have an organization for all professional engineers, junior engineers and associates, with different status for each; second, an organization made up of members of the four big national societies; third, an organization of members and a limited number of associates; and fourth, professional engineers only, all on an equal standing.

Mr. W. H. Hoyt reported preliminary suggestions for arranging a home for the club.

Acting on a resolution offered by Mr. T. W. Hugo, Emeritus Member of the American Society of Mechanical Engineers, that steps should be taken to form an engineers' club in Duluth and that a committee be appointed to develop the plan, Mr. House appointed a committee of eight representative engineers as follows:

American Institute of Electrical Engineers:
W. N. Ryerson, *Chairman*, Walter F. Schwedes.
American Institute of Mining Engineers:
Edwin J. Collins, Walter C. Swart.
The American Society of Mechanical Engineers:
Oscar B. Bjorge, W. H. Gallagher.
American Society of Civil Engineers:
W. H. Hoyt, W. H. Woodbury.

It is hoped that this committee will make such progress that another meeting can be called very shortly to put into effect their decisions.

While it is recognized that engineers are busy with war activities and responsibilities, it is felt that this is the time to unite the whole profession in one effective body promoting the interests and welfare of the profession and rendering service to the community. War has shown the great responsibility and opportunity of engineers to direct and do the work of the nation. The progress made by the national engineering societies in unifying their efforts toward securing the proper recognition and employment of their talents to the fullest degree has been reflected by many cities in the formation of strong, well-conceived engineers' clubs. Duluth has a large list of engineers of high standing as individuals and the leaders of the movement for a club are very optimistic of the strength and success possible.

The program of the night included addresses by men of nationwide reputation in the engineering field: Dean John Allen of the College of Engineering of the University of Minnesota spoke on the heavy call for engineers, the depletion of the numbers of students attending the universities and the thinning of the ranks of their instructors. He urged upon the engineers present, the necessity of encouraging young men to take up engineering studies in order that deficiencies in numbers of engineers may be prevented.

Mr. Calvin W. Rice, National Secretary of The American Society of Mechanical Engineers, brought greetings from his Society to the engineers of Duluth, and also read a telegram from the American Institute of Electrical Engineers expressing good will for the organization of a club and hoping their members would take an active part as well as form a local branch of the Institute. Mr. Rice's talk was full of eloquent appeal to the engineers to take up the work and place on its banner the idea of high service for the general welfare of the commonwealth and profession. He set forth that it is for the engineers of America to render the loftiest expression of its objects in the organizing of any technical society.

Mr. Kirk L. Strickland, erecting manager of the American Bridge Co., Chicago, gave a talk illustrated with lantern slides on the Union Pacific Railway Company's new bridge over the Missouri River at Omaha.

Mr. Richard Khuen, Jr., member of the Board of Direction of the American Society of Civil Engineers, and who had a hand in building the famous Hell Gate Bridge at New York, described the work and with lantern slides illustrated the construction in a very interesting manner. A moving-picture film was used to show further how the job was arranged.

Section Meetings

BALTIMORE

May 22. At the final meeting of the Section the following officers were elected: A. E. Walden, chairman; Wm. L. DeBaufre, vice-chairman and A. G. Christie, secretary-treasurer.

The address of the evening was delivered by W. H. Blood, Jr., of the American International Shipbuilding Corporation, on Hog Island, the greatest shipyard in the world.

The speaker called attention to conditions at the outbreak of the war and showed the steps that led up to the undertaking of the Hog Island enterprise. He explained in detail the relations of the Corporation and the Government and showed clearly that the undertaking had been grossly misrepresented in many statements appearing in print. He then discussed the difficulties in construction last winter and how in spite of all the yard was well ahead of schedule. The speaker next took up a discussion of many of the yard's details and impressed his hearers with the immensity of the undertaking.

The address was illustrated by lantern slides showing all stages of construction. These were very impressive.

Another paper by Charles R. Schmidt on The Coal Problem was handed to the Secretary. On account of the lateness of the hour, it was decided to read this by title only, to be taken up at a meeting next fall.

A. G. Christie,
Section Secretary.

BIRMINGHAM

May 16. The Atlanta Section were the guests at the Annual Meeting of the Birmingham Section. A very enjoyable and instructive inspection trip was made to some of the large plants in the district. Leaving the Tutwiler Hotel at nine o'clock the party proceeded to the plant of the Hardie-Tynes Manufacturing Co., manufacturers of marine engines and the party witnesed the manufacture of what is known as 1-lb. naval shells. A small section of the plant is devoted to the manufacture of these shells, where they turn them out at the rate of about 2,000 per week.

From the Hardie-Tynes Manufacturing Co., the party proceeded to the plant of the Birmingham Machine & Foundry Co., principally engaged at this time in the manufacture of 14-in. semi-steel naval practice shells and also large cotton compresses. Here was seen the largest boring mill in the Birmingham district; a mill of 16-ft.-diameter table, and at the time of inspection this boring mill was working on a large cotton compress platen weighing approximately 60,000 lb.

A trip was then made to the plant of Joubert & Goslin who make large castings for evaporators used in the sugar-refining industries.

After leaving Joubert & Goslin's the party arrived at the plant of the American Cast Iron Pipe Co. A trip through the company's industrial village for negroes known as West Acipco disclosed the fact that they are second to none in welfare work. This village has paved streets, stone and sanitary sewerage and numerous houses with large garden lots for their negro employees. All the houses are of different design, have plastered walls, are equipped with hot and cold water and, in fact, modern in every respect. A picture was taken of the group, numbering approximately 30, at the plant of the American Cast Iron Pipe Co. in front of their modern office building. The entire process of manufacturing pipe was noted at this plant and also the manufacture of large castings for the Air Nitrates Corporation at Sheffield and the experimental 8-in. semi-steel high-explosive shells. A dinner was then served at the Y. M. C. A., which is controlled and operated by the American Cast Iron Pipe Co.

Picture Taken of the Group at the American Cast Iron Pipe Company's Plant

In the afternoon the party proceeded to the Ensley Works of the Tennessee Coal, Iron & Railroad Company, where an inspection was made of the steel mill and furnaces.

At eight o'clock the party assembled at the Tutwiler Hotel for dinner and a business session. Mr. Klinck, Chairman of the Birmingham Section, after giving the Atlanta Section a hearty welcome, delivered a short talk on the achievements of the Section during the past year. Mr. Scott, Chairman of the Atlanta Section, in response, thanked the Section for the hospitalities extended and the very enjoyable inspection trip. He also extended an invitation to the Birmingham Section to visit Atlanta either this fall or next spring, and expressed the hope that the Baltimore, Birmingham, New Orleans and various other sections in close proximity could be induced to meet together in Atlanta at that time.

Vice-chairman W. F. Caine gave a short talk and pledged his best efforts in making the ensuing year count a great deal for the Section. Mr. Caine read a letter from the Detroit Engineering Society enclosing a copy of resolutions recently passed by that Society urging colleges and manufacturers to coöperate in the training of women to take the place of men in our industries. It was brought out in discussion that this was an excellent idea and that a great deal rested upon the patience of heads of departments in the manufacturing plants towards the successful training of women, and that whereas they would get their preliminary training in the college, their special training would naturally be obtained

after taking their place in the ranks of industry. It was voted that the resolutions submitted by the Detroit Engineering Society be adopted by the Birmingham Section and that publicity be given these resolutions and an effort made to bring about coöperation and the establishment of places of training for women.

Major F. H. Wagner, O. O. R. C., of the United States Army, who is engaged in work for the Air Nitrates Corporation, delivered a very interesting address on some of the problems that were being worked out in connection with the fixation of nitrogen. He brought out the fact that while detailed information could not be given at this time, when the war is over the engineers will be supplied with very interesting and helpful data on the various achievements that are now being made.

The Section was honored by having as a guest Secretary Calvin W. Rice, who made a most interesting and helpful address on various timely topics, as Unused Water Power, the Training of Women for Industrial Work, Liberty Motors, Gas Warfare, Coöperation in the Engineering Profession, the work of the Engineering Societies, the Dilution of Labor, etc. The main idea of his talk was to furnish food for thought and stimuate the Section in progressive lines and lofty ideals.

W. L. Roueche,
Section Secretary.

BOSTON

May 29. The Annual Meeting of the Boston Section was held at the Engineers' Club. After brief reports of the Executive Committee, the following were elected for the year 1918-1919 to serve on the Executive Committee: Geo. P. Aborn, Albert C. Ashton, Wm. W. Crosby, Edward M. Jennings, Elmer Smith and Wm. G. Starkweather.

President Charles T. Main and Past-president Ira N. Hollis were present and addressed the meeting, the latter giving some very interesting data on the fuel situation in Massachusetts. Mr. Ashton then told of the work accomplished by the Boston Section during the year, and the successful meetings which had resulted.

An eloquent and forceful address was delivered by Doctor Charles H. Eaton on America at the Gateway of Destiny. An enthusiastic audience of about one hundred persons listened to this address and later enjoyed light refreshments.

W. G. Starkweather,
Section Secretary.

CONNECTICUT SECTION

Meriden Branch

May 17. The annual meeting of the Meriden Branch of the Connecticut State Section was held at the Winthrop Hotel.

The entire list of officers were renominated by the special nominating committee, and were unanimously reëlected, as follows: C. K. Decherd, chairman; C. N. Flagg, secretary-treasurer; F. L. Rowntree, J. A. Hutchinson and Fred L. Wood.

Mr. R. W. Millard was the speaker of the evening and took for his subject "The Need of Systematic Training and Instruction of Workmen in the Factories." It was the sense of the meeting that a special committee should be appointed for this matter.

The experiences of the various members present, with Government work, was next discussed.

C. N. Flagg,
Branch Secretary.

ERIE

May 3. The following officers were elected for the year 1918-1919 on the Executive Committee of the Section: M. W. Sherwood, chairman; C. M. Spalding, vice-chairman; R. Conrader, treasurer and J. St. Lawrence, secretary. Following the business meeting Mr. James Burke, Mem.Am.Soc.M.E., gave an interesting talk on The Conservation of Material.

M. E. Smith,
Section Secretary.

MILWAUKEE

June 12. At a meeting of the Engineers' Society of Milwaukee, Mr. H. M. St. John of the Testing Laboratory of the Commonwealth Edison Co., delivered an illustrated lecture on Products of Electric Furnaces and the Cost of Their Production.

Fred H. Dorner,
Section Secretary.

NEW YORK

May 21. Under the chairmanship of George R. Woods, the subject of the meeting was a timely one on Labor Turnover, and was presented by speakers of prominence representing makers of ships, aeroplanes, ordnance and machine tools.

The first speaker, J. J. Pearson, outlined his work in the British Ministry of Munitions, and his labor-dilution service. Then Orrin W. Sanderson, Director of Labor of the B. F. Goodrich Co., outlined his work in that field, having to do with twenty thousand employees.

Mr. Dudley Kennedy, of the American International Shipbuilding Corporation, and who has charge of the shipbuilding plant at Hog Island, told of the methods employed in that work. Mr. H. F. J. Porter, consulting industrial engineer, outlined the broad principles of the work involved by the operations of the previous speakers. The specialized work that has been done to improve the labor problem was covered by the following speakers: John Calder, of the Aero Marine Plane & Motor Company, at Keyport, N. J., who spoke of the effect of the selective draft; Capt. Boyd Fisher, of the Ordnance Department, U.S.A., who told of the work carried on by the Government in the training of employment managers, and following him L. D. Burlingame, industrial superintendent of the Brown & Sharpe Manufacturing Company, outlined the work of his company in training women for employment. Mr. H. E. Miles, of the Council of National Defense, described the plans and accomplishments of the Council of National Defense to assist manufacturers to train women in their shops.

Major E. N. Sanctuary of the War Service Exchange of the Adjutant General's Office, and other representatives of the Government including the following joined in the discussion: Capt. J. J. Swan of the Committee on Classification of Personnel in the Army, and Mr. J. B. Densmore, Director of the U. S. Employment Service, for the Labor Department.

Mr. G. K. Parsons presented the following resolution which was adopted:

Resolved, That the Chair appoint a Committee to take immediate action to determine how the Society can render the greatest assistance in the solution of the problem of labor turnover.

W. H. Greul,
Section Secretary.

NEW ORLEANS

June 10. At the last meeting of the Louisiana Engineering Society Mr. Howard Egleston, Civil and Industrial Engineer of the New Orleans Association of Commerce, delivered a paper on The Present Situation as Relating to the Introduction and Use of Natural Gas in New Orleans. The speaker described briefly the natural-gas wells which have been successfully operated at Terrebonne Parish about forty miles from New Orleans. One of the wells is said to have the largest flow of any natural-gas well in the world. At present the chief obstacle of piping this gas to New Orleans is the difficulty of securing the steel for the pipe line, but mention was made of the possibility of using other material such as cast iron or reinforced concrete.

H. L. Hutson,
Section Chairman.

ONTARIO

May 27. At the Annual Meeting of the Ontario Section which was held at the Engineers' Club, Secretary Calvin W. Rice gave a very interesting talk on the activities of the Society.

Mr. J. H. Billings, Assoc.-Mem.Am.Soc.M.E., delivered a paper on Strength of Cast Iron in Bending as Affected by Variations in Cross Sections.

The results of the election of new members for the Ontario Section were announced as follows: R. W. Angus, chairman; C. B. Hamilton, secretary; James Milne; J. H. Billings and H. B. Ahara.

Chester B. Hamilton, Jr.,
Section Secretary.

Student Branch Meetings

Members of Student Branches are requested to notify the Secretary of any change in address as promptly as possible, in order to facilitate delivery of The Journal.

BUCKNELL UNIVERSITY

May 8. The following officers were elected for the ensuing year: G. F. Jammer, chairman; H. R. Pars, vice-chairman; H. J. Hann, secretary and B. J. Wilson, treasurer.

Professor Burpee delivered an interesting address on What Is Expected of the Engineering Student at Present.

H. J. HANN,
Branch Secretary.

UNIVERSITY OF CALIFORNIA

April 24. The election of officers for the ensuing year was as follows: J. Mora Moss, Jr., chairman; E. S. Smith, Jr., vice-chairman; G. C. Goldwaithe, secretary, and A. O. Montijo, treasurer.

A paper was presented by Llewellyn Boelter on The Tungar Rectifier.

LLEWELLYN BOELTER,
Branch Secretary.

CARNEGIE INSTITUTE OF TECHNOLOGY

May 4. The annual banquet of the Branch was held in connection with the last meeting of the year. The following officers were elected for the ensuing year: H. D. Krummell, chairman; W. J. Blenko, vice-chairman; D. C. Saylor, secretary and P. D. Wersant, Jr., treasurer.

Mr W. C. Bates, of the Fawcus Machine Co., gave an interesting talk on the automatic control of the torpedo, and showed how the Allies and Germany are striving for superiority, each enjoying brief periods of supremacy, which are soon annulled by a new invention which counteracts this temporary advantage.

Professor Trinks gave a short talk on the early days of the Institute, and several of the alumni present also spoke briefly about their experiences since graduation.

H. D. KRUMMELL,
Branch Secretary.

UNIVERSITY OF CINCINNATI

May 23. The following officers were elected for the ensuing year: L. C. Smith, chairman; H. Dangel, vice-chairman and G. H. Eilers, secretary-treasurer.

Mr. J. F. Pflum of the Heald Grinding Co., delivered an interesting paper on Time Allowances for Internal Grinding. Many samples of work were shown and time studies taken were discussed.

Professors Jenkins, Joerger and Shine briefly discussed accurate working limits.

C. L. KOLHIER,
Branch Secretary.

UNIVERSITY OF COLORADO

May 2. The following officers were elected for the ensuing year: R. F. Hamilton, chairman; W. K. Gray, vice-chairman and H. H. Herman, secretary-treasurer.

HARRY H. HERMAN
Branch Secretary.

UNIVERSITY OF ILLINOIS

During the last semester one meeting each month has been given up to the University War lectures for the College of Engineering. These lectures are intended primarily for engineers, and all of the engineering societies are devoting one meeting a month to the lectures. Subjects of national interest at this time are presented by men well qualified to speak upon the various subjects discussed. The members of the Student Branch feel that it is well worth while to forego one meeting of the Branch by itself in order to hear these lectures.

In addition to talks and lectures by faculty men, and other professional men, the Branch is at this time having a series of talks by student members. Pi Tau Sigma, a professional mechanical engineering fraternity at the University, offers each year a prize to the student member of the Branch giving the best talk on some technical or semi-technical subject before the Branch. A great deal of interest is shown in this contest, and some very good papers have been presented. A prize is offered to each of the four classes, in order to prevent unfair competition. The Branch has voted to send the best paper of the whole set to the parent Society to be entered in competition for the prize offered for the best student paper from all Student Branches.

C. Z. ROSECRANS,
Branch Secretary.

LOUISIANA STATE UNIVERSITY

May 7. A very interesting talk was delivered by Mr. Etheredge on the manufacture of sugar in Louisiana, in which he pointed out the difficulties to be overcome in using cane bagasse as fuel. Many lantern slides of the different kinds of machinery employed by the various refineries were shown.

May 29. The officers elected for the ensuing year are as follows: C. R. Strattman, chairman; C. R. Byrd, vice-chairman; C. Colomb, secretary and J. A. Scheuermann, treasurer.

A brief talk was given by Mr. Taddicken, of the Westinghouse Co., on the apprenticeship work in large shops.

C. R. STRATTMAN,
Branch Secretary.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

The annual election of officers resulted in the election of the following: Charles A. Chayne, chairman; Scott H. Wells, vice-chairman; Everett F. Doren, treasurer and Edward F. Pierce, Jr., secretary.

STUART H. CALDWELL,
Branch Secretary.

UNIVERSITY OF MICHIGAN

April 30. The following officers were elected: D. M. Ferris, chairman; S. T. Huette, vice-chairman; and A. D. Althouse, secretary-treasurer.

A. D. ALTHOUSE,
Branch Secretary.

MICHIGAN AGRICULTURAL COLLEGE

May 16. The following officers were elected for the ensuing year: A. E. Downer, chairman; E. Osborne, vice-chairman and E. C. Hoch, secretary-treasurer.

H. M. SASS,
Branch Secretary.

UNIVERSITY OF MINNESOTA

March 23. The following officers were elected for the ensuing year: G. H. Brennan, chairman; H. A. Abrahamson, vice-chairman; A. Baker, corresponding secretary; R. M. Foltz, recording secretary and M. S. Wunderlich, treasurer.

A very interesting talk was given by Prof. J. J. Flather, on Ancient Shipbuilding in which he discussed the most ancient forms of ships and the methods used in building them.

May 4. An open meeting was given at which Melvin Ovestrud, of the class '14 now in the employ of the Minneapolis Steel Machinery Co., gave an illustrated lecture on Shell Manufacturing.

A. BAKER,
Branch Secretary.

UNIVERSITY OF MISSOURI

April 25. A paper on The Poppet-Valve Engine was presented by R. T. Powers in which he pointed out the utility of the poppet valve in connection with high steam pressures and the application of this type of valve to the unaflow engine, the high pressures permitted and resulting high economies attained.

May 10. The following officers were elected for the ensuing year: Will Copher, chairman; K. K. King, corresponding secretary and Roy H. Jaeger, secretary-treasurer.

Mr. F. C. Hussey presented an interesting paper on The Manufacture of Dynamite in which the various operations of dynamite were fully explained.

J. W. BALDWIN,
Branch Secretary.

UNIVERSITY OF NEBRASKA

May 11. A business meeting was held which resulted in the election of the following officers for the ensuing year: V. E. Kauffman, chairman; W. L. Millar, secretary; Harvey Glebe, treasurer and L. F. Seaton, honorary chairman.

W. L. Millar,
Branch Secretary.

OHIO STATE UNIVERSITY

May 8. This meeting took the form of a banquet which was followed by the election of officers for the ensuing year. The following were elected: F. H. Cover, chairman; H. R. Ansel, secretary and V. Darnell, treasurer.

F. E. Smyser,
Branch Secretary.

UNIVERSITY OF OKLAHOMA

April 11. After a brief business meeting the following short talks were given: Advantages of High Pressure and Superheat by E. H. Reeves; Comparative Economy of Turbines and Engines by L. A. Humphries; Comparison of Different Means of Power Transmission by F. E. Waterfield; Oil versus Coal Under Boilers by R. V. Goodknight; Feedwater Heaters and Economizers by G. L. Barker; Injector, Rotating and Reciprocating Pumps for Boiler Feed by T. J. Bode; Types of Condensers and Their Economy by B. P. Stockwell and Boiler Explosions by C. D. Reasor.

May 7. The following officers were elected for the ensuing year: Geo. L. Barker, chairman; E. K. Warterfield, secretary and Theo. J. Bode, treasurer.

Talks were given on the following: Keokuk Power by B. P. Stockwell, Sioux and Fox Indians by Don Whistler and Emergency Motor-Truck Driving by E. H. Reeves.

B. P. Stockwell,
Branch Secretary.

UNIVERSITY OF PITTSBURGH

John F. Baker, the president for next year, delivered a brief talk on the aims of the Engineering Society for next year. An interesting address was then delivered by S. H. Orr on The Conditions Affecting the Coal Supply for Next Winter. Several valuable suggestions were made on the conservation of the fuel supply and the efficient operation of power stations. After discussion by the various members of the Branch the rest of the meeting took the form of a social.

John H. Allison,
Branch Secretary.

RENSSELAER POLYTECHNIC INSTITUTE

April 11. The following officers were chosen for next year: Robert I. Todd, chairman; James F. Dewey, vice-chairman; Chester G. Bragaw, secretary and Justin L. Smith, treasurer.

Professor Greene gave an illustrated talk on Mechanical Stokers showing the various types of stokers in general use.

Professor Daugherty then delivered a talk on Photography, explaining in detail the development of the camera from the pinhole type to its present form and by means of blackboard diagrams illustrated the different lenses and their defects.

Chester G. Bragaw,
Branch Secretary.

STEVENS INSTITUTE OF TECHNOLOGY

The following officers were elected for the ensuing year: G. H. Spencer, chairman; H. E. Beaven, vice-chairman and L. V. Aquadro, secretary-treasurer.

Lincoln V. Aquadro,
Branch Secretary.

UNIVERSITY OF WASHINGTON

May 14. The election of new officers was held with the following results: Fairman B. Lee, chairman; Corwin P. Rummel, vice-chairman; Ernest E. Bissett, secretary; Thomas R. Gunn, corresponding secretary and Lester R. McLeod, treasurer.

H. B. Sallee,
Branch Secretary.

ROLL OF HONOR

Angell, Harry J., Candidate, Engineer Reserve Officers' Training Camp, Camp Lee, Va.

Bernard, Harold E., Coast Artillery Corps, N. A.

Blake, A. D., Captain, Ordnance Officers' Reserve Corps, Engineering Bureau, Ordnance Dept., U. S. Army.

Boyer, George H., First Lieutenant, Ordnance Officers' Reserve Corps U. S. Army.

Blakeman, S. P., Private, 34th Squadron, 3d Prov. Regiment, Science and Research Division, Aviation Section of the Signal Corps, Waco, Tex.

Bosnian, Luther H., Sergeant, Ordnance Department, U. S. Army, Watervliet Arsenal, N. Y.

Brown, Claude C., Master Engineer, Senior Grade 434th Engineers, Camp Kearny, Cal.

Clarke, Leon L., Captain, Engineer Officers' Reserve Corps, American Expeditionary Forces, France.

Corey, Thomas H., Lieutenant, U. S. Naval Reserve Force.

Durban, Thomas E., Major, Ordnance Officers' Reserve Corps, Ordnance Department, U. S. Army.

Durley, Richard J., Captain, British Army, Imperial Ministry of Munitions, Ottawa, Canada.

Fellers, William M., Lieutenant (Junior Grade), U. S. Naval Reserve Force, Aeronautic Aide, Naval Air Station, Hampton Roads, Norfolk, Va.

Flewelling, Milton F., Candidate, Officers' Training School, Naval Auxiliary Reserve, Naval Training Station, Pelham Bay Park, N. Y.

Haines, Philip G., Co. E, 112th Regiment, U. S. Engineers, American Expeditionary Forces, France.

Hathaway, H. K., Lieutenant-Colonel, Ordnance Department, N. A.

Hayward, H. S., Lieutenant (Junior Grade), U. S. Naval Reserve Force.

Hill, Dudley M., Private, Co. 4, Coast Artillery Corps, Fort Howard, Md.

Hoffman, J. Roy, Aviation Section of the Navy, Massachusetts Institute of Technology, Boston.

Hoyt, Frank W., Lieutenant, Co. C, 6th U. S. Engineers, American Expeditionary Forces, France.

Jarrett, Hillard W., Chief Quartermaster, Naval Aviation, Inspection duty, U. S. Navy.

Kemble, Parker H., U. S. Marines.

Lance, C. C., Lieutenant, Engineer Officers' Reserve Corps, Co. 5A, Engineer Reserve Officers' Training Camp, Camp Lee, Va.

Le Valley, John R., Ensign, U. S. Naval Reserve Force, Annapolis, Md.

Malone, George B., Captain, Engineer Officers' Reserve Corps, 1st Regiment Replacement troops, Engineers School, Washington Barracks, Washington, D. C.

Magill, F. R., Sergeant, School of Motor Transportation, Camp Holabird, Baltimore, Md.

Matthew, Robert M., Private, Co. A, 30th Regiment Engineers, American Expeditionary Forces, France.

Moody, Frederick H., Captain, Infantry Depot, 116th Battalion, Canadian Infantry, England.

Morrison, Barrett W., Sergeant, Battery A, 1st Battalion, 1st Brigade, Field Artillery, Camp Jackson, S. C.

Newby, H. L., Private, Aviation Section of Signal Corps, Aviation Camp, Waco, Tex.

Nicoll, William L., First Lieutenant, Quartermaster Officers' Reserve Corps, office of Director of Storage and Traffic, Washington, D. C.

Penrod, E. B., Meteorological Section, Signal Corps, U. S. Army.

Pettis, John G., Chief Machinist's Mate, Aviation Section, U. S. Navy.

Poirier, Austin E., First-class Private, Meteorological Section of the Aviation Section of the Signal Corps, 3d Regiment, 33d Squadron, Waco, Tex.

Porter, Raymond E., Aviation Section of Signal Corps, U. S. Army, assigned to the Aviation Course, Massachusetts Institute of Technology.

Ritter, Ralph B., Second Lieutenant, Field Artillery, National Army, Camp Jackson, S. C.

Rowe, Harold E., Private, Troop B, 303d Cavalry, Camp Stanley, Tex.

Russell, Troy, Private, Co. C, 341st Machine Gun Battalion, 89th Division, American Expeditionary Forces, France.

Semans, F. Wendell, Second Lieutenant, Aviation Section, Signal Officers' Reserve Corps, Ellington Field, Houston, Tex.

Spencer, O. G., Captain, 9th Battalion, 20th Engineers, American Expeditionary Forces, France.

Spice, C. G., Captain, Ordnance Officers' Reserve Corps, Gun Division, Washington, D. C.

Viedt, H. B., Candidate, Officers' Training School for Steam Engineers, Naval Auxiliary Reserve, Naval Training Station, Pelham Bay Park, N. Y.

Voos, Fred W., Cadet, Officers' Artillery Training School, American Expeditionary Forces, France.

Wade, Alfred D., Headquarters Troop, 78th Division, Intelligence Section, American Expeditionary Forces, France.

Wainwright, A. V., Lieutenant, U. S. Naval Reserve Force, Bureau of Steam Engineering, Navy Department.

PERSONALS

In these columns are inserted items concerning members of the Society and their professional activities. Members are always interested in the doings of their fellow-members, and the Society welcomes notes from members and concerning members for insertion in this section. All communications of personal notes should be addressed to the Secretary, and items should be received by July 15 in order to appear in the August issue.

CHANGES OF POSITION

Royce L. Beers has severed his connection with the U. S. Radiator Corporation, of Detroit, Mich., to enter the engineering department of the Bailey Meter Company.

George A. Armes, formerly engineer-in-chief, Union Iron Works Company, San Francisco, Cal., has become associated with the Moore Shipbuilding Company, Oakland, Cal.

Charles D. Cross has entered the employ of the Machinery Utilities Company, Inc., New York. He was until recently connected with the N. Y. C. R. R. Company, New York, in the capacity of assistant night foreman.

Burt C. Wear, formerly identified with the Tube Company, Lorain, Ohio, in the capacity of estimator, has become affiliated with the ordnance department of the U. S. S. Corporation, Ambridge, Pa.

George P. Sonn, until recently engineer with the Bridgeport Brass Company, Bridgeport, Conn., has accepted a similar position with the National Conduit and Cable Company, Hastings, N. Y.

L. K. Sillcox has assumed the position of master car builder of the Milwaukee Shops of the Chicago, Milwaukee and St. Paul Railway Company. He was formerly mechanical engineer with the Illinois Central Railroad, Chicago, Ill.

Norman G. Reinicker is no longer connected with the New York Edison Company, as assistant to chief engineer, having become associated with the power department of the Du Pont Engineering Company at Nashville, Tenn.

K. M. Irwin has resigned his position with the betterment division of the Stone and Webster Engineering Corporation, Boston, Mass., to take a position with Perry Barker, fuel engineer of the same city.

Harry V. Hunt, until recently general superintendent of the Consolidated Press Company, Hastings, Mich., has assumed the duties of general manager of the O'Neil Iron Works, Buffalo, N. Y.

Arthur S. Robinson has left the employ of the Hyatt Roller Bearing Company, Harrison, N. J., and has become affiliated with the Naval Aircraft Factory, League Island, Philadelphia, Pa., in the capacity of engineer.

Maurice F. Richardson, formerly plant manager of the Arlington Company, has assumed the position of manager of the Easton Car and Construction Company, Eason, Pa

Henry Cave has left the employ of the Davis Bournonville Company, Jersey City, N. J., where he held the position of director of technical research, and has become production manager of the S. K. F. Ball Bearing Company, of Hartford, Conn

William A. Drewell, superintendent of the M. T. Davidson Company, Brooklyn, N. Y., has assumed the duties of vice-president and general manager of the Providence Engineering Corporation, Providence, R. I.

Raymond A. Coll, formerly engineer with Robert T. Pollock Company, Boston, Mass., has entered the employ of the Colt's Patent Fire Arms Manufacturing Company, Hartford, Conn., in the capacity of engineer in the machine-gun department.

Sidney C. Singer, formerly superintendent of distribution, Syracuse Lighting Company, Syracuse, N. Y., has become associated with the Omaha Gas Company, Omaha, Neb.

Irwin H. Benny has resigned his position as superintendent with the A. H. Fox Gun Company, of Philadelphia, Pa., to accept a similar position with the Westinghouse Electric and Manufacturing Company, Lester, Pa.

Palmer St. Clair, formerly affiliated with the E. I. du Pont de Nemours and Company, City Point, Va., in the capacity of experimental engineer, has become identified with the Air Nitrates Corporation, of New York.

Philip M. Guba has resigned his position with the Jones and Laughlin Steel Company, Pittsburgh, Pa., to accept the position of New York sales manager for the Donner Steel Company.

George E. Hagemann, until recently instructor of mechanical engineering, University of Pennsylvania, Philadelphia, Pa., has become affiliated with the Warren Foundry and Machine Company, Phillipsburg, N. J., in the capacity of draftsman and engineer.

Robert H. Wallace has become associated with the Savage Arms Corporation, Utica, N. Y. He was formerly connected with the Alignum Products Company, South River, N. J., in the capacity of factory manager.

S. R. Hunter has resigned as superintendent of the gas-engine department of the Fairbanks Morse Manufacturing Company, Beloit, Wis., to become associated with the American Rolling Mill Company, Middletown, Ohio, as supervisor of production.

ANNOUNCEMENTS

D. W. Brunton, of Denver, Colo., has been elected a member of the U. S. Naval Consulting Board.

Major E. S. Lea, Ordnance Reserve Corps, has been relieved from duty at his own request, after having served for the last year as chief inspection officer of artillery ammunition, at the Frankford Arsenal, and will resume practice as a consulting engineer, specializing on artillery-ammunition inspection and production.

Harold B. Viedt has resigned his position as assistant superintendent of the radium extraction plant of the Radium Luminous Materials Corporation, Orange, N. J., and has entered the Officers' Training School for Steam Engineers, in the Naval Auxiliary Reserve, and is at present stationed at Pelham, N. Y.

Walter V. Turner, manager of engineering of the Westinghouse Air Brake Company, Wilmerding, Pa., has had the degree of Doctor of Engineering conferred upon him by the University of Pittsburgh, at their annual commencement, in recognition of his valuable services to the engineering profession and to humanity.

George M. Brill has recently resigned his commission as Major in the Ordnance Reserve Corps to take up the general matter of Requirements for the Emergency Fleet Corporation. He will continue to be located in Washington, since his duties necessitate the maintenance of a number of points of contact with other war activities, such as army, navy, railroad administration, allied purchasing, etc., in the joint study of all requirements for the purpose of avoiding interference and maintaining equilibrium between Supply and Demand.

Louis A. de Cazenove has assumed the duties of chief engineer of the National Tractor Company, and supervising engineer of the French American Constructive Company.

George F. Pettinos has severed his connections with the firm of Pettinos Brothers, Philadelphia, Pa., which he established in 1892, and is now in busines for himself, following the same lines of business, namely, foundry supplies, iron and steel, molding sands and gravel, and graphite, both foreign and domestic.

Harry C. Wootton has become associated with the Nordyke and Marmon Company, of Indianapolis, Ind.

Walter F. Wells, vice-president and general manager of the Edison Electric Illuminating Company of Brooklyn, has been elected president of the National Electric Light Association.

Tufts College has conferred the honorary degree of Doctor of Science upon **Major Ralph D. Mershon**, a member of the Naval Consulting Board and formerly assistant professor at Ohio State University.

Arthur B. Babbitt, who for the past six years has been head of the Department of Drawing and Design at Wentworth Institute, Boston, Mass., has resigned that position to become general manager of the Kent Machine Company, Kent, Ohio.

E. O. Estwing has resigned the position of management engineer with the Remington Typewriter Company, for a position as production manager with the Free Sewing Machine Company, Rockford, Ill.

Milton F. Flewelling, Jr., has resigned as chief draftsman of the Ashton Valve Company, Boston, Mass., and has enlisted in the United States Navy.

APPOINTMENTS

O. R. Randolph has been appointed engineer inspector for the State Corporation Commission of Virginia.

Harry Himelblau has been appointed representative of the Baltimore territory for the American Steam Conveyor Corporation.

E. Logan Hill, of New York, has been appointed secretary of the United States Shipping Board Commission on Port and Harbor Facilities. Mr. Hill was formerly assistant to the general manager of the Erie Railroad and affiliated lines, and was granted leave of absence from June 10 to serve on the above commission, which was appointed for the purpose of improving port and terminal facilities to the end that ships may be unloaded, repaired, bunkered and reloaded with the minimum loss of movement and time.

Prof. D. S. Kimball, of Cornell University, has been appointed acting president of Cornell University during the absence of President Schurman, who will shortly sail for France, where he will address the soldiers in the camps.

NECROLOGY

CAPTAIN OSCAR JOHN MAY

Oscar John May, Captain in the Signal Corps, United States Army, died on May 22, 1918, at the Washington Sanitarium, Takoma Park, Washington, D. C.

Captain May was born on May 15, 1878, in Chicago, Ill., and was educated in that city and graduated from the Lewis Institute. From 1900 to 1911 he worked with E. B. Ellicott, electrical engineer for the Sanitary District of Chicago, in various capacities—as operating engineer, constructing engineer and as superintendent of the Sanitary District Power House, Lockport, Ill. As superintendent he installed two of the 6000-hp. hydraulic turbines and generators with the necessary electrical equipment, having under his direction a large force of lubrication engineers for the development of advanced lubrication practice. He was next associated with the Texas Company, first as operating and testing engineer, and later as chief engineer of the Chicago district, supervising practical testing and research work on lubricants. In 1914 he was made assistant superintendent of the company and given charge of the designing and rearranging of mechanical conditions directly affected by lubrication.

Captain May entered the Service in June 1917 as a captain in the Engineers' Reserve Corps, and was recommissioned as a Captain in the Signal Corps in November 1917 and was assigned to the Lubrication Department. He had full charge of the experimental work necessary in the preparation of specifications covering lubricating oil for aeronautic engines, necessitating very elaborate tests at the Washington Navy Yard, where he had under his direction a corps of army and navy engineers. Very important work was also carried on under his personal supervision at the altitude testing laboratory of the Bureau of Standards, where in the first consecutive tests made Captain May stood continuously a watch of sixty-five hours, indicating his remarkable physical endurance and the tremendous interest and conscientious responsibility he felt in the work. He had full charge of the lubrication engineers and oil-house men recently established in the various aviation fields in this country, and also of the special experimental testing work in connection with lubricants and fuel at Dayton, Ohio, and at the various manufacturing plants.

As an indication of the appreciation of Captain May's ability and service he was recommended by the Chief of the Lubrication Department early in February for promotion to the rank of Major.

He was a member of the National Association of Stationary Engineers. He became a member of our Society in 1914.

MATTHEW ANDEN SYKES

Matthew A. Sykes was born on March 26, 1865, in Wallingford, Pa. His early education he obtained in the schools of Delaware County, Pa.; later he took several courses in the evening schools of Philadelphia. He was graduated from The Franklin Institute, his course there being in mechanical drawing.

Fom 1880 to 1890 Mr. Sykes worked with the Baldwin Locomotive Works, Philadelphia, where he first served his apprenticeship and was advanced to the position of contractor and then of foreman on production. For a short period in 1890 he was connected with the Midvale Steel Co., Philadelphia, as foreman in charge of the production work. He left this firm to take a position with Goodell & Waters Co., manufacturers of woodworking machinery in Philadelphia, where he directed the designing and making of tools and planned the work throughout the shop. In 1892 he became foreman with Bement, Miles Co., Philadelphia, and directed the building of special machinery. His next position was with the Sprague Electric Elevator Co., New York, as superintendent of their New York and Watsessing, N. J., plants and of construction on the installation of electric elevators. In 1896 he became superintendent of construction in the New York office of Morse, Williams & Co., Philadelphia, and installed all kinds of hydraulic, electric and belt-power elevators in the metropolitan district. The year 1897 to 1898 he spent with the Metropolitan Electrical Construction Co., on the installation of electric elevators in New York City. In 1898 he became associated with the Otis Elevator Co., New York, as assistant superintendent of construction, installing hydraulic and electric elevators, and for six months was superintendent of construction at the Pittsburgh office of the company. Mr. Sykes left the Otis Elevator Co. in 1905 to become superintendent of construction with the Standard Plunger Elevator Co., Worcester, Mass., of their New York and Toronto offices on the installation of plunger and electric elevators. After six years with this company he was for two years superintendent of construction of the Gurney Elevator Co., and for about a year with the Westinghouse Co., Schenectady, N. Y., as superintendent of their plant manufacturing agricultural machinery, grain separators, steam tractors, locomotive stokers, etc. In 1915 Mr. Sykes accepted a position with the Remington Arms Co., Eddystone, Pa., as superintendent of the division on production work of British rifles. At the time of his death he was superintendent of the erection shop of the Baldwin Locomotive Works, Eddystone, Pa.

Mr. Sykes became a member of the Society in 1917. He died on March 10, 1918.

GOLDWIN STARRETT

Goldwin Starrett was born on September 29, 1874, in Lawrence, Kan. He was graduated from the University of Michigan in 1894 with the degree of B. S. in mechanical engineering and spent the following four years in the office of D. H. Burnham, Chicago, Ill., architect, as architectural draftsman and assistant mechanical engineer. In 1898 he became superintendent and assistant manager in the New York office of the George A. Fuller Co., where he remained for about two years, leaving to take the position of secretary and assistant general manager of the Thompson-Starrett Co., New York. While with this firm he did a vast amount of mechanical work in the construction of commercial and office buildings. In 1904 Mr. Starrett became vice-president of the E. B. Ellis Granite Co., Northfield, Vt., which position he occupied for four years when he became the senior member of the architecural firm of Starrett & Van Vleck, designers of many large and important buildings in New York.

Mr. Starrett was a member of the American Institute of Architects and also of the Architectural League. He became a member of the Society in 1914. He died on May 9, 1918.

CANDIDATES FOR MEMBERSHIP

TO BE VOTED ON AFTER AUG. 10

BELOW is the list of candidates who have filed applications since the date of the last issue of THE JOURNAL. These are classified according to the grades for which their ages qualify them, and not with regard to professional qualifications, i.e., the ages of those under the first heading place them under either Member, Associate or Associate Member, those in the next class under Associate or Associate Member, those in the third class under Associate Member or Junior, and those in the fourth under Junior grade only. Applications for change of grading are also posted. Total number of new applications, 82.

The Membership Committee, and in turn the Council, urge the members to scrutinize this list with care and advise the Secretary promptly of any objections to the candidates posted. All correspondence in this regard is strictly confidential. Unless objection is made to any of the candidates by Aug. 10, and provided satisfactory replies have been received from the required number of references, they will be balloted upon by the Council. Those elected will be notified about Aug. 15.

NOTE. The Council desires to impress upon applicants for membership that under the present national conditions the procedure of election of members may be slower than under normal conditions.

NEW APPLICATIONS

FOR CONSIDERATION AS MEMBER, ASSOCIATE OR ASSOCIATE-MEMBER

Alabama

NAGEL, THEODORE, Resident Engineer, Chemical Construction Co., Sheffield

Colorado

KNOWLES, RALPH R., Superintendent, Construction and Operation, The Ouray Consolidated & Reduction Co., Ouray

Connecticut

HALPIN, JAMES F., Superintendent, Tube and Rod Mills, Bridgeport Brass Co., Bridgeport

Illinois

GOTTSCHAL, CHRISTIAN M., Chief Designer, The Service Machine Corporation, Chicago

THALEG, OSCAR E., District Sales Manager, P. & M. Dept., Worthington Pump & Mchy. Corp., Chicago

PLAGWIT, ERIC, Treasurer and Secretary, The Heine Chimney Co., Chicago

WILLARD, DONALD E., Vice-President and Secretary, Decatur Malleable Iron Co., Decatur

Indiana

CLINE, BENJAMIN J., General Superintendent, Aeroplane Eng. Division, Nordyke & Marmon Co., Indianapolis

Maryland

DEDMAN, BRYANT, Engineer, Poole Engineering & Machine Co., Baltimore

Massachusetts

DOOLITTLE, FRED E., Superintendent, Knox Motors Company, Springfield

KIRMES, EDWIN W., Engineer with Walworth English Flett Co., Boston

LIVERMORE, JOSEPH P., Giving advice and testifying as mechanical expert in patent litigation, Boston

OSGOOD, HARRY E., Sales Engineer, Sanford Riley Stoker Co., Worcester

PICKELS, ROBERT F., Proprietor, Watts Regulator Co., Lawrence

PRARAY, CHARLES W., Mill Engineer and Architect, New Bedford

SAWTELL, WILLIAM H., Superintendent, Worcester Shock Absorber Co., Worcester

STETSON, GEORGE W., Sales Agent, Power Plant Equipment, Boston

WAITE, LORENZO E., General Superintendent of Becker Milling Mch. Co., Boston

WICKSTROM, HANS, Grinding Machinery Salesman, Norton Grinding Co., Worcester

Missouri

KEY, FRED, Vice-President and General Manager, Key Boiler Equipment Co., St. Louis

SOLOMON, CHARLES R., Chief Draftsman and Designer, United Iron Works Co., Kansas City

WISELOGEL, ROBERT F., Second Vice-President, John Nooter Boiler Works Co., St. Louis

New Hampshire

DOWNTON, CHARLES E., Employment Manager, The Atlantic Corporation, Portsmouth

New Jersey

FINKEN, WALTER S., Resident Engineer, Baker, Smith & Co., Morgan

MACARTHUR, DONALD, Manager, Seaboard By Product Coke Co., Jersey City

SNEDIKER, WALTER J. E., Manager, Ringwalt Linoleum Works, New Brunswick

TAYLOR, KNOX, President, Taylor-Wharton Iron & Steel Co., High Bridge

TRACY, HOMER D., Engineer, Robins Conveying Belt Co., River Edge

New York

CLARKE, VINCENT A., Special Engineer, Niles-Bement-Pond Co., New York

COTTON, HOWARD W., President, H. W. Cotton, Inc., New York

COZENS, ALFRED E., Outside Chief Engineer, Standard Shipbuilding Corp., Shooters Island

FREELAND, WILLARD E., Associate Editor, "The Iron Age," New York

GOBIN, ANDRÉ F., Mechanical Draftsman, U.S. Navy Yard, New York

HATCH, MELLEN C., Assistant to President, Locomotive Pulverized Fuel Co., New York

McCLELLAN, GEORGE F., Inspecting Engineer of public utility properties, Henry L. Doherty & Co., New York

MINER, ROBERT L., Assistant to General Superintendent, The Bossert Corp., Utica

PATTERSON, DUNCAN, Vice-President, Foamite Fire Extinguisher Co., New York

ROBERTS, WILLIAM E., Checker, Wilputte Coke Oven Corp., New York

RODEMEYER, HENRY, Superintendent, Cook Spring Co., New York

TRONELL, EDGAR R., Jr., New York Sales Manager, Spencer Heater Co., New York

VAN FLEET, HERMAN, Engineer in charge, Liquid Air Division, Air Nitrates Corp., New York

North Carolina

WHITE, GILBERT C., Consulting Engineer, Gilbert C. White, Durham

Ohio

SKINNER, ORAMEL H., Engineering Executive, Airplane Engineering Dept., Bureau of Aircraft Production, McCook Field, Dayton

Pennsylvania

BACH, GEORGE W., General Manager, Union Iron Works, Erie

BRAMWELL, JOSEPH W., Manager, Boston Office of American Bronze Corporation, Berwyn

McGINN, Michael J., Superintendent, American Insulation Co., Philadelphia

Washington

ABELL, ASHEL C., Assistant Professor of Mechanical Engineering, Washington State College, Pullman

Cuba

DALE, WILLIAM J., Chief Engineer in charge of Power Installations, Minas de Mathahambre, Pinar del Rio

Holland

VAN DIJK, JAN WILLEM, Dr., Managing Director of J. W. Brouwersplein 2, Amsterdam

India

AYEY, HARRY T., Professor, Ewing Christian College, Allahabad

Italy

DE LACOURT, ALBERTO F., Engineer, Conseil de la Societé Ansaldo, Genoa

FOR CONSIDERATION AS ASSOCIATE OR ASSOCIATE-MEMBER

Connecticut

SCHLEIFER, NORMAN H., Secretary, Superintendent and General Manager, Meriden Press & Drop Co., Meriden

New York

SMITH, WILLIAM H. C., Sugar Machinery Engineer, Buyer, W. R. Grace & Co., New York

Pennsylvania

BARKLEY, JOHN F., Assistant Efficiency Engineer, Carnegie Steel Co., E. T. Works, Braddock

EBY, SAMUEL E., Master Mechanic, American Steel Films, care of Thurlow Works, Chester

HEIMPEL, EARL F., Assistant M. M. of Rolling Mill, Bethlehem Steel Corp., Bethlehem

FOR CONSIDERATION AS ASSOCIATE-MEMBER OR JUNIOR

California

KITSON, FRANK C., Junior Engineer with the U.S. Shipping Board, Emergency Fleet Corporation, San Francisco

Connecticut
GLEDHILL, THOMAS, Foreman Dept. M.E.T.L., Remington Arms U.M.C. Co., Inc., Bridgeport

Illinois
NEWTON, LEONARD V., Supervision of Equipment, The Texas Co., Chicago
MADISON, RICHARD D., Chief Draftsman, Indianapolis Office, Ordnance Engineering Bureau, Indianapolis

Maryland
BUSTOS, ENRIQUE, Assistant Engineer, Mechanical Engineer, Baltimore Copper Works, Baltimore

Massachusetts
ARMOUR, WILLIAM W., Vice-President and Superintendent of Armour's Pattern Shop Co., Worcester
STEVENS, HAROLD F., School Teacher, Junior Master, Hyde Park High School, Hyde Park

New York
BEWLEY, WILLIAM E., Manager, Inter-Continental Machinery Corporation, New York
CALDWELL, WILLIAM E., Chemist, The United Electric Light & Power Co., New York
FELLOWS, OLIN B., Vice-President, Ideal Wrapping Machine Co., Middletown

Pennsylvania
PRUDDEN, THEODORE M., First Lieutenant, Ordnance Department, R.C., Frankford Arsenal, Philadelphia
SLEEMAN, EARL C., Chief Draftsman, Monessen Plant, Pittsburgh Steel Products Co., Monessen

Wisconsin
KNOCKE, LOUIS T., Testing Engineer, Waukesba Motor Co., Waukesha

FOR CONSIDERATION AS JUNIOR

Alabama
HARTLEY, ALBERT O., Special Engineering work for Capt. C. G. Landes, U.S. Nitrate Plant, No. 1, Sheffield

Colorado
JOHNSON, EDWIN C., Student graduate Colorado Agricultural College, Denver

Connecticut
BISHOP, WILLIAM R., Junior Engineer, Gage Dept., Remington Arms,
McKEON, E. JAMES, Designing Draftsman, Remington Arms Co., Bridgeport
MOORE, HENRY H., Tool designer, Liberty Ordnance Co., Bridgeport

District of Columbia
EICHLER, EDWARD, Aeronautical Designer, Bureau of Construction & Repair, Navy Dept., Washington

Illinois
VONACHEN, FRANK J., 2d Lieutenant, Ordnance Dept., N.A., Rock Island Arsenal, Rock Island

New York
BAKER, ROLAND H., Ensign, U.S.N.R.F., U.S.S. Mt. Vernon, New York
MERCNER, RAYMOND O., Designing (Research Design), Western Electric Co., Inc., New York

Ohio
KNOX, CARLOS C., Assistant Inspector of Engineering Material, U.S.N., Cleveland
SNYDER, HOMER R., Foreman at The Hess-Snyder Co., Massillon

Pennsylvania
MARQUARDT, WILLIAM C., Assistant Superintendent, Nelson Valve Co., Philadelphia
UHLENHAUT, FRITZ, III, With Duquesne Light Co., Pittsburgh

Texas
ELSEY, GEORGE W., 2d Lieutenant, R.M.A., A.S.S.R.C., Camp Dick, Dallas

APPLICATIONS FOR CHANGE OF GRADING

PROMOTION FROM JUNIOR

Colorado
KRAEMER, MILTON, Consulting Engineer and General Manager, Standard Potash Co., Senior Member of Firm Kraemer & Schwarz (Reinstatement), Denver

Georgia
GREEN, JOHN S., Superintendent, Southern Iron & Equipment Co. (Reinstatement), Atlanta

Massachusetts
GIFFORD, GEORGE N., Assistant Plant Engineer, American Printing Co., Fall River
PEPPER, CHESTER L., Agent in charge of Industrial Education, Mass. Board of Education, Boston

New York
MONTAGUE, CHARLES E., Mechanical Engineer, The Engelberg Huller Co., Syracuse
ROBBINS, WALTER C., Motor Engineer, Curtiss Aeroplane & Motor Corp., Buffalo

Canada
CARISS, CARINGTON C., Superintendent, 4.5-in. Shell Dept., Waterous Engrg. Wks. Co., Ltd., Brantford, Ontario

PROMOTION FROM ASSOCIATE-MEMBER

Minnesota
BJORGE, OSCAR B., Chief Engineer, Clyde Iron Works, Duluth

New York
STAEGE, STEPHEN A., Consulting Hydraulic and Electrical Engineer, Light & Power Building, Watertown

SUMMARY

New applications	82
Applications for change of grading	—
Promotion from Associate-Member	2
Promotion from Junior	7
Total	91

EMPLOYMENT BULLETIN

THE SECRETARY considers it a special obligation and pleasant duty to make the office of the Society the medium for assisting members to secure positions, by putting them in touch with special opportunities for which their training and experience qualify them, and for helping any one desiring engineering services. The Society acts only as a clearing house in these matters.

GOVERNMENT POSITIONS

Stamps should be inclosed for transmittal of applications to advertisers; non-members should accompany applications with a letter of reference or introduction from a member; such reference letter will be filed with the Society records.

Members applying in person for Government positions at such places as Navy Yards should invariably make appointments beforehand by letter, telephone or telegraph, and arrange to have passes or the equivalents so that they can gain entrance. In this way they will avoid disappointment.

TECHNICAL WRITERS to visit colleges and technical schools and write up courses to be used by the Government in the training of about 90,000 men during the coming summer months. 2620.

HIGH-GRADE EXECUTIVE for ship-construction plant in the South; capable of assuming responsibility for oversight of new construction both for wood and cement ships and supervision of the operation of the property under the direction of a president or general manager. Company is prepared to pay generous salary to right man and will consider giving him an interest in the property if he demonstrates his ability. 2621-A.

ASSISTANT to the above executive. 2621-B.

STATISTICIAN for Fuel Administration to keep records of events in Washington, to design and organize the Statistics Department for his work, to keep records of State operations and present these facts graphically. Location, Washington. 2622.

FOUR MEN FOR FUEL ADMINISTRATION; technical education not essential; of pronounced executive ability to take charge of a group of five States and report their affairs to Washington. 2623.

SUBMARINE FORCE, U. S. NAVY. It is desired to call the attention of young men who have had technical training and experience to the fact that their abilities can best be put at the service of the country by selecting a branch of service in which their special qualifications will be of the greatest use.

The Submarine Force of the United States Navy requires the services, as officers on board submarines, of young men who have had technical training in mechanical and electrical engineering and who have had experience in these professions. It is intended to enroll a number of such men as provisional ensigns in the Naval Reserve Force, give them a course of instruction in deck duties at Annapolis and a course in submarine work at New London. Those who successfully pass these courses will then be sent on board submarines for regular duty.

It is requested that any men who desire this duty and who are qualified as below outlined send their names and addresses to

c/o Commander Submarine Force, U. S. S. *Chicago*, care of Postmaster, New York.

Qualifications required: Desire to serve in submarines; degree of M.E., E.E., or E.M.; two and a half years of practical experience in profession; not over 35 years old; physically strong and sound.

Candidates should, if practicable, receive the indorsement of one of the following organizations: Naval Consulting Board; National Research Council; American Society of Mechanical Engineers; American Institute of Electrical Engineers; American Institute of Mining Engineers.

Conant Taylor,
Lieutenant-Commander, U. S. Navy,
Senior Member.

By direction Commander Submarine Force, U. S. Atlantic Fleet. 2624.

CIVILIAN POSITIONS

MECHANICAL ENGINEER for large eastern Massachusetts company, as assistant in physical testing laboratory, competent to take entire charge of this work at an early date. Man of good personality and diplomacy, as part of his work will be investigating conditions in outside plants offering recommendations as to the proper adaptation of our product and assisting salesmen with the bigger propositions. Salary commensurate with experience and demonstrated ability. 0358-G.

DRAFTSMEN, general and mechanical with structural experience. Salary, $135. Location, New Jersey. 0359-G.

SALESMAN on sugar machinery. Expert in operation. Location, Tukaman, Argentine, South America. Salary, $5,000. 0360-G.

ONE MECHANICAL AND ONE ELECTRICAL ENGINEER, preferably married men without children, for positions at sulphur refining factories at Marseilles and Cette, France. Men able to transact business in French. No one with German blood or connections need apply. 0361-G.

INSTRUCTOR in mechanical drawing and possibly some mathematics, for a University on Pacific Coast. Work to begin about the first of October. Salary, $1,200. 0362-G.

ASSISTANT TO GENERAL MANAGER. Must have shop and office experience; preference given to applicant experienced in scientific management methods or in manufacture of paper or its products. State experience, references, age, salary, and when available. Location, New England. 0363-G.

SALES ENGINEERS, men familiar with furnace and boiler operation and refractories to handle high-grade furnace specialties; fine opportunity for right man. Location, Eastern or Middle Pennsylvania, New York State, Connecticut or Indiana. Salary and commission. 0364-G.

INSTRUCTOR IN MECHANICAL ENGINEERING in recently established department of well known University. College graduate with some experience in machine design or with internal-combustion engines desired. Salary depends on man engaged. Location, Maryland. 0365-G.

DRAFTSMEN to work out surveyor's maps. Location, New Jersey. Salary depends on man. 0366-G.

YOUNG ENGINEERS FOR OFFICE OF CONSULTING ENGINEER in Pittsburgh; office work, operation and investigation of public utilities. Salary $20 to start. 0367-G.

MATERIAL CHECKERS, young men to check up material for shipment and on receipt at plant, follow distribution to proper departments. Location, Alabama. Salary about $125 a month. 0368-G.

DRAFTSMEN, checkers on industrial plant layouts, elevating and conveying machinery, piping, etc. Headquarters, New York. Salary $30 to $40. 0370-G.

INSPECTORS accustomed to receiving engineering material. Salary $125. Headquarters, Plant at Muscle Shoals, Alabama. 0371-G.

SUPERINTENDENT, man with executive experience capable of handling mechanics. Location, Niagara Falls, N. Y. Salary, $350. 0372-G.

FILE CLERK, to have charge of files, record of blue prints, distribution and filing. Salary $30. Headquarters, New York. 0373-G.

FILE CLERK FOR DRAFTING ROOM RECORDS. Salary $25. Headquarters, New York. 0374-G.

MECHANICAL ENGINEER, technical graduate with chemical laboratory experience, if possible. Salary, $150. Location, New York. 0375-G.

MECHANICAL DRAFTSMAN, preferably one with experience in hydraulic machinery. Salary depends on man. Headquarters, New York. 0376-G.

DRAFTSMEN, experienced in power-house design and equipment, also foundation and structural works. State age, nationality, and salary expected. Location, New York. 0377-G.

TESTERS AND INVESTIGATORS for large New York company. Work on gas-fired boilers, gas engines, gas heaters, etc. Salary, $20 to $25. 0378-G.

INSTRUCTOR in machine design. Opening in Eastern Institution for M. E. graduate with two or three years' experience on machine design. Give full record. 0379-G.

INSPECTOR OF MECHANICAL AND ELECTRICAL EQUIPMENT. Technical graduate preferred. Salary, $110 to $120. 0381-G.

DRAFTSMEN on power-house layout, and piping. Salary depends on man. Location, New York. 0382-G.

TECHNICAL GRADUATE, man over 30 years of age for estimating and engineering work in general sales department of concern manufacturing large power plant equipment. Salary depends on man. Location, New York City. 0383-G.

DRAFTSMAN on marine-engine work in factory having large Government contract. Permanent employment for right man. One having oil-engine experience preferred. Location, New York State. 0384-G.

DESIGNER, mechanical engineer for work in connection with development of new chemical plant. Knowledge of chemical industry valuable. Location, Philadelphia. 0385-G.

SHIPBUILDING DRAFTSMEN. Salary, $35 to $40. Location, Brooklyn, N. Y. 0386-G.

SALES ENGINEER, 24 to 25 years old, exempt or class 4. Good appearance and personality; energetic and willing to work. Must have initiative and be a thinker. College degree and one year shop work on telephone or electrical equipment; or high school education and two or three years shop work as above. Location, New York to travel. Salary about $1,500 to $1,800. 0389-G.

ENGINEERING EDITOR, with mechanical engineering education, some appreciation of the economic side of engineering and some insight into shop management, a liking for writing; good address, and if possible, so-called mixing qualities. Age preferably between 30 and 40 years. Salary depends on his measuring up to these specifications, his experience, and the time needed to make him a producer. He is wanted for one of the most important positions on Engineering Journal of enviable reputation, and his progress will be dependent solely on his ability to make good. 0390-G.

ESTIMATOR wanted by firm doing high grade of work and which offers possibilities of developing to assistant in charge of the department where all estimating work is done. Requires knowledge of general building construction. Location, New York. 0391-G.

MASTER MECHANIC OR PLANT ENGINEER, technical graduate with engineering ability, who has had practical experience along these lines. Location, New Jersey. Salary, $2,500 to $3,000. 0392-G.

DRAFTSMEN on power plants. Location, New York. Salary, $140. 0394-G.

TOPOGRAPHICAL DRAFTSMAN wanted by New York City firm. 0395-G.

MAINTENANCE ENGINEER to take care of all piping and pipe line in plant. 0396-G.

INSPECTOR PIPE COVERING. Salary about $200. 0397-G.

MASTER MECHANIC, with experience in handling men and in repair maintenance and up-keep of mechanical equipment used in chemical plants. 0399-G.

PRODUCTION ENGINEERS for staff of firm located in New York City. 0401-G.

CHIEF ELECTRICAL ENGINEER, experienced in repair and maintenance of electrical equipment. Salary $3,000 to $3,600. Headquarters, Alabama. 0404-G.

TWO MECHANICAL ENGINEERS, with civil-engineering experience if possible, in maintenance of cement, fertilizing and chemical plants, including roads, sewer, water-gas, steam and air lines all sizes and pressures. 0405-G.

FOUR ASSISTANT MASTER MECHANICS, experienced in repair work, maintenance, operation and equipment, as used in cement, fertilizing and chemical plants. Location, Alabama. 0406-G.

TEN FOREMEN familiar with mechanical piping, electrical work, blacksmithing, welding, structural steel, sheet metal, etc., having experience in charge of shops. 0407-G.

COMBUSTION ENGINEER, man familiar with fuel problems, sampling coal, able to make researches, determinations of product, and to handle sampling force of five men. Salary depends upon man. 0409-G.

FOREMAN for sampling department. 0408-G.

COST CLERK to estimate on costs of equipment, appraisal work, etc. Location, Alabama. Salary, $130 to $160. 0410-G.

OFFICE EXECUTIVE for office-cost department, having charge of crane and other machine costs, preparing these for use of sales department in making their estimates and proposals. Man must be steady, reliable, and preferably married. Good accountant and must possess sufficient executive ability to direct four or five others under him and get out the work assigned to him; will be expected to work himself and get into the details of this department. Location, Michigan. 0411-G.

TURBINE MAINTENANCE ENGINEER, man for inspection of turbine and auxiliary equipment and taking charge of the major repairs to apparatus for large power company operating several stations. One with experience with Westinghouse turbine preferred. Location Pennsylvania. 0413-G.

BOILER MAINTENANCE ENGINEER, man for inspection of boilers and boiler-room apparatus. One with construction experience in large boilers preferred. Location, Pennsylvania. 0413-G.

MASTER MECHANIC for large power plant; experienced in repairs and maintenance of large turbo-generators and boilers. Location, Pennsylvania. 0414-G.

ENGINEER to take charge of large generating station, consisting of three 10-kw. General Electric turbo-generators with 8 Stirling boilers equipped with Coxe traveling stokers for burning small sizes of anthracite fuel. Plant has three shifts of 8 hr. each and employs about 100 men. Man to take charge of this station should have considerable executive ability as well as general operating knowledge. Location Pennsylvania. Salary $3500 to $4000. 0415-G.

SUPERINTENDENT for growing concern having machine shop, foundry, pattern shop and blacksmith shop, just starting on attractive specialty, requiring capable superintendent experienced in above lines, and a good systematizer. Excellent opportunity for a young man. Location Michigan. 0417-G.

ASSISTANT ESTIMATOR, man able to take off accurate quantities for mechanical equipment from engineers' drawings, and have fair idea of cost of various machine-shop operations, pattern making, and the installation of steam lines, shafting and general mill equipment. Position will probably last from 1½ to 2 years with good opening later on for capable man. For first few weeks he would be required to help on the quantities for reinforced-concrete buildings, etc. Location Ontario, Canada. Salary $130 to $150 to start. 0418-G.

FIELD INSPECTORS wanted on electrical, plumbing and drainage work. 0419-G.

ENGINEER-DESIGNER on reinforced concrete, light steel construction. Salary $250 up. 0420-G.

DRAFTSMAN of conveying machinery. Salary depends on man. Location New York. 0421-G.

YOUNG TECHNICAL MEN with a few years of practical experience, preferably along executive lines; men with good common sense and tact. Opportunities are innumerable and a good man has chance to advance rapidly. Location Virginia. Salary $150 to $200. 0422-G.

MARINE DRAFTSMEN in connection with piping layouts and machinery arrangements. Location Pennsylvania. Salary according to qualifications. 0423-G.

LABORATORY ASSISTANT in instrument and standardizing laboratory for men of technical ability to carry out research work. Location Massachusetts. 0424-G.

CONSTRUCTION, ARCHITECTURAL and MECHANICAL DRAFTSMEN wanted for Government work connected with the ship-construction program at Philadelphia. Also SQUAD CHIEFS and SPECIFICATION WRITERS. 0425-G.

TECHNICAL GRADUATE with considerable practical training and experience. Man abreast of the times, with respect to the developments in the design and application of machinery; capable of supervising the design and manufacture of special tools and equipment; up-to-date in modern machine-shop practices and who possesses executive ability of a high order. Age 35 to 38 years. Location New York State. 0428-G.

POWER PLANT ENGINEER, must be familiar with modern boiler-room practice. Location Pennsylvania. 0429-G.

MECHANICAL DRAFTSMEN on Government Shipyard work near Philadelphia.

CONSTRUCTION ARCHITECTURAL DRAFTSMEN on heavy steel and concrete work. State salary expected, age, experience, and when available. 0430-G.

PRODUCTION ENGINEER for concern manufacturing gages, fixtures and cutters to speed up deliveries of shop doing war work. Give past experience and salary expected. 0431-G.

INSTRUCTOR in mechanical engineering, to teach descriptive geometry, machine drawing, some laboratory work, and elementary steam engineering. Salary $1500 per year. Location Ohio. 0433-G.

YOUNG MAN not subject to draft in very near future. Mechanical training not necessary, but must have a fair knowledge of drafting. Immediate chance of advancement. Salary $75 to $100 per month to start. 0436-G.

CIVIL ENGINEER with knowledge of mechanics; good instrument man experienced in the execution of plans, laying out buildings, following out plan work, concrete work, construction, steel work, trestles, etc. Should be able to follow construction of bridges, sewers, roads and mill machinery. Location Canada. 0437-G.

ENGINEER IN CHARGE OF DIVISION OF CONSTRUCTION AND DESIGN for New York office of chemical plant. 0438-G.

ASSISTANT PURCHASING AGENT for chemical plant in New York City. Some travelling. 0439-G.

PRODUCTION MANAGER familiar with, and experienced in factory production. Location Alabama. 0440-G.

EXECUTIVE REPRESENTATIVE. Man to attend to affairs in Washington and report back to head office. 0441-G.

GENERAL CONSTRUCTION ENGINEER AND EXECUTIVE wanted as general assistant to the resident manager. Salary $7500. Location Alabama. 0446-G.

OFFICE MANAGER for resident manager in the field. Salary $3000. Location Alabama. 0447-G.

GENERAL CONSTRUCTION AND EQUIPMENT ENGINEERS on staff of resident manager. Works or equipment engineer, no chemistry necessary. Salary $2400 to $3600. 0448-G.

ASSISTANT SUPERINTENDENT of construction of coal, lime and coke plant. Salary $225. Location Alabama. 0449-G.

ASSISTANT SUPERINTENDENT of construction of carbide and lime-nitrogen plants. Salary $225. Location Alabama. 0450-G.

ASSISTANT SUPERINTENDENT of construction on liquid-air plant. Man familiar with erecting air compressors, high-pressure piping, etc. No technical knowledge of liquid-air works required. Salary $225. Location Alabama. 0451-G.

ASSISTANT SUPERINTENDENT of construction of nitrate plant. Some knowledge of nitrate plants and equipment desirable, but not essential. Salary $225 Location Alabama. 0452-G.

ASSISTANT SUPERINTENDENT of construction of nitric-acid plant. A comprehensive knowledge of nitric-acid work highly desirable, and a fair working acquaintance essential. Salary $225. Location Alabama. 0453-G.

ELECTRICAL AND MECHANICAL ENGINEERS for plant-layout work. Temporary employment. Location New Jersey. 0454-G.

TESTS ENGINEER, man experienced in the operation of boilers, engines, etc. Work covers testing and investigations in steel mills in western Pennsylvania, Ohio, West Virginia, and Indiana. 0455-G.

PRODUCTION ENGINEER for large established New England manufacturer of mechanics' hand tools; high-grade man with executive qualifications. Must be technical graduate with successful factory and labor experience, possess initiative and be familiar with modern methods of producing mechanics' hand tools and kindred products under favorable and profitable conditions, and generally competent to meet with diplomacy all wage and product problems. Man of 35 to 40 years of age preferred State age, experience, salary expected, and when available. 0456-G.

DRAFTSMAN, 19 to 30 years of age; man who can think as well as work; the more education the better. A few years' training, preferably in shop and drawing room on medium or heavy machinery. No instrument makers or electricians wanted Location, Newark, N. J. Salary about $100. 0388-G.

DETAIL EQUIPMENT SUPERINTENDENT for carbolite furnaces and electrode shop. Maximum salary $250. 0398-G.

TESTS ENGINEER, 25 to 38 years old, aggressive, analytical mind, worker Complete technical foundation, college graduate. Must be trained in responsible engineering work, preferably along testing and research lines, either mechanical or electrical. Location Newark, N. J. Salary about $200. 0387-G.

MECHANICAL-LABORATORY ASSISTANTS and DRAFTSMEN required for important war work in development of parts for sheet metal, fabric and rubber. Graduates from manual-training schools with one or two years' shop experience or one or two years in an engineering school. Enclose photograph, state age, give references, position in draft and willingness to enlist or be induced in the army for work of this nature. 0459-G.

[illegible] AVAILABLE

[illegible] society are listed in [illegible] the [illegible] band by the 12th of [illegible] should be [illegible] cards indicate the [illegible] not repeated in [illegible]

MECHANICAL ENGINEER, age 34, married, college graduate, 15 years experience, employed [illegible] seeking for greater possibilities than present position offers. Will be glad to consider one requiring initiative and organization ability along executive lines. Correspondence with firms desiring to be represented in Washington especially invited. G-177.

EXECUTIVE ENGINEER SALES OR DISTRICT MANAGER. Eastern territory preferred account of large acquaintance here. 12 years experience handling power-plant equipment and power-transmission machinery. Graduate mechanical engineer, can show record as to results and ability to get business; ten years in last position with concern of national reputation. G-178.

MECHANICAL ENGINEER, Member, technical graduate, age 39, desires position as engineer or chief draftsman. Expert in design of high-power hydraulic turbines, governors, etc., also shop practice, layout of power plants and design of general machinery. One year's experience in a testing laboratory for machinery and material. G-179.

ASSISTANT TO PRESIDENT OR GENERAL MANAGER of a manufacturing company desired by a resourceful and successful executive mechanical engineer with broad industrial experience in factory layouts, equipment and management. Complete record on request. G-180.

PRODUCTION OR PRODUCTION EQUIPMENT ENGINEER, mechanical superintendent or assistant or other responsible position on either designing or manufacturing end or both. Must be war work. Salary about $4000. Would like to correspond with party needing self-starting man for above positions. Have successfully held them and am also practical mechanic and designer. Experience covers originating, designing, building and operating numerous special and standard automatic and semi-automatic machines for producing a wide variety of articles from wire, sheet metals, paper, wood, etc., for assembling, labor saving, processing, conveying, cost reducing, etc. Punches and dies, jigs, fixtures and tools and general engineering. Also routing, cost accounting, bookkeeping, time study and production. Will finish contract on non-essential work and be available shortly. Prefer place where the position is big and difficult and with after-the-war prospects. Am an American, 28 years old, married with family, draft exempted. Will go anywhere. G-181.

EXECUTIVE ENGINEER; American; 35 years of age, married; University graduate; general engineering experience; four years electrical and mechanical consulting office, one year construction draftsman, four years chief designing engineer for large public utility holding corporation in charge of design, materials and construction. At present employed as assistant works engineer [illegible]. Easily adaptable to con[illegible] and ambitious. Will con[illegible] reliable [illegible] in [illegible] organization. Central location preferred. G-182.

MECHANICAL [illegible], Junior Member, age 28, [illegible] draft. Technical graduate with [illegible] experience along mechanical and [illegible] lines in manufacturing and [illegible] a large manufacturing plant. [illegible] position offering good opportunities [illegible] preferably located in Chicago or the Middle West. G-183.

A COMPETENT FOUNDRY MAN will be available June 1. Capable of handling any foundry position; has had vast experience in handling complicated foundry work and can give satisfactory reasons for wanting to change position. G-184.

EXPERT INDUSTRIAL EDUCATION AND SAFETY ENGINEER. Graduate Massachusetts Institute of Technology, mechanical engineering, 1911, 29 years of age, married, in Class IV of the draft. Have three and a half years' experience as factory inspector, fire protection and safety engineer. For last four years have had charge of all day and evening industrial education for men and boys in largest manufacturing state in the country. Can furnish highest credentials. Desire position of greater responsibility. Salary $3500 or over. Location in New England preferred. G-185.

ASSOCIATE MEMBER, with 20 years' experience in designing, constructing and operating power plants, sub-stations, pumping plants, factories, gas-producer plants, etc., also extensive experience designing and constructing electric railway and floating equipment, will be open for engagement about June 15. Competent to assume full charge and to produce results. No objections to office or drafting work. G-186.

SALES AGENT, mechanical engineer, technical graduate, 13 years' experience in selling, designing and estimating, desires to represent high-class manufacturer in New England territory with headquarters in Boston. Best of references. G-187.

EXECUTIVE OR PURCHASING ENGINEER in touch with largest manufacturers of mechanical, electrical equipment and sources of engineering materials; presently engaged along these lines. Wishes connection with opportunities for greater activity. G-188.

MECHANICAL ADVISER AND DEVELOPMENT ENGINEER. Special machine designer, policy investigator, practical and technical education, good organizer and systematizer. Specialist on mechanical efficiency operation. Expert on substituting mechanical devices for hand labor. Past 15 years specializing on designing, developing and manufacturing up-to-date cost-cutting appliances, special equipment, tools and labor-saving devices for manufacturing special product efficiently. Age 35. Associate member. Salary $4800. Desire new connections with large corporation contemplating improving or redesigning its present manufacturing methods where above experience is essential. Location vicinity Newark or New York City. G-189.

MECHANICAL, ELECTRICAL ENGINEER. American, 14 years' practical and theoretical experience in manufacture of engineering specialties, machine tools, shop equipment, power, machinery and shop maintenance, oxy-acetylene, drafting, physical and experimental testing, shop welfare and power-house work. An executive with initiative and aggressiveness. At present employed. Location immaterial. Salary $2800 and expenses. G-190.

EXECUTIVE MANAGER, Member, with experience in designing, manufacturing, installing, estimating and selling of electric, pneumatic and mechanical apparatus. Experienced in the investigation of unsatisfactory methods and conditions and capable of devising and executing efficient remedies. New York or vicinity preferred. G-191.

GRADUATE ENGINEER, with ten years' active and consistent experience in the practice of principles of industrial management; is not an efficiency engineer or cost clerk. Will associate himself with a bank as industrial expert or with large manufacturing enterprise as confidential assistant to president or manager, or will take charge of an executive department but not below works manager. Available July 1. G-192.

EXECUTIVE, MECHANICAL, and ELECTRICAL ENGINEER. Strong technical man on power and power equipment. Has had 12 years' operating and construction experience with large public-utility and manufacturing companies. An exceptional man for a manufacturing or operating company. 35 years of age, and married. G-193.

SALES ENGINEER, mechanical engineering graduate, two years' experience, desires to get in touch with manufacturer in Middle West, having opening in office or in outside work. No continuous traveling desired. Experience in air-compressor work and heat-treatment of metals. Salary $200 jer month. G-194.

GENERAL MANAGER. Graduate mechanical engineer, 40 years old member, at present engaged, desires opening as general manager of manufacturing company in which he can obtain an interest. New England preferred. Twenty years' experience in manufacturing heavy and light machinery, selling and management. G-195.

MECHANICAL ENGINEER, now chief engineer of small concern, desires position with medium or large concern as chief draftsman, head of development work, or other executive position. Experience in general engineering, automatic machinery and machine tools, hydraulic machinery, rubber celluloid manufacture, electrical heating for industrial purposes, quantity manufacture, system and organization generally; some airplane experience. New York, Newark and vicinity preferred. Salary not under $3000. G-196.

MEMBER with broad business and engineering experience here and abroad, American, 45; fully conversant with the principal languages; knowledge of purchasing and selling; tactful in handling of men; at present employed as designer of special plant. Desires change by September 1, preferably to supervise work, inspect or represent, or act as assistant to executive where responsibility is required. To start, $4000. G-197.

EXECUTIVE MECHANICAL ENGINEER, member of leading professional societies, important war committees and commissions, degrees, author, American, employed on technical research and development work in non-essentials; special ability, mechanical invention, simplification of design, cheapening and elimination of manufacturing operations, industrial-plant operation, cost reduction, etc.; seeks more war-essential duties. Usefulness first, salary secondary consideration. G-198.

EXECUTIVE OR ASSISTANT. Cornell M. E., with nine years' practical experience in shipyard, machine shop, and general heavy and medium work. Capable of directing work and men with maximum production and minimum friction. Capable and thorough organizer, familiar with manufacturing details. Salary at least $2800. G-199.

ENGINEERING SURVEY

A Review of Engineering Progress and Attainment in Mechanical Engineering and Related Fields, Including a Digest of Current Technical Periodicals and Selected Titles of Engineering Articles

Evolution of the Aircraft Engine

THE War Department authorizes the following statement of evolution in aircraft engines prepared by the National Advisory Committee for Aeronautics:

The first man-carrying airplane flights were made in December 1903, with the Wright Bros.' engine, developing 12 hp. and weighing 152 lb., or 12.7 lb. per hp. In 1910, seven years later, the average horsepower of aeronautic engines had increased to 54 and the weight decreased to 5.7 lb. per. hp. In another seven years, 1917, the average power output had advanced to 243 hp. and the weight decreased to 2.8 lb. per hp. In March 1918 the Liberty 12 developed 432 hp. for a weight of 808 lb., or 1.86 lb. per hp. At the present time (May 1918) the Liberty 12 is yielding a maximum of 450 hp. for a weight of 825 lb., or 1.83 lb. per hp.

Advance in Ratio. The accompanying table shows the advance in the average power-weight ratio by years for the engines in actual flying use. It is to be especially noted that the Langley-Manly engine, built in 1901, was 9 years ahead of its time in the matter of power output, and 16 years ahead in its weight per horsepower.

In 1917 the Liberty 12 was 65 per cent more powerful and 28 per cent lighter per horsepower than the average in service for that year. So far this year these figures are probably changed to 50 per cent and 25 per cent, respectively, which indicate the advance of the Liberty over the average engine in service at the present time.

AIRCRAFT-ENGINE EVOLUTION

	Year	Horse-power	Weight, lb.	Weight per horse-power, lb.
Langley-Manly engine	1901	52	151	2.9
Original Wright Bros.	1903	12	152	12.7
Improved Wright Bros	1904	16	180	11.4
Improved Wright Bros.	1905	19	180	9.5
Redesigned Wright Bros.	1908	35	182	5.5
Average on market	1910	54	309	5.7
Wolseley engine	1913	147	720	4.9
Average on market	1914	112	437	3.9
Average on market	1915	133	512	3.8
Average on market	1916	185	570	3.1
Average on market	1917	243	693	2.8
Liberty 12-cylinder	1917	400	801	2.0
Liberty 12-cylinder (March)	1918	432	808	1.9
Liberty 12-cylinder (May)	1918	450	825	1.8

Consumption of Fuel. The average consumption of fuel decreased from about 0.8 lb. per hp-hr. in 1903 to about 0.65 lb. in 1914, since which it has slowly dropped to 0.55 lb. in 1918, and for the Liberty to 0.50 lb. The present Liberty consumption is approximately 0.46 lb. per hp-hr.

Illustrating the advance made, the Wolseley Co. in 1913 could only obtain 147 hp. at 1400 r.p.m. from eight cylinders, 5 in. bore by 7 in. stroke, or 18.375 hp. per cylinder. This is the same size cylinder as used in the Liberty, which now gives 450 hp., at 1800 revolutions, from 12 cylinders, or 37.5 hp. per cylinder, which is double the power per cylinder obtained in the Wolseley. Even if we reduce the Liberty results to the same speed as the Wolseley—that is, 1400 revolutions—the Liberty still represents a great advance, for at that speed 350 hp. are developed, or 29.2 hp. per cylinder. Moreover, the Wolseley weighed 4.9 lb. per hp. as compared with 2.3 for the Liberty at the same speed, or 1400 r.p.m. (*The Official Bulletin*, June 12, 1918, p. 16.)

International Aircraft Standards

As has been previously stated in THE JOURNAL, an American commission has recently been sent to Europe, where it spent several weeks in conference with engineering representatives of the Allies on the formulation of specifications of materials, mounting and dimensions of parts for aircraft and automotive apparatus generally.

The general feeling is that these conferences have constituted a real advance and facilitated ultimate international standardization. A formal international conference was held in London with representatives of France, Italy, Great Britain and the United States being present. A number of less formal sessions and conferences were held in various places, and many factories, repair stations, laboratories, etc., were visited.

The prime objects of the conferences were to facilitate the sending of most usable supplies to England, France and Italy from the United States, and also to arrange so as to have parts, fittings and instruments made interchangeable on aircraft produced in the different countries.

Progress was made at the conference abroad in the formulation of Allied standard specifications for aircraft steels, using the current American, British, French and Italian specifications as a basis, covering both the general procedure for testing and the chemical and physical requirements of wrought steels.

In the metric sizes the S.A.E. and the British ball-bearing series are identical, except that six S.A.E. sizes have not been included in the British list. A revision of tolerances and limits recommended by the British and the American delegates is under consideration. Limits of eccentricity in radial bearings and outside dimensions of thrust bearings were other subjects of study.

The 18-mm. spark plug, incorporating the best features of the British and the S.A.E. plugs, has been recommended for use on American and British stationary-cylinder and rotary engines. Practically the same plugs are used in France and Italy.

The dimension specifications for British and for American magnetos are substantially the same, with the exception of one dimension of magneto space. The American specification of the taper as one in five is the same as the British specification of the taper as one in ten, owing to the fact that the British refer to the slope of the conical surface to the axis.

The plan, provisionally adopted by the subcommittee of the International Commission on Pipe Threads, which met in Paris, July 1914, for a standard method of designating units of construction, was discussed, with reference particularly to screw threads and gear-wheel teeth, the idea being to seek

a unit which could be used with either the inch or the metric system is employed. Taking screw threads as an illustration, a system of notation was outlined by which each screw would bear a distinctive number based on the diameter in eighths of an inch, and the pitch in the number of threads per inch or per 127 mm. (= 5 in.), without reference to the unit in which the measurement might be made. For example, a $\frac{3}{4}$-in. U. S. standard bolt having 10 threads per inch would be designated a "6 x 50" bolt in countries using the metric system. The selection 127 mm. as the length over which the number of threads should be stated in countries using the metric system is based on the fact that this gives *whole* number of turns, these being five times the number of threads per inch.

The very difficult problem of bringing together the advocates of the metric and of the inch bases is in abeyance, but it is felt by some that the plan outlined above may afford the first step.

The practices in the preparation and use of glue are much the same in the United States and Great Britain. Mechanical methods of application and electrical method of heating are used largely here, but neither of these methods is common in England. Comparative tests of British and American methods of testing glue are being made.

The question of spruce supply was naturally discussed. Kiln procedure has been simplified, the results being satisfactory almost invariably. It is appreciated by all that the splicing of wood is an important subject. Additional approved designs of laminated and box spars will be recommended.

Propeller-hub and fittings practice will be further unified so far as shall prove advisable and possible.

Coördination of water and fuel piping standards is largely dependent on thread practice. The use of outside dimension only for nominal diameters of metal tubing has been recommended by the British and the American committees.

The British and American practice in wheels and tires are substantially in accord. Discussion is being had as to the advisability of extending the list of wheel sizes which has been adopted here.

The number of tire sizes will be kept to the lowest possible minimum.

The British and the American steel wire cables are sufficiently alike to be practically interchangeable. The same thing is true of high-tension steel wire.

It is felt that similarity of design is not necessary in turnbuckles, satisfactory interchangeability being securable if the fork-end and pin dimensions are standardized

The single aim in considering the various matters is to ascertain to what extent we can, without interfering with our productive capacity, adopt European standards with advantage; to what extent we can assist more effectively in cases of European conformity with our practices; following the course that will bring the best results. That which does not contribute to the winning of the war is of quite secondary importance. Anything that does contribute to the winning of the war is obviously of prime importance. (Abstract of a paper presented by Coker F. Clarkson before the *Society of Automotive Engineers*).

Standard Heavy-Duty Motor Truck Adopted by War Department

The following statement is authorized by the War Department:

One of the questions of standardization of motor transportation for use of the Army has been settled by the Secretary of War, i.e., the quartermaster standard type B truck has been officially adopted as the standard heavy-duty cargo truck for use of the Army in all its departments requiring this capacity truck. A large number of these trucks are now on order, and it is expected that the first 10,000 of these will be completed on or about August 1, 1918. (*Official Bulletin*, June 7, 1918, p. 8)

The Liberty Engine Described in Detail

The War Department authorizes the following statement:

The designs of the parts of the Liberty engine were based on the following:

Cylinders. The designers of the cylinders for the Liberty engine followed the practice used in the German Mercedes, English Rolls-Royce, French Lorraine-Dietrich, and Italian Isotta Fraschini before the war and during the war. The cylinders are made of steel inner shells surrounded by pressed-steel water jackets. The Packard Company by long experiment had developed a method of applying these steel water jackets.

The valve cages are drop forgings welded into the cylinder head. The principal departure from European practice is in the location of the holding-down flange, which is several inches above the mouth of the cylinder, and the unique method of manufacture evolved by the Ford Company. The output is now approximately 1,700 cylinder forgings per day.

Camshaft and Valve Mechanism Above Cylinder Heads. The design of the above is based on the Mercedes, but was improved for automatic lubrication without wasting oil by the Packard Motor Car Company.

Camshaft Drive. The camshaft drive was copied almost entirely from the Hall-Scott motor; in fact, several of the gears used in the first sample engines were supplied by the Hall-Scott Motor Car Company. This type of drive is used by Mercedes, Hispano-Suiza, and others.

Angle Between Cylinders. In the Liberty the included angle between the cylinders is 45 deg.; in all other existing 12-cylinder engines it is 60 deg. This feature is new with the Liberty engine, and was adopted for the purpose of bringing each row of cylinders nearer the vertical and closer together, so as to save width and head resistance. By the narrow angle greater strength is given to the crankcase and vibration is reduced.

Electric Generator and Ignition. A Delco ignition system is used. It was especially designed for the Liberty engine to save weight and to meet the special conditions due to firing 12 cylinders with an included angle of 45 deg.

Pistons. The pistons of the Liberty engine are of Hall-Scott design.

Connecting Rods. Forked or straddle-type connecting rods, first used on the French DeDion car and the Cadillac motor car in this country, are used.

Crankshaft. Crankshaft design followed the standard 12-cylinder practice, except as to oiling. Crankcase follows standard practice. The 45-deg. angle and the flange location on the cylinders made possible a very strong box section.

Lubrication. The first system of lubrication followed the German practice of using one pump to keep the crankcase empty, delivering into an outside reservoir, and another pump to force oil under pressure to the main crankshaft bearings. This lubrication system also followed the German practice in allowing the overflow in the main bearings to travel out the face of the crank cheeks to a scupper which collected this excess for crankpin lubrication. This is very economical in the use of oil and is still the German standard practice.

The present system is similar to the first practice, except that the oil, while under pressure, is not only fed to main bearings but through holes inside the crank cheeks to crankpins, instead of feeding these crankpins through scuppers. The difference between the two oiling systems consists of carrying oil for the crankpins through a hole inside the crank cheek instead of up the outside face of the crank cheek.

Propeller Hub. The Hall-Scott propeller-hub design was adapted to the power of the Liberty engine.

Water Pump. The Packard type of water pump was adapted to the Liberty.

Carburetor. A carburetor was developed by the Zenith Company for the Liberty engine.

Bore and Stroke. The bore and stroke of the Liberty engine is 5 by 7 in., the same as the Hall-Scott A-5 and A-7 engines, and as in the Hall-Scott 12-cylinder engine.

Remarks. The idea of developing Liberty engines of 4, 6, 8 and 12 cylinders with the above characteristics was first thought of about May 25, 1917. The idea was developed in conference with representatives of the British and French missions, May 28 to June 1, and was submitted in the form of sketches at a joint meeting of the Aircraft (Production) Board and the Joint Army and Navy Technical Board, June 4. The first sample was an 8-cylinder model, delivered to the Bureau of Standards, July 3, 1917. The 8-cylinder model, however, was never put into production, as advices from France indicated that demands for increased power should make the 8-cylinder model obsolete before it could be produced.

Work was then concentrated on the 12-cylinder engine, and one of the experimental engines passed the 50-hour test August 25, 1917.

After the preliminary drawings were made, engineers from the leading engine builders were brought to the Bureau of Standards, where they inspected the new designs and made suggestions, most of which were incorporated in the final design. At the same time expert production men were making suggestions that would facilitate production.

The Liberty 12-cylinder engine passed the 50-hour test, showing, as the official report of August 25, 1917, records, " that the fundamental construction is such that very satisfactory service with a long life and high order of efficiency will be given by this power plant, and that the design has passed from the experimental stage into the field of proven engines."

An engine committee was organized informally, consisting of engineers and production managers of the Packard, Ford, Cadillac, Lincoln, Marmon and Trego companies. This committee met at frequent intervals, and it is to this group of men that the final development of the Liberty engine is largely due. (*Official Bulletin*, May 16, 1918, p. 3)

New German Textile Substitute

There has been much discussion in the German press recently concerning a wood-pulp fiber named "cellulon," for which large claims are made as an efficient substitute for jute, cotton and other fibers. The Swiss spinners and weavers are keenly watching the developments of this textile substitute and already regard it as of considerable importance. A memorandum on the subject has been received by the Foreign Office from the British Consul General at Zurich, who has seen a sample of the cloth made from cellulon, and describes it as extremely strong, although made directly from wood pulp.

It is not easy to reconcile the various descriptions of the process of manufacturing cellulon from pulp, and it may be that more than one method is employed. It appears to be certain that the fiber is not made by spinning long strips of paper run off reels through water in the manner which German paper textile substitutes have made familiar. The accounts agree in describing the process, or processes, as a direct manufacture from wood pulp.

The British Consul General states that the method employed is on the same general principles as artificial-silk manufacture—that is, by squeezing pulp under high pressure through small holes in plates. He is familiar with the artificial-silk works at Crefeld and considers that the methods employed there are adaptable to making cellulon.

On the other hand, the *Münchener Neueste Nachrichten* gives some details of two processes: one, the invention of an engineer named Scherback, and the other the revival of the discovery made 25 years ago by Gustav Turk. In the Turk process, according to the Munich journal, the cellulose pulp is conducted over drums, the surface of which is divided into parallels corresponding to the number of the yarns to be produced. The roving, which consists of a solid mass of cellulose, is taken from the drum by means of a special apparatus and then twisted (i.e. finished or twined) on spinning machines.

In the Scherback process cellulose is added to cotton waste or wool in the ordinary mixed spinning process. The somewhat longer fibers of the cotton or wool bind together the shorter cellulose fibers, and thus a yarn is produced similar to cotton or woolen yarn. These processes materially differ from one another, and from the method of manufacture—similar to that of artificial silk—which is described by the Consul General at Zurich. They agree, however, in one respect: that cellulon is made from wood pulp which has not been previously converted into paper.

But however cellulon may be manufactured, there is no doubt that it is being exploited very actively in Germany, especially as a substitute for jute. The *Münchener Neueste Nachrichten*, which describes the extent of its adoption in Germany up to last month, states that many of the largest industrial concerns in the cellulose, paper and textile industries have already taken out licenses for the working of this invention. Some large factories are already at work exploiting it: other factories for such exploitation are being built or projected. The Cellulon Company has been formed by the existing license holders in conjunction with the proprietors of the patent (namely, The Turk Company, Ltd., Hamburg), with the object of establishing a research company, as well as a central point for all common interests of the cellulon industry.

The British Consul General writes that the Augsburger Spinnerei A. G. is largely interested in the Cellulon Company, and that a very powerful combination of spinners and weavers has been formed. (*Journal of Commerce*, May 31, 1918, p. 3)

Three Training Camps Open with 6,500 College Students

The following statement is authorized by the War Department:

Reports received in the Adjutant General's office indicate that the three training camps for college students opened with the full quotas present. The camps are located at Plattsburg, N. Y., where 3,000 students are enrolled; Fort Sheridan, Ill., where there are 2,500 students, and the Presidio, San Francisco, where there are 1,000. All three camps opened on Monday for a one-month course of training.

Only infantry instruction is given at these camps. Full equipment of the latest model has been furnished. The object of the camps is to prepare students with such additional training as may be prescribed for commissions in the Officers' Reserve Corps.

Those who qualified for the camps are members of Reserve Officers' Training Corps units which are located at about 120 different colleges and universities. Members of the camps receive mileage and subsistence. Most of them are under military age.

A similar camp for college students who are members of artillery units of the Reserve Officers' Training Corps at Yale University and the Virginia Military Institute, Lexington, Va., will be held at Camp Jackson, Columbia, S. C., from August 1 to September 1. These are the only schools where there are artillery units. About 350 students will be in attendance. (*The Official Bulletin*, June 13, 1918, p. 9)

The Oldest French Engineer

On May 18, 1918, Jules Gaudry, a member of the French Society of Civil Engineers, celebrated his one hundredth birthday. Notwithstanding his great age he has all his faculties and attended the meeting of the French Society of Civil Engineers at which a special medal was presented to him.

It is an interesting fact that Gaudry started his life as a law-

Jules Gaudry

yer, having even been admitted to the Paris bar, but in the 40's of the past century he entered the Cavé shops and studied steam-engine construction. In 1819 he entered the service of the state railroads, where he remained until 1870.

In 1876 he was appointed commissioner of accounts for the Trans-Atlantic Company, a position which he continued to occupy until 1906, or until he reached the age of 88 years.

In 1855 he was secretary of the Jury Commission in the general class of machinery at the famous Paris Exposition.

During the Franco-Prussian war of 1870-1871, Gaudry had the important task of acting as inspector of testing and construction of all kinds of artillery supplies, and by the time the siege of Paris by the Prussians ended he had succeeded in providing the complete material necessary for seventeen batteries.

The last paper read by Gaudry before the French Society of Civil Engineers, and bearing on the progress of engineering of water transportation, was at the age of 83 years.

British Parliamentary Commission on the Metric System

A final report has been presented to the British Parliament by the Committee on Commercial and Industrial policy after the War, which has been at work in the past two years. Chapter 10, dealing with Weights and Measures, presents the conclusions of the committee relative to the proposal for the compulsory adoption of the metric system. The 19 members were a unit in reporting adversely, and it is highly significant that this is taken to mean the dismissal of the metric-system proposal from consideration as a subject of legislation in Great Britain. Following are extracts from the report:

"Having given very full consideration to the subject, we are unable to recommend the compulsory adoption of the metric system in this country. In our opinion, it is absolutely certain that the anticipated uniformity could not be obtained for a very long period, if ever.

"There is, further, the serious objection that if we induced the above-mentioned countries to change over to the metric system, we should be surrendering to Germany the advantage which our manufacturers now enjoy over hers, both in their marks and our own.

"We are informed that even in France, which has made the metric system nominally compulsory for more than half a century, the 'pouce' (or inch) is used in textile manufacture, and numerous local measures still survive.

"In referring to these considerations, we have to point out that there is no unanimity even as to the theoretical merits of the metric system as compared with our own. The practical argument that its adoption is desirable in order to secure uniformity in the markets of the world has been shown to be unfounded. We are not satisfied by any evidence which has been brought before us that trade has actually been lost to this country owing to the fact that the use of the metric system is not compulsory.

"But to attempt to make the use of the system universal and obligatory in this country would cause loss and confusion at a particularly inopportune moment for the sake of distant and doubtful advantages. We are convinced that, so far from assisting in the reëstablishment of British trade after the war, such a measure would seriously hamper it.

"As regards the educational advantages claimed for the change, we have been referred to a statement quoted by the Select Committee of 1895 that no less than one year's school time would be saved if the metric system were taught in the place of that now in use. The information which we have received does not support that statement, and even if it were well founded, it must be remembered that for at least a generation children would have to learn both the new and the old measures and how to convert from one to the other.

"It is often popularly supposed that the introduction of the metric system would render possible the immediate sweeping away of many complicated and varying weights and measures. As we have already indicated, this belief is, in our opinion, wholly fallacious.

"We are not convinced that the metric system is, upon the whole, even theoretically superior to the British system, and we are satisfied that the practical objections to the proposed change are such as decisively to outweigh any advantages which are claimed for it." (*The Iron Age*, vol. 101, no. 21, May 23, 1918)

REVIEW OF ENGINEERING PERIODICALS

SUBJECTS OF THIS MONTH'S ABSTRACTS

For Articles on Subjects Relating to the War, see Aeronautics, Engineering Materials, Machine Tools, Munitions, Varia

Aeronautics (See also Internal-Combustion Engineering)

STABILITY OF AEROPLANES, H. A. Webb. The writer considers the conditions of stability of an aeroplane, both in steady and disturbed flight, by the use of Newton's laws of motion and axes fixed in space. He does not discuss the practical consequences that follow from the loss of stability. It is of interest to note that the present writer does not use the usual mathematical convention, in which it is assumed that the aeroplane is travelling with a negative velocity.

The writer also gives two fundamental equations of longitudinal and lateral stability. The gyroscopic terms in the case of forward translation are claimed to be negligible, but it is stated that they may have an important effect on the stability of banked or spiral flights. (*Engineering*, vol. 105, no. 273, May 3, 1918, pp. 475-476)

EXHAUST-VALVE TROUBLES. As a result of reports of trouble on several occasions through the burning of exhaust valves or aero engines, the Rolls-Royce, Ltd., have carried out a series of experiments to determine the cause of this trouble and means for obviating it.

These tests have given some valuable results. Thus, it was found that the temperature of an exhaust valve in the hottest portion is 700 to 750 deg. cent. and the temperature of the exhaust gases in the exhaust port is approximately 700 deg. cent.

It was also found that the valve is hottest when the cylinder is working with the most efficient mixture, that is, when the maximum power is obtained with the minimum amount of fuel. Hence, the general impression that weak mixtures cause valves to get very hot was not borne out by these experiments. It was apparent that the effect the mixture had on the burning out of valves is controlled by the amount of free oxygen in the exhaust.

As regards the material used for valves, it appears that chromium steel has the advantage of not oxidizing at ordinary working temperatures. Tungsten-steel valves in ordinary conditions scale and gradually get thinner, but once the valve reaches the temperature at which burning commences the difference between the two kinds of steel is not appreciable.

The tappet clearance is of course directly affected by the elongation of the valve at normal working temperatures. Tests carried out showed that this elongation is 0.014 in. to 0.016 in. A set of valves were run with no clearance at all in the tappets when cold, so that at normal temperatures the exhaust valves did not seat by 0.015 in. The engine ran for 25 hours and the valves were in perfect condition when the test was finished. It was noticeable when the engine was running that the valves were the same heat all over, whereas in normal working conditions they all cooled on the seating where they come in contact with the cylinder. It was found that it was possible to run with the valves not seating by as much as 0.008 in. and still obtain a cooled ring round the outer ridge of the valves. It is assumed that in this case the valve is cooled by the thin volume of gas passing around the valve at a considerably reduced velocity and itself being cooled by contact with the seating of the cylinder. Investigation showed that with no tappet clearance in the exhaust valves when cold the power was reduced by 1.5 per cent, and, further, that it was possible to run with only 0.005 in. clearance with no loss of power. In carrying the tests still further, the tappets were adjusted so that the exhaust valves could never seat when cold by 0.01 in. As a result the power was reduced by as much as 15 per cent, and the exhaust valves became excessively hot. In these conditions it was distinctly noticeable that the valves were hottest on the outer ring and cooler towards the stem; thus, of course, being the converse of the results with correct tappet adjustment. This test also revealed another interesting point in that the valve was found to be much hotter on the sector towards the top center of the cylinder. This is of particular interest, because when burning occurs in an exhaust valve it has apparently never been appreciated why a bite is taken out of one portion, leaving the rest of the seating in fairly good condition. During these experiments it was noticed that this bite always occurs on the sector just mentioned towards the top center where the valve gets hottest. In conjunction with this it was also found that if a valve is turning round while the engine is running it takes a very much longer time to start to burn. Immediately burning commences the valve ceases to turn.

The effect of preignition was found to be of the greatest importance. It is stated that the spark plug which preignites under ordinary running conditions causes the exhaust valve to run at an incandescent heat. It was found that preignitions are greatly influenced by the amount of lubricating oil in the combustion chamber. In fact, it is claimed that no case of preignition has ever been known in an overlubricated cylinder and it was proved by actual experiments that if a spark plug commenced to preignite this could be redeemed by squirting a little oil into the air intake. It was also proved that it was possible to inject a certain amount of oil without affecting the horsepower of the engine and still secure a reduction of the temperature of the valve.

The Rolls-Royce Company affirms that with reasonable care

there should be no pregnition and the chief reason for its occurrence is, in their opinion, that the engine is run with the oil too cold.

It was also found in the course of tests that the water circulation has a very important effect on the overheating of exhaust valves. It was noticeable that if the water circulation is faulty the first part to be affected is the exhaust valve. If the failure of the water circulation causes the spark plug to preignite, which is natural, the valve is burned in a few minutes. They state that very encouraging results have been obtained by increasing the flow of water per minute through the cylinder jackets. (*The Auto-Motor Journal,* vol. 23, no. 19/805, May 10, 1918, pp. 338-339, *epA*)

A German "Mystery" Biplane—the H. W. Description of the so-called H. W. German biplane recently brought down on the French front.

The smash and subsequent fire did not leave much on which to base the reconstruction of the machine. Apparently, however, the biplane is a two-seater with staggered wings having a dihedral angle but no sweep back. The most characteristic element of construction is the tail, which is of the biplane form with the top plane considerably smaller than the bottom one.

The shape of the ailerons is not quite certain. One of the observers claimed that the tail planes are polygonal with the angles rounded off. It appears also that the fuselage is very deep and the top plane very close to it. This would give the rear gunner an opportunity to easily fire upwards. (*Flight,* no 487, no. 17, vol. 10, April 25, 1918, pp. 444-445)

The Story of the Liberty Motor. This article claims to give the true story of the Liberty motor. There are no facts which were not previously known in one way or another, but the whole article gives a very clear and consistent history of this interesting war development. (*Scientific American,* vol. 118, no. 22, June 1, 1918, pp. 500)

Conventions

National Coöperative Convention A. A. E. *Power,* vol. 47, no. 22, May 28, 1918, pp. 780-781.

Meeting of the National Machine Tool Builders' Association. *American Machinist,* vol. 48, no. 23, June 6, 1918, pp. 959-967.

Engineering Materials

Failure of Ductile Materials Unler Fluctuating Stresses, H. A. Webb and W. H. Barling. The paper starts with a brief introduction and a summary of previous work on fatigue of materials under fluctuating stresses. The writer believes that

$$\text{Equivalent static stress} = \frac{2\ (\text{maximum stress})}{1 + \frac{1}{2}\frac{(\text{minimum stress})}{(\text{maximum stress})}}$$

is well supported by experiment for ductile materials under fluctuating direct stresses, and by analogy with it suggests the following formula for ductile materials under more complicated conditions of loading.

Let s_1 and s_2 be the maximum and minimum shear stresses (s_2 may be negative) at a given point, in a given plane through that point; then the equivalent static shear stress at that point, and in that plane, is

$$s = \frac{2s_1}{1 + \frac{s_2}{2s_1}}$$

Taking as an example the crankshaft of an aero engine, the shaft is subjected, at any given section, to a fluctuating direct stress, p, due to bending and thrust, and a fluctuating shear stress, q, due to torque. Let p and q be represented on a polar diagram, as in Fig. 1.

Let p_1, q_1, and p_2, q_2, be two pairs of corresponding values of p and q, i. e., p_1 and q_1 occur simultaneously, and so do p_2 and q_2. We assume temporarily that p_1 and q_1 represent the limits of fluctuation, and on this assumption we shall find a formula for S. In theory, we ought then to apply the formula to read off from the polar diagram and choose the largest of all the values of S so obtained, as the "maximum maximorum." In practice, experience should enable us to guess from the diagram, as a rule, what values of p_1 and q_1, p_2 and q_2 are likely to give the largest value of S. Probably

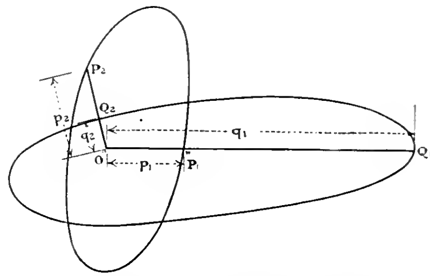


Fig. 1 Polar Diagram of Stresses on a Crankshaft of an Aeronautical Engine

we should not be far wrong, for a crankshaft, in taking the greatest and least values of q (the least value may be negative), together with the corresponding values of p, to determine the value of S.

We shall then prove that if

$$H = \frac{p_1q_2 - p_2q_1}{q_1^2 + \frac{1}{2}q_1q_2 + \frac{1}{4}p_1^2 + \frac{1}{8}p_1p_2} \quad \text{[4a]}$$

is numerically greater than 1.414, then

$$S = \frac{2(p_1q_2 - p_2q_1)}{\sqrt{(q_1+q_2)^2 + \frac{1}{4}(p_1+p_2)^2}} \quad \text{[5]}$$

But if

$$H = \frac{p_1q_2 - p_2q_1}{q_1^2 + \frac{1}{2}q_1q_2 + \frac{1}{4}p_1^2 + \frac{1}{8}p_1p_2} \quad \text{[4b]}$$

is numerically less than 1.414, then S either has the value given in [5], or it is equal to

$$\frac{2(q_1^2 + \frac{1}{2}q_1q_2 + \frac{1}{4}p_1^2 + \frac{1}{8}p_1p_2)^2 + (0.3)(p_1q_1 - p_2q_1)^2}{\{(q_1 + \frac{1}{2}q_2)^2 + \frac{1}{4}(p_1 + \frac{1}{2}p_2)^2\}^{3/2}} \quad \text{[6]}$$

whichever is the greater numerically.

TABLE 1 DUCTILE MATERIALS UNDER FLUCTUATING STRESSES

p_1	q_1	p_2	q_2	S
23,000	4,600	12,300	0	20,200
3,600	12,000	0	4,800	20,300
12,500	10,000	7,500	5,000	19,500
12,000	5,000	6,000	−5,000	20,000
2,000	5,000	1,000	−5,000	20,400
2,500	7,500	0	−3,700	20,100
9,000	7,500	3,000	−3,000	20,100
12,000	6,000	−9,000	4,500	20,400

These formulæ are proven mathematically. This part of the paper is not suitable for abstracting.

The writer gives the following numerical illustrations: As a special case if $q_1 = q_2 = 0$, we find from [6] that

$$s = \frac{p_1}{1 + \frac{p_2}{2p_1}}$$

which agrees with [2] (as we should expect), since under a simple tension the maximum shear stress is half the tensile stress.

In the eight cases given in Table 1 the value of the equivalent static shear stress is about 20,000 lb. per sq. in., so that they are all, on this theory, about equally wrong. All the stresses are in pounds per square inch. (*Aeronautics*, vol. 14, no. 235, April 17, 1918, pp. 331-333, 3 figs., *tm*)

PRINCIPAL PROPERTIES OF ACIERAL. A new aluminum alloy under the name of acieral was placed on the market last year (for details of its composition see *The Iron Age*, April 5, 1917). Some tests of this metal have recently been made by the Bureau of Construction and Repair of the United States Navy, with results shown in Table 2.

These tests represent metal varying from 0.064 in. and up in thickness. (*The Iron Age*, vol. 101, no. 23, June 6, 1918, p. 1467, *e*)

TABLE 2 RESULTS OF TENSILE TESTS OF ACIERAL

Grade of alloy	Original area, sq. in.	Proportional limit, lb. per sq. in.	Ultimate strength, lb. per sq. in.	Elongation in 2 in., per cent	Reduction of area, per cent	Modulus of elasticity, lb. per sq. in.
A	0.0498	37,500	51,300	4 6	6 22	10,870,000
A	0.0498	37,000	49,400	2 0	4.62	10,000,000
B	0.0561	34,000	46,900	4 0	18 71	8,854,000
B	0.0561	35,000	45,800	3 1	16 85	8,700,000
C	0.0489	51,000	66,400	1 8	6 81	10,210,000
C	0.0495	51,000	67,600	4 1	7 28	10,640,000
D	0.0500	52,000	71,800	2 0	3 80	10,200,000
D	0 0500	54,000	69,000	2.0	2 80	10,525,000

ANNEALING AND RECRYSTALLIZATION OF COLD-ROLLED ALUMINUM SHEETS, Robert J. Anderson. The present article gives the results of a series of tests made on the effects of heat at different temperatures on the softening of cold-rolled sheet aluminum.

The main results of these tests have been reported in an abstract of another article by the same author in THE JOURNAL for June 1918, p. 506.

The present investigation, on the whole, shows that the existing general practice of annealing aluminum is faulty. The effect of long-time annealings, such as are common in present practice where sheets are exposed for, say, 24 hours at 375 deg. cent., is to cause an undue coarsening and weakening of the metal, evidenced by the coarse domes in the Erichsen test used in the present investigation.

Fabricating blanks which have been so annealed and which have undergone deep draws in the draw press also show the same coarse appearance at the edges of drawn shapes and this can be traced only to the long annealing period. (*Metallurgical and Chemical Engineering*, vol. 18, no. 10, May 15, 1918, pp. 523-527, 6 figs., *ep*)

THE ANNEALING OF CARBON STEELS AS AFFECTED BY VARIOUS TEMPERATURES AND MAGNETIC FLUX, R. B. Fehr, Mem.Am.Soc.M.E. The primary object of the investigation was to make a study of the range of temperature in which the various steel heat-treating operations should be carried out. For this purpose the critical range of temperatures was investigated through *small* intervals with the object of finding out what improvements would be brought about by better temperature control.

This research made it also possible to investigate whether there was any unusual effect on the physical properties of steel that was subjected to heat treatment and the action of magnetic flux simultaneously.

The main data of this investigation have already been reported from an advance publication of the paper in THE JOURNAL for January 1917, pp. 82-84. (*Pennsylvania State College Bulletin*, vol. 11, no. 11, October 1, 1917, *e*)

OCCLUDED GASES IN FERROUS ALLOYS, Gellert Alleman and Charles J. Darlington. Interest in occluded gases was aroused in the writers during an investigation conducted by one of them which had to deal with the bubbles formed around wire in wire glass. At first, it was assumed that these bubbles were composed of carbon dioxide and emanated from the glass itself, but subsequent work indicated the possibility of the gases coming from the metal of the wire.

A series of extensive tests was undertaken which gave some interesting data, summed up by the writers in the following manner:

1 We have constructed a gas-tight vacuum furnace, capable of continuous service at temperatures of approximately 1900 deg. cent.

2 By means of this apparatus, all the gases occluded in ferrous alloys may be removed and collected.

3 It appears that the gases are evolved in the following order: hydrogen is most readily set free, carbon monoxide comes next, and nitrogen seems to be held most tenaciously.

4 Whether oxygen is the result of the decomposition of various oxides of iron or the dissociation of carbon monoxide or carbon dioxide has not been determined.

5 We have shown that ferrous alloys may occlude relatively large volumes of gases—in some cases equal to about 200 times the volume of the metal.

6 We suggest that in addition to the ordinary functions of metals like aluminum, tungsten, chromium, menganese, titanium, silicon, etc., when placed in ferrous alloys these elements may act as catalytic agents and either prevent the occlusion of large quantities of gases or aid in the elimination of such gases at lower temperatures than would ordinarily take place.

7 We have shown that the removal of gases from ferrous alloys markedly changes the microstructure and increases the density of the alloy. (*Journal of The Franklin Institute*, vol. 185, no. 4, April 1918, pp. 461-480, 4 figs)

THE INFLUENCE OF SURFACE TENSION, F. C. Thompson. *The Iron Trade Review*, vol. 62, no. 12, May 23, 1918, pp. 1299-1304, 9 figs. Reprint of a paper presented at a recent meeting of the British Iron and Steel Institute. The hypothesis is offered for surface tension and bears an important influence on the structure of iron and steel.

THE DEFINITION OF HARDNESS, W. Cawthorne Unwin. The writer points out the interesting fact of the identity of the hardness numbers of Martel and Brinell. In view of the fact that Martel's work is comparatively little known, the following passage from the article is of particular interest:

In 1895 to 1900 Lieutenant-Colonel Martel communicated two very interesting and valuable papers to the Paris Congress on testing materials. He used the falling-monkey

method with various forms of indenting points and various heights of fall. He established conclusively that the work expended in indentation, notwithstanding these variations of the conditions, is proportional to the volume of the indentation.

If V is the volume of the indentation, P the weight of the monkey and F the height of fall, $D = PF/V$ is constant for any given ductile material. Then D in kilogram-millimeter units is Martel's hardness number.

It is easy to see that D is the amount of work necessary to cause a cubic unit of indentation and is independent so far as the tests go of the form of the indenting body.

Further, a few tests were made with a gradually applied load and the same law was satisfied, except that D was about

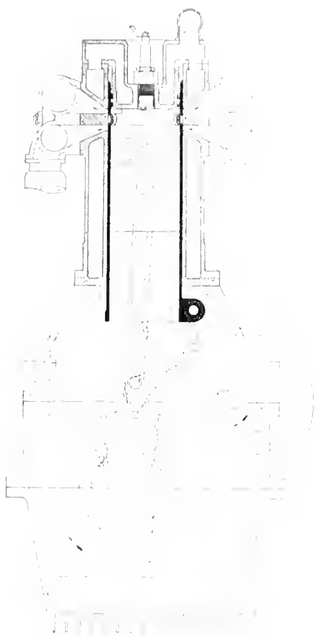


FIG. 2 SINGLE-SLEEVE-VALVE MOTOR

20 per cent less in the case of a gradually applied load. Probably this was due either to there being some loss of work in vibrations, etc., in the impact test; or to inexactness in determining the work expended in tests by a gradually applied load. (*Engineering*, vol. 105, no. 2733, May 17, 1918, p. 535)

SUR L'HÉTÉROGÉNÉITÉ DES ACIERS, G. Charpy and S Bonnerot. *Revue de Métallurgie*, 15 Année, no. 2, March-April 1918, pp. 132-136, 4 figs. Discussion of the heterogeneous character of the structure of steel.

Fuel and Firing

THE STORAGE OF BITUMINOUS COAL, H. H. Stock. *University of Illinois Bulletin*, vol. 15, no. 27, Engineering Experiment Station, Circular no. 6, March 1918, 192 pp.

FIRING WITH COAL DUST. *Engineering*, vol. 105, no. 2733, May 17, 1918, pp. 552-553. General discussion of the subject largely based on American practice.

FIGURING FURNACE GRATE AREA. *Power*, vol. 47, no. 22, May 28, 1918, pp. 756-758, 7 figs.

LE SERVICE D'ÉCONOMIE DE COMBUSTIBLE À LA CIE DES FORGES ET ACIÉRIES DE LA MARINE ET D'HOMÉCOURT, M. Theodore Laurent. *Revue de Métallurgie*, 15 Année, no. 2, March-April, 1918, pp. 117-126, 1 fig. Description of methods of fuel economy employed in a French metallurgical plant.

ALCOHOL AS A MOTOR FUEL. Report by the Commonwealth Advisory Committee on Science and Industry presented to the Australian government on alcohol fuels and engines. The report considers in very favorable light the possibility of using alcohol as a fuel. For denaturants it recommends tar-oil distillates as being cheap, effective and having no corrosive effect on valves or cylinders. For Australian conditions the use of mixtures of alcohol with benzol or ether are not recommended. As regards the source of raw materials the report recommends the use of molasses, sorghum stalks, cassava and sorghum grain. (*The Autocar*, vol. 40, no. 1176, May 4 and 11, 1918, pp. 435-436, 459-460, 3 figs.)

Handling and Conveying

CONVEYOR SCHEME FOR NEW YORK'S "PACKAGE FREIGHT," M. A. Long. *Freight Handling and Terminal Engineering*, vol. 4, no. 5, May 1918, pp. 158-160.

Internal-Combustion Engineering (See also Railroad Engineering)

OIL-ENGINE SPRAYERS OR PULVERIZERS, A. H. Goldingham and T. C. O'Brien. *Motorship*, vol. 3, no. 5, May 1918, pp. 3-4, 10 figs.

SINGLE-SLEEVE-VALVE MOTOR. A new sleeve-valve engine is being developed by the S. S. V. Motor Company, of Pittsburgh, Pa., the design being due to Charles B. and James M. Gearing. A cross-sectional view of the engine is shown in Fig. 2.

The engine has four cylinders of $3\frac{1}{2}$ in. bore by 5 in. stroke, and a single sleeve is interposed between each piston and its cylinder wall. The sleeve, of course, reciprocates at one-half the speed of the piston, making one reciprocation during each complete engine cycle. Its travel is equal to 13-16 in. This makes a total travel of $1\frac{5}{8}$ in. during a complete cycle, as compared with 20 in. of piston travel. The sleeve is said to have a dwell corresponding to 275 deg., during which period the compression and power strokes take place. The ports in the cylinder wall and in the inner head are so arranged that the port in the sleeve is between the inlet and exhaust ports during this particular period.

When the crankshaft is 45 deg. from the bottom dead center on the power stroke, the sleeve moves up and begins to open the exhaust port. The latter closes at the top dead center. The inlet port is opened by a quick motion of the sleeve valve.

There are two inlet and two exhaust ports to each cylinder. The sleeve is positively operated by a double toggle combination, one link of which is driven by an eccentric shaft rotating at one-half crankshaft speed and the other half by an eccentric which is placed above the crankshaft and operated by means of the connecting rod so that it has an irregular angular motion. The upper end of the two links is connected by a third link to a lug on the sleeve.

The whole cylinder block is an aluminum casting, without special lining, as all of the wear comes on the inside of the sleeve. An experimental engine that has been built developed

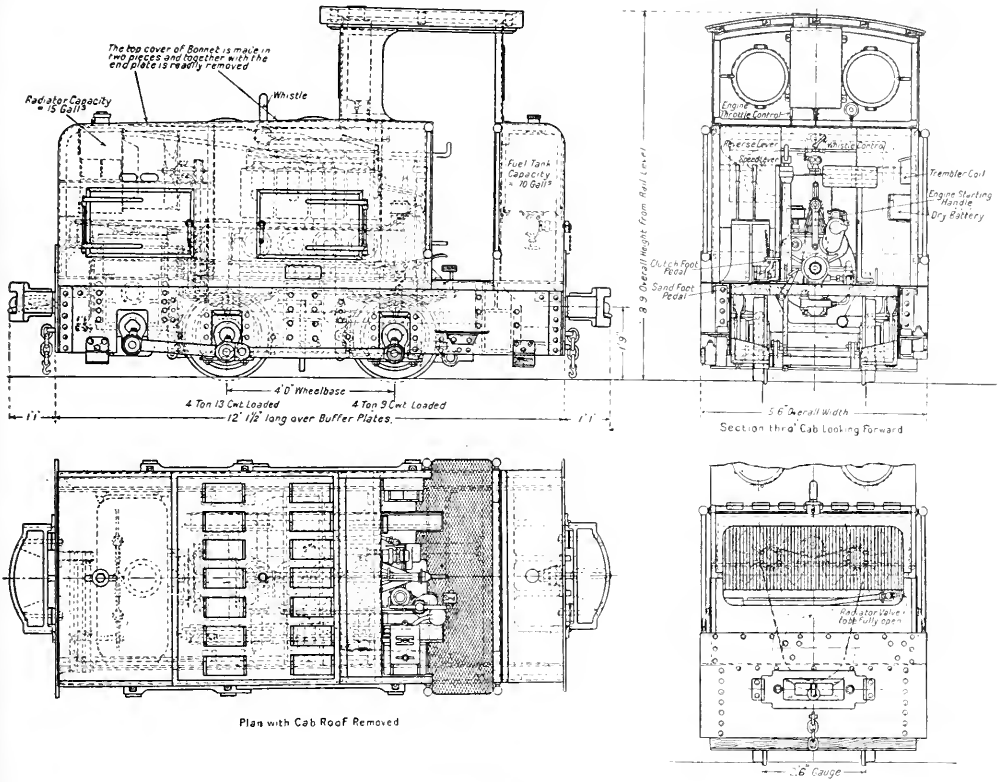


Fig. 3 British Narrow-Gage Internal-Combustion Locomotive

a torque of 110 lb. (length of brake arm not given) at 1400 r.p.m. The spark plugs are located centrally in the cylinder heads. This engine will run up to 2700 r.p.m., it has been definitely stated.

The exhaust ports have their top edge on a line with the bottom of the inner head and are 2 7-18 in. wide, measured circumferentially. They afford a very direct passage for the exhaust gases from the cylinder and this is believed to have a tendency to keep the cylinders free from carbon.

Lubrication is by the force-feed system, oil being fed under a pressure of 5 to 10 lb. per sq. in. to the three main bearings and through drill holes in the crankshaft to the crankpin bearings. Oil thrown off from the crankpin bearings lubricates all the other internal parts. The sleeve-operating shaft, as will be seen, is chain-driven. (*Automotive Industries*, vol. 38, no. 20, May 16, 1918, p. 953, *d*)

Small Locomotives of Special Types. The first of a series of articles describing small locomotives such as are used by contractors or for special purposes. The locomotives described are both steam and internal-combustion, the steam locomotives being of the fireless type.

As regards fireless locomotives, the one described is built by Hawthorn, Leslie and Company. A particular feature of the engine is a special superheater and steam drier which is claimed to effect a gain in efficiency ranging from 10 to 15 per cent, according to the charging pressure available and the pressure at which the reducing valve is set. It is said that it has been found that in order to obtain a perfectly satisfactory operation of reducing valves, it is necessary to provide an adequate volume of steam between the valve and the cylinders so as to act as a cushion on the reducing valve and prevent violent fluctuations in the pressure of steam in the delivery pipe. The superheater referred to here does it, and, in addition, also provides a reservoir of low-pressure steam, which is drawn upon for supplying the cylinders and, at the same time, allows the steam to become thoroughly dried before entering the cylinders for a period when the reservoir is at or about at its maximum pressure and corresponding temperature. The amount of superheat gradually decreases until the point is reached when the pressure in the reservoir corresponds with that at which the reducing valve is set. During the ensuing period of working, the reducing valve ceases to be operated and passes the steam directly from the reservoir to the cylinders at a gradually falling pressure.

The same firm builds an internal-combustion locomotive driven by a 4-cylinder marine-type engine designed to develop 55 b.hp. at 600 r.p.m. The power is transmitted through a friction clutch to a change-speed gearbox, arranged to give traveling speeds of 4, 8 and 15 miles per hour, both forward and backward.

The unit has a weight in full running order of 8.75 tons and runs on a gage of 2 ft. 6 in.

Another type described in the article is the narrow-gage internal-combustion locomotive built by the Avonside Engine

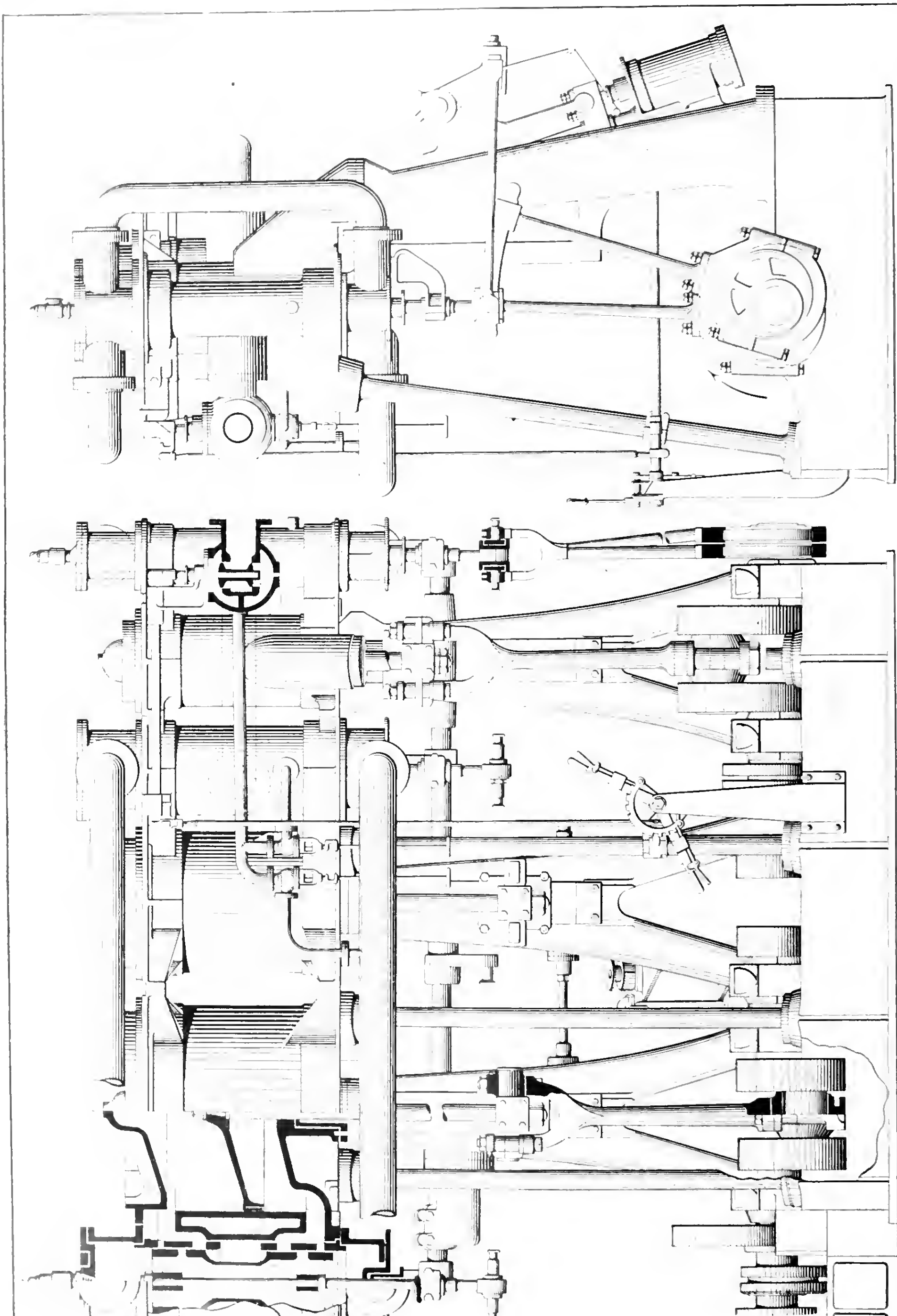


FIG. 4 GENERAL ARRANGEMENT OF THE EMERGENCY FLEET FORE-AND-AFT TRIPLE-EXPANSION ENGINES

Company at Bristol (Fig. 3). This locomotive is of the M. L. M. type; that is to say, it is from 55 to 60 hp., and is suitable for gages varying from 1 ft. $11\frac{5}{8}$ in. to 5 ft. 6 in., the drawing here showing a 2 ft. 6 in.-gage locomotive.

There are four wheels 2 ft. in diameter and coupled, the wheelbase being 4 ft. The total weight loaded is 9 tons and 2 cwt., 4 tons 13 cwt. being on the front axle and 4 tons 9 cwt. on the rear axle.

The motor is of the four-cylinder ($6\frac{1}{2}$ in. by 8 in.) vertical type, designed to run normally at 550 r.p.m. The power is transmitted through a clutch and change-speed gearbox, no chains being used. The engine is designed to work on any ordinary kerosene having a flash point up to about 150 deg. fahr. It is started from cold by running on gasoline for a few minutes and changing over to kerosene. (*The Engineer*, vol. 125, no. 3255, May 17, 1918, pp. 419-421, 5 figs., *d*)

Machine Tools

Bullard Maxi-Mill Boring Mill. Description of a boring mill embodying in its construction some features which are stated to have never before been applied to a machine of this type.

In the new mill such standards and complete units as the drive, feed works, spindle construction, rail construction have been embodied with only minor changes, but new features also appear.

In the bed the gears and bearings are flooded with oil at all times.

A new form of centralized control has been introduced. The crank handles were eliminated on the hand wheels, these being of the hammer type, which is claimed to make possible very fine settings of the tools.

Graduated scales mounted on the face of the cross rail and on the tool slides give the coarser readings, while micrometer dials graduated to thousandths and equipped with Bullard observation stops give the final readings.

Another feature of construction claimed to be new permits the use of large and effective amounts of cutting lubricant on the tool. In fact, the machine was designed with this in mind from the start and it is claimed that the construction is such as to avoid the possibility of the cutting lubricant entering parts of the machine where it is not desired. (*American Machinist*, vol. 48, no. 23, June 6, 1918, pp. 973-974, 4 figs., *s*)

Marine Engineering

Ljungström Turbo-Electric Ship-Propelling Machinery. *Engineering*, vol. 105, no. 2731, May 3, 1918, pp. 489-491, 9 figs. (serial).

Hydraulic Equipment of a Modern Shipyard, J. H. Rodgers. *Canadian Machinery and Manufacturing News*, vol. 19, no. 20, May 16, 1918, pp. 505-509, 9 figs.

Design and Progress of the Floating-Frame Reduction Gear, John H. Macalpine. *Proceedings of the Engineers' Society of Western Pennsylvania*, vol. 34, no. 1, February 1918, pp. 1-38, 21 figs., 2 tables.

The Hull Weight of Cargo Ship, H. Hashiguchi. *Journal of the Society of Naval Architecture*, vol. 22, April 1918, pp. 60-74 (in Japanese).

The Stokes Wave and Trochoidal Deep Sea Waves, Prof. S. Yokota. *Journal of the Society of Naval Architecture*, vol. 22, April 1918, pp, 74-79 (in Japanese).

Suction and Repulsion Between Two Ships Based on Model Experiments, H. Makita. *Journal of the Society of Naval Architecture*, vol. 22, April 1918, p. 79 (in Japanese).

The Turbo-Electric Ship "Wulsty Castle"—Controlling Resistances. *The Engineer*, vol. 125, no. 3255, May 17, 1918, pp. 423-426, 6 figs.

Emergency Fleet Engines. In view of the great interest naturally felt by American engineers in propelling machinery of the Emergency Fleet ships, there is reproduced on the opposite page from *Power* a cut showing the general arrangement of the fore-and-aft triple-expansion engine built for the Corporation by the Buckeye Engine Company.

It is of 700-hp. capacity and has a $15\frac{1}{2}$-in. diameter high-pressure cylinder, a 26-in. intermediate and a 44-in. low-pressure cylinder with a stroke of 26 in. Piston valves are to be used on all cylinders and are $7\frac{1}{16}$, $14\frac{1}{16}$ and 15 in. in diameter, respectively, and 3 ft. [illegible] in. long.

The columns on which the cylinders are secured are 7 ft. 1

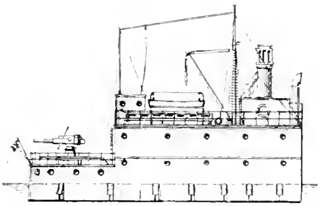


Fig. 5 Diagram of a Large Poop-Type Detachable Ship Electromobile When Not Attached to the Ship

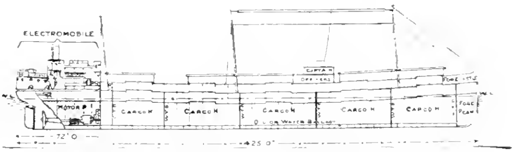


Fig. 6 Cargo Ship of 10,000 Tons Deadweight Carrying Capacity on the Snell Electromobile System

in. high and 7 ft. wide at the base. The frame consists of a front and back column. The front column is $4\frac{1}{2}$ in. in diameter and the back column is of A-shaped form when looked at from the forward end. These columns carry the guide bars.

The crankpins are $8\frac{1}{2}$ in. and the wristpins $4\frac{1}{2}$ in. in diameter. The shaft is $8\frac{3}{8}$ in. in diameter and the cranks are placed at 120 deg. apart. (*Power*, vol. 47, no. 23, June 4, 1918, pp. 794-795, 2 figs., *dA*)

Snell System of Electric Propulsion for Ships. The Snell system of electric propulsion is to be used in particular for ships operating under such conditions that the time of loading and unloading is considerably greater than the time during which the ship is under way. This applies in particular to cross-channel navigation.

Instead of a complete set of machinery in each ship, the Snell system provides one set of transferable power-producing machinery so constructed as to be attachable to several independent hulls. Only propellers and electric motors, which form a small proportion of the total cost of machinery, are fixed in the hulls themselves and are connected during the voyage to the power-producing machinery by electric cables.

The hulls of the ships may be similar to those of ordinary cargo steamers, the space usually occupied by engine and boiler being available for cargo. The power-producing plant will consist preferably of internal-combustion engines or high-speed steam turbines driving alternators, the whole enclosed in a detachable structure of special design carried on the stern or amidship of the hull and firmly attached thereto during the voyage.

Such a detachable "electromobile" with Diesel engines of 4500 b.hp. is shown in Fig. 5, while a cargo ship with the electromobile attached is shown in Fig. 6.

It is claimed that this system insures greater safety against torpedo attacks, as the hull is practically independent of the machinery. Even if it be seriously damaged, the ship, with its machinery intact, would have a good chance of making port. Further, as the electromobile is to be constructed so as to have flotation of its own when not engaged in propelling ships, the machinery portion may be saved even should the hull be so damaged as to cause it to sink.

It does not appear whether any ships on the Snell system have been actually built, the whole matter being quite new. (*Snell Economic Ship*, January 1918, 14 pp. and 2 plates, *d.*)

Measurements

VARIANCE OF MEASURING INSTRUMENTS AND ITS RELATION TO ACCURACY AND SENSITIVITY, Frederick J. Schlink, Mem.Am. Soc.M.E. Instrumental variance, which forms the major part of the discussion of this paper, is a factor whose effect in causing error in measuring instruments has hitherto been given but little consideration. In order to bring out the essential relations of the variance characteristic, the paper opens with a discussion of accuracy and sensitivity, showing how each of these terms can be given precise definition with definite numerical significance. Such values when determined have important use in establishing the figure of merit or value of a given instrument or type of instrument. A distinction is drawn between the commercial accuracy commonly called for in direct-reading instruments of the shop and plant, and the higher grade of accuracy required in the laboratory where instrumental indications are normally subject to the application of corrections for error of calibration.

A definition of sensitivity of an instrument is of real significance only when there are means for expressing it numerically. It is suggested that the unit of response for an instrument should be based upon a definite and inherent characteristic of that instrument rather than upon some accidental factor, such as the length of a pointer or an arbitrarily graduated scale.

The paper shows the necessity for distinguishing between insensitiveness and passiveness or sluggishness in an instrument, and consideration is given to the effect of friction in preventing response to certain small changes in the measured quantity. The paper gives the following definition of sensitivity:

Sensitivity in an instrument is the rate of change in the indicating of such instrument with respect to the change in the quantity being measured, it being necessarily assumed for the purpose of this definition that friction and lost motion in the mechanism have been eliminated or are negligible.

The amount of the least alteration in the value of the measured quantity, producing instrumental response, divided by the initial value of the measured quantity may be called the passivity of the instrument at that point. Passiveness is a special case of the phenomenon of variance, next discussed.

Variance is defined as the range, at any given value of the measured quantity, of variation in reading which may be exhibited by the instrument under repeated application of the same value of the quantity being measured, after a steady reading has been attained—the environment remaining unchanged.

The specific variance or variancy may be defined as the ratio of the range, at any given value of the measured quantity, of variation in reading which may be exhibited by the instrument under repeated application of the same value of the quantity being measured, divided by the measured quantity itself, the same assumptions applying as above as to the attainment of a steady state of indication and as to the maintenance of unchanged environment.

Determination of the variance is a most important part of the calibration of an instrument and appreciable error may arise from failure to recognize or express it.

The paper illustrates the derivation of the variance from a certain hysteresis loop and discusses in detail the phenomena occurring in the measuring instruments used therefor. It also analyzes in detail the possible sources of inaccuracy and shows, among other things, that the phenomena usually ascribed to the operation of friction of resistances only may be due to more complicated causes.

The frequency-curve method of delineation is applied to the expression of variance of an irregular nature, as found in instruments exhibiting bad workmanship or ill repair, and it is seen that the variance characteristic of such an instrument can be completely defined by reference to a family of frequency curves obtained in the following manner: One series of points will be plotted for readings taken at varying rates and amounts of increase of the measured quantity terminating in the value corresponding to the particular point of the scale under investigation, and another set for decreasing values terminating at the same point. Such a curve, in which frequency of occurrence of a particular reading or error is plotted against the true value of the measured quantity at that reading, gives the probability of occurrence of any amount of variation from, say, the mean instrumental reading.

Far from being a relatively unimportant source of inaccuracy in measuring instruments, it can be shown that the hysteresis or variance type of error demands consideration in practically every type of instrument, while in some (such as pointer-and-dial types of displacement indicators) it is a preponderating factor in design and actually limits the application or utility of the instrument and sets the limit of sensitivity and accuracy practicably to be obtained.

A few means of reducing instrumental variance are given, including the use of special types of bearings in which slack or clearance can be reduced to a minimum without impairing easy operation; and the use of flexible elastic connectors between elements of the linkwork instead of gears and racks or pin-and-link connectors. Such tape-like connectors which may wind on cam-shaped members to provide for correction of displacements to a linearly graduated scale, exhibit excellent properties in the matter of reversibility of calibration, and have important advantages over the more usual types of linkwork details.

The action of vibration in reducing instrumental variance is found in accord well with the principles previously set down, and it appears that, within limits, errors of result due to mechanical sources of variance can be considerably reduced by judiciously applied vibration treatment.

In designing and constructing an instrument, due consideration should be given to the effect of variance errors in

practically limiting the sensitivity to be sought in adjustment, as well as the interval between the graduations and the smallness of the units of graduation. It is suggested that in view of this condition, the mean interval of graduation of laboratory instruments should not be less than five times the mean variance, while for commercial or plant instruments the ratio of mean scale interval to mean variance may be of the order of two to one. Likewise the sensitivity may easily be disadvantageously high, inducing erroneous estimates of the precision of results and requiring special care in the calibration and use of the instrument.

The factors of maximum or mean inaccuracy (or accuracy), sensitivity, variancy and special set (the amount of which the variance loop may fail of closure, divided by the range of the deflection cycle) may be referred to the total range of graduation instead of to particular values of the measured quantity under observation, as a convenient means of arriving at single significant numbers to be composed into a "figure of merit" for an instrument whose characteristics are being determined. (Abstract of Scientific Paper now in press, U. S. Bureau of Standards.)

The Spinning Top in Harness. *Engineering,* vol. 105, no. 2733, May 17, 1918, p. 553, 2 figs. Abstract of a lecture given before the Royal Institution of London on May 3 by Sir George Greenhill. The lecturer discussed the general phenomena of gyrostatic action with particular application to practical uses in automatic control of such rapidly moving apparatus as flying machines and torpedoes.

Devices for Comparing the Rotation of Shafts, Prof. K. Suyehiro and T. Tsuchiya. *Journal of the Society of Naval Architecture,* vol. 22, April 1918, pp. 39-40 (in Japanese).

Object of Measuring CO_2 in Chimney Gas and New CO_2 Recorder, I. Naito. *Journal of the Society of Naval Architecture,* vol. 22, April 1918, pp. 48-60 (in Japanese).

The Electric Dynamometer, C. F. Scott. *Aviation,* vol. 4, no. 9, June 1, 1918, pp. 596-598, 2 figs.

Milling-Machine Dynamometer. Description of a dynamometer specially designed for use on the milling machine, by R. Poliakoff, Mem.Am.Soc.M.E. The general design of the instrument is shown in the accompanying illustration, Fig. 7. It is adapted to measure the pressure exerted in milling cuts resolved into three components, each one at right angles to the other two. In this respect it goes much further than the usual machine-tool dynamometer.

Its operation is substantially as follows: The instrument is mounted on a foundation plate *A*, which rests upon the table of the milling machine and is attached thereto by bolts in the usual manner. The work to be milled is placed on the auxiliary table *B* and made fast thereto. The work and milling cutter are then brought together and the cut started.

The resulting pressures exerted on the work upon the table *B* may be resolved into three components.

Referring to Fig. 7, the horizontal arrow pointing in the right-hand direction indicates the direction of one of these components. The vertical arrow pointing downward toward the table indicates a second component. The direction of the third is parallel with the surface of the table at right angles to the other two. So the resultant pressure can be split up into three components and each is registered on a separate gage of the instrument. Two of these gages are shown in Fig. 7. The pressure is transmitted by causing a flow of liquid to register accurately upon the gages the amount of the pressure in each of the three directions.

The instrument is adapted to determine the pressure required for various milling operations, and thereby assist in determining the strength of the parts of milling machines or to analyze the action of various types of cutters or the degree of difficulty for cutting the various materials. (*Machinery,* vol. 24, no. 10, June 1918, p. 932, 4 figs. *d*)

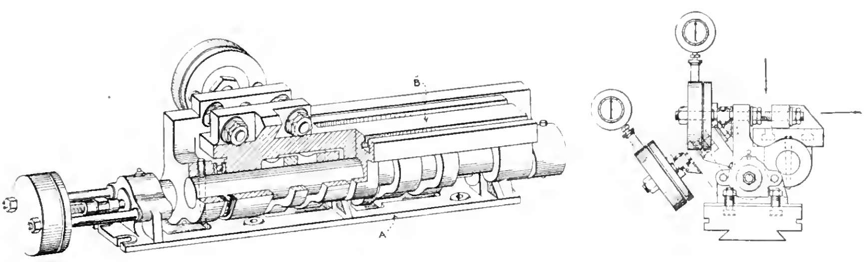


Fig. 7 Maching-Tool Dynamometer

Mechanics

Leaf Springs, Their Capacity for Dissipation of Energy, C. P. Schwarz. The writer discusses the potential dissipation of a spring, or its ability to dissipate energy when subject to shock. He gives expressions for this energy which depend entirely upon the structure of the spring and which would express the amount of heat dissipated by the spring as soon as the value of a certain coefficient is experimentally determined.

The analysis of the expressions derived by the writer discloses some interesting facts. The dissipation increases in the same ratio as the product of the thickness of the leaves and their number, not counting the master leaf. That is really the height of the spring. Locomotives which require springs with high dissipation have springs composed of numerous leaves of very substantial thickness.

The dissipation decreases with the length of the master leaf; if, however, all leaves are made of the same length ($= 2\ L$) the dissipation is doubled.

When a maximum of dissipation has to be accompanied by a minimum of weight the semi-elliptic spring is unexcelled. The three-quarter elliptic, platform, and full elliptic spring follow in the order enumerated. The cantilever spring is theoretically equal to semi-elliptic. However, it must be provided with a "dead" end for anchoring purposes, and then its weight efficiency is reduced.

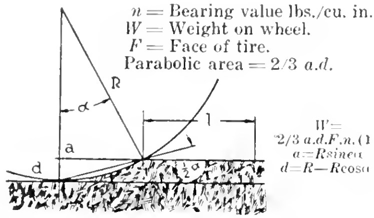
To increase the dissipation until a practically satisfactory

periodicity is reached two main avenues of development are open to us, leading to:

1 Thin leaf spring

2 Spring with inserts.

(*The Automobile Engineer*, vol. 8, no. 114, May, 1918, pp. 141-142)



$$W = 2/3Fn(R^2\text{sine}\,\alpha - R^2\text{sine}\,\alpha\cos\alpha)$$
$$= 2/3FR^2n(\text{sine}\,\alpha - \tfrac{1}{2}\text{sine}\,2\alpha)$$
$$\frac{W}{2/3FR^2n} = \text{sine}\,\alpha - \tfrac{1}{2}\,\text{sine}\,2\alpha \qquad (2)$$

FIG. 8 RESISTANCE TO ROLLING OF A HARD CYLINDRICAL BODY

$$\text{Mean unit pressure} = \frac{W}{FR\text{sine}\alpha}$$
$$= 2/3 \text{ maximum unit pressure.}$$
$$\therefore \text{Max. unit pressure} = 3/2\ \frac{W}{FR\text{sine}\alpha}$$

Which varies as depth from zero at the surface.

$\therefore$ Work per unit area $=$

$$d \times \tfrac{1}{2} \times 3/2\ \frac{W}{FR\text{sine}\alpha}$$

Work of depression over distance 1 with resistance P is $\frac{3}{4}\ \frac{W}{FR\text{sine}\alpha}\ dF1 = P1$

$$\therefore \frac{P}{W} = \tfrac{3}{4}\ \frac{d}{FR\text{sine}\alpha} = \tfrac{3}{4} \text{ slope of chord}$$
$$= \tfrac{3}{4}\tan\tfrac{1}{2}\alpha$$
$$\text{or } G = \frac{P}{W} = \tfrac{3}{4}\tan\tfrac{1}{2}\alpha \qquad (3)$$

FIG. 9 EQUATION FOR THE EFFECT OF DEPRESSION OF SOIL THROUGH A BODY ROLLING UPON IT

It can be shown that

$$\text{Cos}\alpha = \sqrt{\frac{2P}{FR^2n}} - 1$$
$$d = R - R\cos\alpha$$
$$d = \sqrt{\frac{2P}{Fn}} \qquad (5)$$
$$P = \tfrac{1}{2}d^2Fn \qquad (6)$$

Or resistance depends upon depth of depression, face of tire and soil factor, irrespective of diameter and weight.

Knowing the soil flow and bearing value, P could be determined from the track alone.

FIG. 10 FACTORS DETERMINING THE MAGNITUDE OF RESISTANCE TO ROLLING

RESISTANCE TO ROLLING OF TRACTOR WHEELS IN SOFT GROUND, Amos F. Moyer, Mem. Am.Soc.M.E. Preliminary report of a research conducted with financial assistance from the University of Minnesota Research Fund and from the Society of Automotive Engineers to determine the relation between rolling resistance, specific load, wheel diameter, speed, and other factors.

The mathematical derivations which it was proposed to verify by these experiments were based on the assumption that soft soil and probably other plastic materials bore up a unit pressure proportionate to the depth of depression. This is equivalent to saying that the total weight borne up is proportionate to the volume perpendicularly enclosed by the displacing surface in actual contact with the substance and below the surface from which the substance was displaced.

In the case of a hard cylindrical body rolling on a level plastic surface this volume consists of prismatic half-segments of the cylinder below the level surface and on the forward side, but, if the deforming body, instead of being a cylinder, were rounded upward in front and continued flat for some distance backward, as in the case of a sled runner or caterpillar tread, the supporting volume of displacement would include also the rectangular prism extending backward a distance equal to the flat supporting surface, which explains the greater carrying capacity of surfaces of this kind. The experiments thus far conducted were confined to plain, flat-tired wheels of varying weight, width and diameter.

In Fig. 8, Equation 1 expresses approximately the low outline for a cylindrical body for plain, flat-tired wheels, where n is the load supported by the soil per unit volume displaced. From this is deduced Equation 2, which expresses a similar law in terms of the wheel dimensions and the arc α which is in contact with the soil.

Fig. 9 gives equations derived through the application of the principle of conservation of energy, by virtue of which it must be true that the work done in rolling a wheel a given distance is equal to that expended in depressing the soil over the same distance.

In Fig. 10, P represents resistance, or pull required to roll the wheel, and this divided by the weight of the wheel is G, or Equivalent Grade, which is the percentage grade, such that if the wheel rolled upward without friction on a hard surface it would give the same resistance as P.

The value given here, or $\frac{3}{4}$ tan $\frac{1}{2}$ α, or three-quarters of the slope of the chord subtending the arc of contact, is a much smaller quantity than some of the data previously published on loss in rolling a round wheel would lead one to believe.

Referring again to Equation 2 in Fig. 8, it is evident that the factors in the denominator other than n are proportional to the cylindrical volume of the wheel, which may be called Q. In the calculations this has been expressed in cubic feet, so that W/Q, which is designated as S, or specific load, is written in pounds weight per cubic foot of wheel volume, and the writer proves mathematically that there is a fixed relation between S and G whenever n remains constant. He also shows that resistance depends upon the depth of depression, face of tire and soil factor, but is independent of diameter and weight. Hence, knowing the soil flow and bearing value, P can be determined from the track alone. In other words, if we know anything about the soil, that is, if we know n, we can tell the resistance of a wheel even if we never have seen anything but the track.

The writer proceeds then to describe the apparatus used in the tests and the method of carrying them out, which indicates the considerable amount of work spent in the present investigation.

This attaches considerable interest to the question whether the values of n found in the present investigation actually

represent weight borne per cubic inch of soil displaced, or merely a hypothetical something which will satisfy a complicated equation. On obtaining data on the actual displacement of soil there was no means at hand for ascertaining the "wave" action in front of the advancing wheel, and merely the volumes were calculated which were below the original soil surface. This "wave" action and the small bank of loose earth which always forms in immediate contact with the tire reduce the value of n, but this happens to be obtained also by the mathematical determination of n from S and G, which would indicate that the mathematical determination of n automatically takes into account several variables which apparently would be difficult to determine by measurement. When the laws of variation of n are once determined, the values thus established will give true values of resistance, since resistance is the quantity whence they are derived. (*Automotive Industries*, vol. 38, no. 20, May 16, 1918, pp. 949-953, *e*)

New Theory of Plate Springs, David Landau and Percy H. Parr. The paper starts with a survey of the previous work on the theory of plate springs and from this proceeds to the consideration of such theory, and description of experiments carried out by the writers.

The new theory is based on the consideration that any leaf of a spring, except a short plate, has a beam *encastré* at one end, loaded at the other, and having a flexible support somewhere between the point of encastrement and that of application of the load.

The writers derive an equation expressing the fundamental relation between the lengths of the leaves and their corresponding reactions of tip pressures. Among other things, this equation shows that the strength of a spring is not nearly in direct proportion to the number of plates, and also explains why the endurance at a given deflection decreases with the increase in the number of leaves.

The writers claim that the fundamental reason for the failure of the old theory is that it ignores the clamping of the leaves at the center of a semi-elliptical spring or at the end of a cantilever spring, this effect of the clamping being sufficient to vitiate the old theory to such an extent as to render it useless from both the theoretical and practical points of view.

The question of the permissible load that any spring may safely carry according to the new theory is discussed in detail. The writers claim that a two-leaf spring has 1.6 times the strength of a single-leaf spring.

The following two general laws are formulated with regard to non-tapered leaf springs:

1 In any leaf spring having leaves of equal cross-sections, and with equal steps, the reactions or pressures between the leaves continually decrease from the short leaf toward the master leaf, as do likewise the stresses.

2 In any leaf spring having leaves of equal cross-sections, and in which the reactions or pressures between the leaves are equal, the steps or overhangs continually decrease from the short leaf toward the master leaf. (*Journal of The Franklin Institute*, vol. 185, no. 4, April 1918, pp. 481-508, 9 figs., 6 tables.)

Stresses in Bolts in Fulcrum Brackets. *The Railway Gazette*, vol. 28, no. 20, May 17, 1918, pp. 579-581, 8 figs.

Motor-Car Engineering

A Remarkable French Tractor, the Theillier-Mesmey. *The Auto*, no. 907 (no. 21, vol. 23), May 24, 1918, pp. 371-374, 3 figs.

Munitions

Ordnance Tools Present Problem, Col. H. W. Reed. *The Iron Trade Review*, vol. 62, no. 23, June 6, 1918, pp. 1425-1426.

An Equation to Express Fair Return, Wm. G. Raymond. *The Railway Gazette*, vol. 28, no. 20, May 17, 1918, pp. 578, 2 tables.

Developments in Artillery During the War, John Headlam. *Journal of the Washington Academy of Sciences*, vol. 8, no. 10, May 19, 1918, pp. 301-319.

Hydraulically Operated Shell Production Machinery, I. William Chubb. *American Machinist*, vol. 48, no. 23, June 6, 1918, pp. 939-943, 12 figs.

Relation of Locomotive Maintenance to Fuel Economy, Frank McManamy. *Railway Review*, vol. 62, no. 21, May 25, 1918, pp. 752-754.

Some Important Points in Design of Truck Bolsters, Louis E. Endsley. *Railway Review*, vol. 26, no. 20, May 18, 1918, pp. 735-741, 17 figs.

Safety Engineering

Grain-Dust Explosions, B. W. Dedrick and David J. Price. Investigation of conditions under which carbonaceous dusts became explosive carried out in the experimental attrition mill at the Pennsylvania State College.

Under the term "carbonaceous dusts," in this investigation, in addition to coal dust, are comprised other types of dusts now known to be inflammable and capable of propagating flame, such as dust in flour and feed mills, grain elevators, threshing separators, etc.

The investigation conducted was undertaken for the determination of possible causes of explosions and the testing of various preventive measures suggested. It was carried out along very broad lines, but only the features of interest to mechanical engineers are briefly abstracted here.

In the original article the results are presented in the form of tables and the experimental installation used and methods employed are described in detail.

As regards the explosibility of various grains, it was found that elevator dust flour, wheat scourings and malt sprouts seem to produce explosions the most consistently, while oat hulls do not appear to give very inflammable mixtures unless they contain a considerable amount of fine dust.

From the tests on the action of static electricity, it appears that, at least in the case of the attrition mill, any static electricity that may be generated is dissipated so rapidly by leakage, which is due to the relatively high atmospheric humidity (Pennsylvania) that no potential is built up in the frame of the machine. Further, it appears to be comparatively difficult to ignite inflammable dusts in an attrition mill by means of static electricity. Nevertheless, every precaution should be taken to eliminate static electricity in the operation of any kind of mill, one good method being the grounding of the machine.

The moisture content of the material appears to have an important bearing on its inflammability. The less moisture the dust contains the more inflammable it is likely to be, and it is probable that there is a maximum moisture content above which the dust cannot be ignited.

Revolving dampers and relief valves as a means of prevention for the propagation of explosions were tried. Both were found of some value. In particular, it was found that a double

re-sliding damper does not appear to serve the purpose of a ... better than a single damper. (*U. S. Department of Agriculture Bulletin*, no. 681 (also *Bulletin* no. 26 of the *Engineering Experiment Station of Pennsylvania State College*) May 18, 1918, 54 pp., 5 figs., bibliography appended, *ep*

Steam Engineering

CAPITALIZATION VALUE OF STEAM LEAKS, R. Von Fabrice. *Power*, vol. 47, no. 19, May 7, 1918, pp. 656-658, 1 chart.

SOME NOTES ON TURBINE BEARINGS AND THEIR LUBRICATION, Charles H. Bromley. *Power*, vol. 47, no. 21, May 21, 1918, pp. 734-736. An interesting collection of data taken from the author's loose leaf notebook.

BOILER SETTINGS—CHAIN GRATE STOKERS, Chas. H. Bromley. One of several articles on boiler settings for various boilers and types of stokers most suitable for the different coals. The chief purpose of the articles is to assist those in the Middle West and Northwest who are confronted with combustion problems by reason of the zone system for the distribution of bituminous coal enforced by the Fuel Administration. Several excellent chain-grate settings are shown in this article. (*Power*, vol. 47, no. 23, June 4, 1918, pp. 788-792, 6 figs.)

BOILER SETTINGS, Chas. H. Bromley. Data on boiler settings for various stokers under different kinds of boilers adapted to high-volatile coal. The writer claims that secondary arches are sometimes superfluous. Thus, secondary arches on Stirling boilers of the usual class are far from the fire and cannot exert an appreciable performance upon the fuel bed. It is therefore of no help in coking the coal, unless the grate is run too fast. This may explain the gradual abandonment of the secondary arches on these boilers. In some settings, however, a secondary arch may be useful for mixing the air and gases, provided the bridge wall is continued high enough to form a narrow passage between the end of the bridge wall and the end of the secondary arch. (*Power*, vol. 47, no. 22, May 28, 1918, pp. 760-762, 3 figs., 2 tables)

CONCRETE BOILERS NEXT. Now, according to the San Francisco *Chronicle*, cement may be used in the construction of boilers in the near future, as it is understood that an experiment will be made at the Union Iron Works. The report says that considerable figuring has been done and numerous sketches have been made, and that a boiler will be constructed shortly. It is stated that it is expected that with the exception of the boiler shell there will be but little change, and instead of one thick boiler sheet the new construction of shell is to consist of two thin sheets of steel, probably 1/4-in. in thickness, and these will be fastened together, leaving between them 2 or 3 in. of space, which will be filled with a high-grade cement. (*Power*, vol. 47, no. 23, June 4, 1918, p. 808)

NOTE SUR LA CORROSION DES TUBES DES CONDENSEURS PAR SURFACE ALIMENTÉS À L'EAU DE MER, G. Costeseque. *Revue Générale de L'Electricité*, 2 annee, tome 3, no. 18, May 4, 1918, pp. 647-650. Discussion of the corrosion in surface-condenser tubes supplied with sea water as a cooling medium.

*TUBE FAILURE IN WATER-TUBE BOILERS. An editorial presenting in an interesting manner a survey of the general state of our knowledge on tube failure in water-tube boilers. The article properly emphasizes the fact that water-tube explosions generally result in more damage to human life and health than to property, and that every precautionary measure available should be applied to minimize these accidents. (*Power*, vol. 47, no. 21, May 21, 1918, pp. 739-740.)

DESIGN AND LAYOUT OF CONDENSERS, D. D. Pendleton. *The Iron Trade Review*, vol. 62, no. 22, May 30, 1918, pp. 1361-1365, 5 figs. Paper presented at the recent meeting of the Engineers' Society of Western Pennsylvania. A practical discussion on the subject of selection of condenser equipment under various conditions, and the importance of providing the installation with proper auxiliaries.

SUPPORTING EFFECT OF BOILER HEADS, Neil M. Macdonald. The writer discusses the question as to whether the strength of the unbraced head should be added to the strength of the stays to find the allowable pressure in a boiler, especially in one of large dimensions and operating under high pressure.

In particular, and by way of illustration, he examines the case of a 72-in. by 18-ft. horizontal tubular boiler having a distance of 26 in. between the top of the tubes and the shell plate.

The area to be braced in this case is the area of a segment enclosed by lines drawn 3 in. from the shell and 2 in. from the tubes, or an area of 936 sq. in.

For the strength of the unbraced flat head he uses the Nichols formula, which, while experimental, is sufficiently accurate for the purpose. For a boiler head 1/2-in. thick and a material having a tensile strength of 55,000 lb. per sq. in. this formula gives a safe working pressure of 37 lb. per sq. in., so that if the boiler was to be designed for a safe working pressure of 125 lb. per sq. in. and the strength of the unstayed head be added, the bracing would be sufficient if good for $125 - 37 = 88$ lb. In accordance with this theory, if the factor of safety on the unbraced head was 8 and on the braces 6, the bursting pressure on the braced head would be $(37 \times 8) + (88 \times 6) = 824$ lb. per sq. in. The writer shows that this is absolutely wrong and that the real bursting pressure of the head is only the value of the strongest portion, which, in this case, is the braces, and is $88 \times 6 = 528$ lb. per sq. in., which gives a safe working pressure of 88 lb. per sq. in.

The writer, in his discussion, compares what happens in the boiler to the case of two walls joined by a rope fastened so that it cannot slip and capable of withstanding any pull up to 528 lb. As soon as the pressure rises above 296 lb., which is more than the weaker wall can stand by itself, the only thing that holds the wall from collapsing is the staying power of the rope. But when the pressure reaches 528 lb. the rope breaks, allowing the full load of 528 lb. to come on the weaker wall, and, as the latter can stand only 296 lb., both the rope and the wall must let go. This explains the case of the boiler with unstayed head.

The same argument applies to the staybolted furnace sheet of a vertical tubular boiler with the slight difference when the furnace sheet proper is stronger than the staybolts. It also applies to the stay bolting of a cone top in a submerged vertical tubular boiler and to the flat firebox sides of a locomotive-type boiler. The writer sums up the subject by stating that a braced or staybolted portion of a boiler is no stronger than its strongest part, and on no account should the strength of the braces or staybolts be added to the strength of the plate and their sum considered the strength of that portion of the boiler. (*Power*, vol. 47, no. 21, May 21, 1918, pp. 733-734, *g*)

STRESSES IN TURBINE BLADING, Gerald Stoney. The blading in steam turbines is exposed not only to stress due to centrifugal force, but also to stress due to pressure of steam on the blades, and to vibratory stresses.

The stress due to centrifugal force is nearly a function of the weight of the blade and speed of rotation and is a steady stress. The writer gives formulæ for the centrifugal stress in brass and steel blades and asserts that due regard in considering it must be had to the fact that in some types of blade fixing the strength of the fixing is less than the tensile strength of the blade, and often the blade is cut away at the root to provide for the blade fixing. Furthermore, in some types of construction the yield point at which the blade begins to draw out of its fastening is reached considerably before the yield point of the material of the blade, which is especially liable to occur with blades of brass or other alloy which have a much higher coefficient of expansion than the steel of the turbine rotor. (In this connection, more data are given below.)

The next stress on the blades is that due to the pressure of the steam on the blades, which is also the force that drives the turbine. The writer indicates a method which has been found convenient in practice.

In designing a turbine the following quantities, among others, are generally known:

R = revolutions per minute

Q = maximum pounds steam per hour

$\alpha = u/c$ = velocity ratio or ratio of blade speed u to steam speed c in feet per second

η_1 = blade efficiency.

In his calculations the author introduces also the unit of blade width, w, that is, width of a row of blading measured axially in the turbine. In this way he shows that the force on each blade is:

$$t = \frac{Q\eta_1 Rbw}{168\alpha^2} \times 10^{-6} \ldots\ldots\ldots\ldots\ldots [3]$$

where b is a constant depending on the type of blading (in impulse blading b is generally between 0.5 and 0.6 and in reaction blading it is between 0.6 and 0.7).

If Z is the resistance modulus of the blade section when 1 in. wide and f_s is the stress on the blades due to steam pressure, then the moment is $f_s Z w^3$, and is equal to $\frac{th}{2}$ Putting this value for t into the above equation, we have:

$$\frac{h}{w^2} = 336 \times 10^6 \frac{\alpha^2 f_s Z}{Q\eta_1 Rb} \ldots\ldots\ldots\ldots\ldots [4]$$

Values of $\frac{\alpha^2}{\eta_1}$ for impulse blading for various values of α derived from Fig. 11 are given in Fig. 12. Strictly speaking, these should be corrected for leakage; but in neglecting this correction we are keeping on the safe side, and in a modern turbine the leakage is small. This seems a difficult equation to work with; but in practice it must be remembered that usually the velocity ratio and blade shape are constant throughout the whole or a large part of the turbine, and therefore α, η_1, b and Z are constant; so that

$$\frac{h}{w^2} = C\frac{f_s}{QR} \ldots\ldots\ldots\ldots\ldots\ldots [5]$$

The total tensile stress on the blade is then given by $f = f_s + f_c$; and here a distinction must be made between the strength of the blade and the strength of the way in which it is fixed into the rotor; in other words, of the blade fixing.

The stress due to steam pressures in the blade, or f_s, causes bending of the blade, and this combined with the centrifugal force f_c gives the stress which must be allowed for at the weakest section of the root of the blade. On the other hand, so far as pulling the blade out of the rotor is concerned, only the centrifugal force f_c must be taken into account.

As regards the factors of safety, much higher factors must be allowed for the stresses due to bending where there is pressure admission on account of intermittent action of the steam. In the case of partial admission the value of h/w^2 must be multiplied by the proportion of the circle occupied by nozzles. Actually, the suitable blade widths can be seen at once when the blade heights are known.

The writer mentions another method applicable when partial admission is used and the velocity of the steam is above the critical velocity. This method is based on the formulæ of Rankine and Rateau, namely, that the flow of steam in pounds per second is approximately proportional to the absolute pressure in pounds per square inch.

The writer believes that the cutting away of the sides of the blades for fixing them into a dovetail curve in the rotor weakens the blade against bending stress much less than might be supposed. In fact, he claims that in some cases this cutting away even increases its theoretical stress, as the resistance modulus of the blade action $Z = I/\sigma$, where I is the moment of inertia of the blade and σ is the distance of the

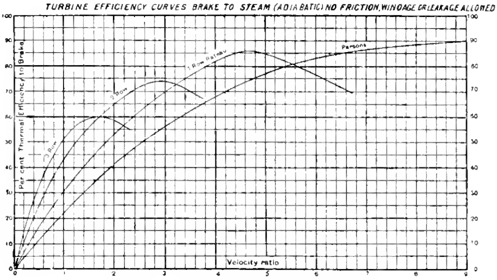


FIG. 11 TURBINE EFFICIENCY CURVES

edge of the blade through the center of gravity. Cutting away the edges reduces σ largely, and I only a little, as the edges are thin, so that a certain amount of cutting away actually increases the strength of the blade. In practice, however, the amount of cutting away is so large (in order to provide sufficient bearing surface to take a centrifugal force) as to weaken the blade.

In the preceding discussion which applied to impulse turbines, only the tangential force on the blades has been considered, while the axial force parallel to the axis of the turbine and due to drop of pressure in the moving blade has been neglected, since in impulse turbines it is generally small in amount.

But in reaction or Parsons blading the drop of pressure across the moving blades is considerable and the axial stress large, in fact, under ordinary conditions is equal to or rather more than the tangential.

With such blading where there is equal expansion of the steam in the fixed and moving blades we have the equation

$$t = \frac{Q\eta_1 Rbw}{84\alpha^2} \times 10^{-6} \ldots\ldots\ldots\ldots\ldots [7]$$

for the tangential force only. Here α is the true velocity ratio or the ratio of the blade speed to the steam speed in either the fixed or the moving rows. In some books the velocity ratio is taken as if the whole of the expansion were in the fixed row, as in the impulse turbine, this latter velocity being, therefore, $1/\sqrt{2}$ of the above value of α.

Let T be the tangential force on the blading and L the axial,

Δp being the drop of pressure across either moving or fixed row, and V the volume of steam in feet per second.

$$T = \frac{2 r_t V \Delta p}{u}$$

and

$$L = A \Delta p$$

A being the area of the annulus. Therefore:

$$\frac{T}{L} = \frac{2 V r_t}{u A} = \frac{2 r_t \sin\theta}{\alpha} \quad \ldots\ldots\ldots\ldots\ldots\ldots [8]$$

since V / A = axial velocity of the steam, or $c \sin\theta$, θ being the blade angle; and the forces on each blade have the same

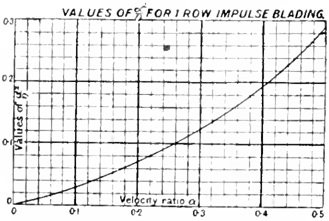


FIG. 12 $\frac{\alpha^2}{\eta}$ FOR IMPULSE-TURBINE BLADING

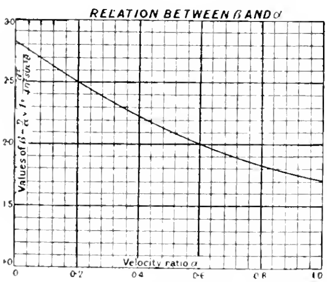


FIG. 13 $\frac{\beta}{\alpha}$ FOR REACTION-TURBINE BLADING

ratio. The resultant force on the blade, n, is then the resultant of these two forces, or:

$$n = t \sqrt{1 + \left(\frac{\alpha}{2 r_t \sin\theta}\right)^2}$$

$$= \frac{QRbwr_t}{84 \times 10^6 \alpha^2} \sqrt{1 + \left(\frac{\alpha}{2 r_t \sin\theta}\right)^2}$$

Calling

$$\frac{r_t}{\alpha} \sqrt{1 + \left(\frac{\alpha}{2 r_t \sin\theta}\right)^2} = \beta$$

$$n = \frac{QRbw}{84 \times 10^6 \alpha} \beta \quad \ldots\ldots\ldots\ldots\ldots\ldots [9]$$

From this it follows that:

$$\frac{h}{w^2} = 168 \times 10 \frac{tZ\alpha}{QRb\beta} \quad \ldots\ldots\ldots\ldots\ldots [10]$$

Fig. 13 gives the relation between β and α, derived from Fig. 11, θ being taken as 20 deg.; and since, of course, the minimum value of α in any section of the turbine must be taken, it is seen that between the values of $\alpha = 0.4$ and $\alpha = 0.6$, which are the usual minimum values in modern turbines, the value of β is 2.15, so that:

$$\frac{h}{w^2} = 78 \times 10 \frac{tZ\alpha}{QRb} \quad \ldots\ldots\ldots\ldots\ldots [11]$$

which gives the total stress on the blades due to the combined effect of pressure drop and reaction.

Hitherto no account has been taken of the stiffening effect of the shrouding or lacing of the blades. This is because shrouding riveted on to the top of the blades cannot be considered rigid for small movements. Shrouding would increase the strength of the blade if it could be rigidly fixed to the blades by silver soldering or bracing, but this is difficult to accomplish. (*Engineering*, vol. 105, no. 2730, April 26, 1918, pp. 447-448, 3 figs., *ta*)

Thermodynamics

LOSSES OF HEAT THROUGH ENGINEERING AND BUILDING MATERIALS, R. B. Fehr, Mem.Am.Soc.M.E. Report on the thermal testing plant at the Engineering Experiment Station of the Pennsylvania State College.

This plant was designed and built for the purpose of studying the loss of heat through various engineering and building materials. Thus far the plant has produced data on the total transmission in various materials and has emphasized the importance of studying the effect of velocity, humidity and surface resistance. The following program of experiments with the present apparatus was adopted:

1 Study of temperature gradients through glass
2 Calibration of corkboard test box (5 ft. cube)
3 Transmission of heat through glass
4 Transmission of heat through air spaces formed by building paper.

The writer gives brief résumé of the theory of heat transmission and a rather elaborate description of the apparatus, methods of testing and method of calibration of the corkboard box.

As regards the results themselves, it appears that in the case of glass, as well as other poor insulators, practically all high resistance is to be found in the so-called surface resistance. It appears also that in spite of their entirely opposite insulating properties corkboard and glass exhibited a rather remarkable agreement in their value of k_1 (radiation and convection effect of surface on warm side or surface transmission in B.t.u. per 24 hours per sq. ft. per degree difference), k_2 (surface transmission on cool side), and K (total surface transmission for both sides), the values at 70 deg. difference of temperature being respectively, 59, 43 and 25 for corkboard and 90, 46 and 30 for glass. The higher values for glass are probably due to its smooth surface and transparency to radiation from within the test box.

Rather interesting tests were carried out on air spaces formed by building paper. The curves in the lower half of Fig. 14 show that there is an appreciable increase in the value of u, which is transmission in B.t.u. per 24 hours per sq. ft. per deg. fahr. with increase of temperature difference, as was also found by the Bureau of Standards. The curves in the upper part of Fig. 14 were obtained by plotting the values of the lower half as percentages of the fall of u for one layer of paper at a particular temperature difference. These curves show that for the ordinary differences of temperature found in heating and refrigerating and for ½-in. dead air spaces, the total transmission varies inversely as the number of layers of paper; in fact, the transmission falls off more rapidly, the statement implies, and, therefore, the rule will give results on the safe side for insulation problems.

The gradual approach to the theoretical curve (derived from

the above rule) as the temperature difference increases, leads to the conclusion that for temperature differences higher than, say, 100 deg. fahr., the greatly increased effect of radiation would render this simple rule useless. This fact is in line with the one recently established by the Bureau of Standards that for high-temperature insulation air spaces are not as effective as solid walls, because of transparency of air to radiation. Nevertheless, the writer comes to the conclusion that properly arranged inexpensive air spaces can be made as effective as the same thickness of the best insulating material on the market.

Attention is also called to the following conclusions:

1 More attention should be given to the matter of surface resistances, which, in the cases of glass or other poor insulators, constitute practically the total resistance.

2 The velocity of the air on the warm side of the wall probably exerts as much influence on the total surface resistance as the velocity of the air on the cool side.

3 The total surface transmission (both sides) for corkboard, glass and building paper, in the usual ranges of temperature for conditions involving slight air movements, is not far from 25 to 30 B.t.u. per 24 hours per sq. ft. per deg. fahr., and in the case of poor insulators rises to about 50 for a moderate velocity on the warm side and a higher velocity (1000 ft. per min.) on the cool side. (Report on the Thermal Testing Plant for 1916-1917, *The Engineering Experiment Station Bulletin No. 24. The Pennsylvania State College Bulletin*, vol. 12, no. 4, February 15, 1918, 25 pp., 6 figs., *ep*)

Varia

Neville Island Gun and Projectile Plant. The proposed plant will be built and operated for the Government by the U. S. Steel Corporation and will be in charge of a new organization called the U. S. Steel Corporation Ordnance Department, with John Ries, chairman, and L. E. Thomas, chief engineer.

One of the great problems in connection with the building of the new plant is that of securing labor and of housing the many hundreds of men who will be engaged for two years or more on construction work. Tentatively, it is proposed to establish a model town at the lower end of Neville Island with houses for employees of the arsenal as well as for operating officials at the plant. It is not unlikely that one or two bridges will be built across the Ohio River to connect Neville Island with the tracks of the Pennsylvania Lines West, and it is possible that one or two bridges will be erected across the back channel of the Ohio River connecting the island with the Pittsburgh and Lake Erie tracks.

Nothing has been determined so far as to the number and size of the steel works or other units that will be built, there being one stack now with a capacity of 450 tons per day; neither has the number of electric and open-hearth furnaces been determined at yet. (*The Iron Age*, vol. 101, no. 21, May 23, 1918, pp. 338-339, 1 fig.)

The Metric System for the British Empire. Arthur J. Stubbs. *The Post Office Electrical Engineers' Journal*, vol. 11, pt. 1, April 1918, pp. 1-18.

Against the Metric System. *The Iron Age*, vol. 101, no. 21, May 23, 1918, p. 1327.

Emergency Construction Work Due to War Conditions, with Especial Reference to the Construction Division of the Army. Geo. W. Fuller. *Proceedings of the American Society of Civil Engineers*, vol. 44, no. 5, May 1918, pp. 615-685, 3 figs., 10 tables.

Silicon and Carbon. *Engineering*, vol. 105, no. 2733, May 17, 1918, p. 552. Discussion of the chemical relations of these two elements, to a certain extent from the standpoint of comparison.

Charts

Horsepower per Revolution for Cast Iron and Cast Steel Gears for Both Cast and Cut Teeth. C. L. Miller. *The Coal Industry*, vol. 1, no. 5, May 1918, p. 170.

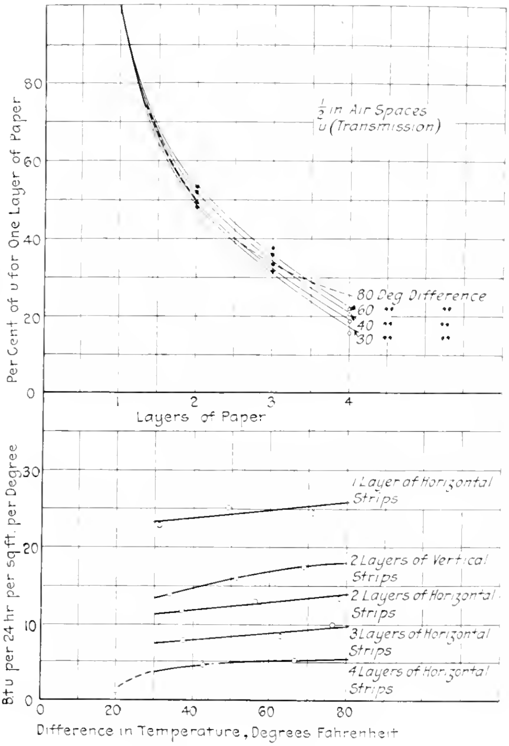


Fig. 14 Total Transmissions for ½-in. Air Spaces

Chart Showing Very High Pressures in Spray Valves of the Pump-Injection Type. *Motorship*, vol. 9, no. 5, May 1918, p. 4.

Chart Showing Pressures Recorded in the Combustion-Space and Cylinder at the Same Time as the Oil-Injection Pressures. *Motorship*, vol. 3, no. 5, May 1918, p. 4.

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Survey.

LIBRARY NOTES AND BOOK REVIEWS

ARTICLES of interest from the Library of the four Founder Societies, selected list of accessions during the month, and reviews of books of special importance prepared by members of the A.S.M.E. and others particularly qualified.

BOOK NOTES

The Chemical Analysis of Iron. A Complete Account of All the Best Known Methods for the Analysis of Iron, Steel, Pig-Iron, Alloy Metals, Iron Ore, Limestone, Slag, Clay, Sand, Coal and Coke. By Samuel Alexander Blair. Eighth Edition. J. B. Lippincott Co., Philadelphia, 1918. Cloth, 6x9 in., 318 pp., 102 illus., 2 tables. $5.

In this work the aim of the author has been to assemble in a single volume descriptions of the various methods and special apparatus which have been shown to be of real value to the iron analyst. Since the appearance of the seventh edition, in 1912, so many improvements have been developed in methods and the alloy metals have become so increasingly important that it has been found necessary practically to rewrite the book to bring it down to date. The table of atomic weights gives the values recommended by the Committee for 1918, and the table of factors has been revised to correspond with the new values.

Analysis of Financial Statements. By Richard P. Wilson and Harry J. Carpenter. La Salle Extension University, Chicago (copyright 1918). Paper, 6x9 in., 38 pp., 4 illus.

In this book the methods and principles of these analyses are described and illustrated by typical examples.

The Automobile Repairman's Helper. A Pocket Book for the Mechanic, Owner, Chauffeur and Student. By S. T. Williams. U. P. C. Book Co., Inc., New York (copyright 1918). Flexible cloth, 5x7 in., 438 pp., 322 illus. $2.50.

The object of the compiler has been to give the best method of doing each particular job of repairing and also to explain the proper sequence in which the various operations should be done. The methods described are thought to cover every trouble likely to be found in all the standard cars.

A Bibliography of Municipal Utility Regulation and Municipal Ownership. By Don Lorenzo Stevens. Harvard University Press, Cambridge, 1918. Cloth, 6x9 in., 410 pp. $4.

An extensive bibliography of material published in English, brought down to the end of 1916. Covers electric, gas, water and traction utilities, listing the material which the author considers of practical value, after an extensive study of the field. The entries are classified and annotated, and an index of subjects and authors is provided.

The Coal Catalog. Combined with Coal Field Directory for the Year 1918, Containing Explanatory Articles on Rank, Usage, Analysis, Geology, Storage and Preparation of Coals, together with a Typical Section of the Productive Formation of Each Coal Mining State in the Union, Maps Showing the Various Mining Districts or Fields, Descriptions of the Seams Mined . . . List of Seams Producing Coal Suitable for Each Industrial Purpose, etc., and a Directory of all the Coal Mines in the United States. . . . Keystone Consolidated Publishing Co., Inc., Pittsburgh (copyright 1918). Cloth, 9x12 in., 671 pp., 90 illus., 25 maps. $25.

A remarkably complete compendium of the coal industry of the United States and Canada, in which is collected the information needed by producers and users.

Digest of Publications of Bureau of Standards on Electrolysis of Underground Structures Caused by the Disintegrating Action of Stray Electric Currents from Electric Railways. Prepared by Samuel S. Wyer. Paper, 7x10 in., 96 pp.

Summarizes by verbatim quotations the essentials of the extensive laboratory and field investigations on this subject which the Bureau of Standards has published up to August 22, 1916. The quotations selected have been classified, and the compiler has added editorial notes. Copies may be procured from the Bureau of Standards, Washington, D. C.

Direct Costs of the Present War. By Ernest L. Bogart.

The Early Effects of the European War Upon the Finance, Commerce, and Industry of Chile. By L. S. Rowe. (Carnegie Endowment for International Peace, Division of Economics and History. Preliminary Economic Studies of the War.) Oxford University Press, New York, 1918. Paper, 7x10 in.

These two pamphlets, belonging to a series of economic studies of the effects of the European War, and undertaken by the Carnegie Endowment for International Peace, discuss separate phases of the question. Professor Bogart's summary of the cost of the war to each participant covers only the direct financial outlays of the governments, compiled from the best available reports. Dr. Rowe gives an account of the immediate effects of the war in the period of the fall of 1914 and the spring of 1915, based on a personal investigation during the latter year.

Dyke's Automobile and Gasoline Engine Encyclopedia. Treating on the Construction, Operation and Repairing of Automobiles, and Gasoline Engines. Also Trucks, Tractors, Airplanes and Motorcycles. By A. L. Dyke. Seventh edition, revised and enlarged, containing dictionary and supplements on the Ford, Packard and airplanes. Published by the author, St. Louis, Mo. (copyright 1918). Cloth, 7x10 in., 864 pp., 515 charts. $3.50.

Presents in clear, simple and concise form the principles upon which gasoline engines and automobiles are built and operated. Sections are included on repairing, adjusting and driving, together with much miscellaneous information of value to automobile engineers and drivers. Over three thousand illustrations accompany the text.

Elements of Machine Design. By Henry L. Nachman. First edition. John Wiley & Sons, Inc., New York, 1918. Cloth, 6x9 in., 244 pp., 275 illus., 22 tables. $2.

A classroom text on the subject of elementary machine design, for students in technical institutes.

Elements of Sanitary Engineering. By Mansfield Merriman. Fourth edition, revised with the assistance of Richard M. Merriman. John Wiley & Sons, Inc., New York, 1918. Cloth, 5x9 in., 250 pp., 47 illus., 17 tables. $2.

A textbook intended to present the subject clearly in the smallest possible space, and to give greater prominence to fundamental principles than to details of construction and operation. The present edition has been revised, and fourteen new pages of text have been added.

Employment Department and Employee Relations. By F. C. Henderschott and F. E. Weakly. La Salle Extension University, Chicago (copyright 1918). Paper, 6x9 in., 60 pp., 20 illus., 4 tables.

Suggestions based on methods in use by various corporations. Contents: Selection of the Employee, the Labor Supply, Promotions and Transfers, Progressive Scale of Promotion Based on General Intelligence Requirements, Employee Records as a Basis for Promotion, Annual Survey of Employees, the Principle of Transfer, the Vocational Laboratory, Job Analysis, Labor Turnover, Educational and Welfare Work.

A Handbook of Rocks.. For Use without the Microscope. With a Glossary of the Names of Rocks and of other Lithological Terms. By James Furman Kemp. Fifth edition, revised. D. Van Nostrand Co., New York, 1918. Cloth, 6x10 in., 272 pp., 41 illus., 75 tables. $1.50.

Professor Kemp has attempted to avoid the difficulties usually met by students, by mentioning and emphasizing only those characteristics which a beginner with preliminary training in mineralogy can observe and grasp. An extensive glossary is included in the work.

Eye Hazards in Industrial Occupations. A Report of Typical Cases and Conditions, with Recommendations for Safe Practice. By Gordon L. Berry. National Committee for the Prevention of Blindness, New York, 1917. Paper, 6x9 in., 145 pp., 51 illus. $0.50.

A survey of the hazards to the eyes in industrial occupations in the United States, with recommendations and suggestions for minimizing them.

General Lectures on Electrical Engineering. By Charles Proteus Steinmetz. Fifth edition, compiled and edited by Joseph LeRoy Haden. McGraw-Hill Book Co., Inc., New York, 1918. Cloth, 6x9 in., 242 pp., 50 illus., 1 por., 1 table. $2.50.

A series of descriptive, non-mathematical lectures on the problems of the generation, control, transmission, distribution and utilization of electric energy. The present edition has been largely rewritten to include the changes that have taken place in the electrical industry during the last eight years.

How to Become a Wireless Operator. A Practical Presentation of the Theory of Electrical Waves, their Propagation, and their Adaptation to Wireless Communications, including Simple and Clear Instructions on how to operate Wireless Devices and how to comply with Government Requirements for Operators. By Charles B. Hayward. American Technical Society, Chicago, 1918. Cloth, 6x8 in., 298 pp., 196 illus., 1 pl., 9 tables.

This work does not discuss the history nor the mathematics of radiotelegraphy, but is intended for those wishing to become proficient operators. Designed for individual study.

An Introduction to Statistical Methods. A Textbook for College Students; a Manual for Statisticians and Business Executives. By Horace Secrist. The Macmillan Co., New York, 1917. Cloth, 5x8 in., 482 pp., 28 pl., 95 tables. $2.

A study of the principles governing the collection, analysis, and synthetic treatment of numerical data, intended to supply the need for a fundamental treatment of the methods of statistical investigation and interpretation. The methods discussed are of general application, and are accompanied by illustrations drawn chiefly from economic and business fields. The treatment is non-mathematical.

Machine Design. A Manual of Practical Instruction in Designing Machinery for Specific Purposes, Including Specifications for Belts, Screws, Pins, Gears, etc., and many Working Hints as to Operation and Care of Machines. By Ernest L. Wallace. American Technical Society, Chicago, 1918. Cloth, 6x8 in., 157 pp., 90 illus., 2 pl., 9 tables.

A simple treatment of the subject, adapted for home study and intended for use by machinists, draftsmen and apprentices.

Manual of Forestry for the Northeastern United States. Being Vol. 1 of Forestry in New England revised. By Ralph Chapman Hawley and Austin Foster Hawes. Second edition. John Wiley & Sons, Inc., New York, 1918. Cloth, 6x9 in., 281 pp., 64 illus., 50 tables. $2.

The first of the two volumes dealing with the specific forestry problems of New England, but applicable also to conditions in neighboring states. This volume presents, in the simplest and least technical form possible, a brief survey of the whole field of forestry, for the use of woodland owners.

Metal Statistics 1918. Eleventh annual edition. The American Metal Market Co., New York (copyright 1918). Cloth, 4x6 in., 427 pp. $0.50.

Tables showing production, prices, imports, exports, etc., of iron ore, coke, iron and steel products, copper, tin, lead, spelter, aluminum, antimony, silver and other metals. In most cases the statistics cover a number of years.

The Modern Gasoline Automobile. Its Design, Construction, Operation and Maintenance. A Practical, Comprehensive Treatise Explaining All Principles Pertaining to Gasoline Automobiles and Their Component Parts. By Victor W. Pagé. Revised and enlarged. The Norman W. Henley Publishing Co., New York, 1918. Cloth, 6x9 in., 1032 pp., 1000 illus., 11 charts. $3.

This edition has been brought up to date by careful revision and the introduction of supplementary matter on ignition, tractors, power transmission, carburetion, etc.

Sulphuric Acid Handbook. By Thomas J. Sullivan. First edition. McGraw-Hill Book Co., Inc., New York, 1918. Flexible ..., 5x7 in., 239 pp., 35 illus., 57 tables. $2.50.

The author has collected in one volume of convenient size the chemical and mechanical data of practical value to makers and users of sulphuric acid in American industries.

Military Observation Balloons (Captive and Free). A Complete Treatise on Their Manufacture, Equipment, Inspection and Handling, with Special Instructions for the Training of a Field Balloon Company. By Emil J. Widmer. D. Van Nostrand Co., New York, 1918. Flexible cloth, 5x8 in., 171 pp., 38 illus., 3 pl. $3.

This manual is based on the balloon manual of the German army, and the equipment and drill in use by the Germans at the beginning of the war. It gives a complete survey of the field.

Patenting and Promoting Inventions. By Mois H. Avram. Robert M. McBride & Co., New York, 1918. Cloth, 5x8 in., 166 pp. $1.50.

Written for the inexperienced inventor, this book gives sound, practical advice on the proper method of securing, protecting and promoting commercial patents.

Principles of Mechanism. By Walter H. James and M. C. Mackenzie. First edition. John Wiley & Sons, Inc., New York, 1918. Cloth, 5x8 in., 241 pp., 246 illus. $1.50.

Presents the elementary principles of mechanism without the use of advanced mathematics. Intended especially for trade schools, etc.

Principles of Ocean Transportation. By Emory R. Johnson and Grover G. Huebner. D. Appleton & Co., New York, 1918. Cloth, 6x9 in., 513 pp., 68 illus., 3 folded pl., 9 maps (two folded), 2 folded charts, 18 tables. $2.50.

A systematic, comprehensive review of the whole subject, including ocean couriers and their services, ocean conferences, ocean rates and fares, and the principles and practices of Government aid and regulation of ocean shipping. The book does not attempt to treat the various questions exhaustively but seeks to present the essential facts for students and business men.

Radiometric Apparatus. For Use in Psychological and Physiological Optics. Including a Discussion of the Various Types of Instruments That Have Been Used for Measuring Light Intensities. By C. E. Ferree and Gertrude Rand. Published as Psychological Monographs, No. 103. Paper, 7x10 in., 65 pp., 6 illus. $0.75.

After a discussion of various types of instruments that have been used for measuring light intensities, and the advantages and disadvantages of each, the authors describe the apparatus which they have found most desirable.

A Text-Book of Laying Off. The Geometry of Shipbuilding. By Edward L. Attwood and I. C. G. Cooper. Second edition. Longmans, Green & Co., London, 1918. Cloth, 6x9 in., ... pp., ... illus., 2 plates. $2.

This work is intended to provide students of naval architecture and ship draftsmen with a description of the processes and methods used in various shipbuilding yards and centers. The second edition has been revised with a view to greater clearness and some additions have been made to the text.

A Treatise on Roads and Pavements. By Ira Osborn Baker. Third edition, rewritten and enlarged. John Wiley & Sons, Inc., New York, 1918. Cloth, 6x9 in., 666 pp., 235 illus., 83 tables. $4.50.

Dr. Baker's work is a discussion of the engineering principles involved in the construction of country roads and city pavements, intended for the designer and inspector rather than for the contractor. Attention has been given to materials and forms of construction that affect the quality and cost of roadway rather than to methods of doing the work. This third edition has been thoroughly revised and entirely rewritten. Five chapters of minor importance have been dropped to make room for an equal number of new ones, and the number of illustrations have been greatly increased.

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Grain Dust Explosions. Investigation in the experimental attrition mill at the Pennsylvania State College. (U. S. Dept. of Agriculture. Bulletin No. 681.) *Washington, 1918.* Purchase.

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Iron Ore Occurrences in Canada. Vol. II. with maps. *Ottawa, 1917.* Purchase.

The Lake Clark Central Kuskokwim Region, Alaska. (U. S. Geological Survey. Bulletin No. 655.) *Washington, 1917.* Purchase.

Laying the Rails for Future Business. With a synopsis of the law for the Federal control of railroads. *New York, 1918.* Gift of Guaranty Trust Co.

List of Fertilizer and Lime Manufacturers and Importers in Pennsylvania. (Bulletin No. 305, Penn. Dept. of Agriculture.) *Harrisburg, 1918.* Purchase.

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Mariners and Merchants of the North. Plans of Norway and Sweden to meet conditions after the war. *New York, 1918.* Gift of Guaranty Trust Co.

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Standard Plunger Elevator Co. Worcester, Mass. Standard Plunger Elevators.

THE ECONOMICAL USE OF FUEL

A Symposium Contributed to the Worcester Meeting of The American Society of Mechanical Engineers, June, 1918

TOPICAL INDEX

C. 55. The Society as a body is not responsible for the statements of facts or opinions advanced in papers or discussions.

THE ECONOMICAL USE OF FUEL

At the Spring Meeting of The American Society of Mechanical Engineers, held at Worcester, Mass., June 4-7, 1918, sessions were held for the discussion of the all-important subject of fuel economy. In preparation for this session the Committee on Meetings invited the Fuel Conservation Committee of the Engineering Council to formulate a set of questions which was sent out to a list of fuel engineers throughout the country, and over 60 of whom responded with contributions.

The country now faces a coal shortage of 80,000,000 tons this year. We need 100,000,000 tons more this year than last, or 220,000,000 tons more than ever before mined in one year. Military draft has taken about 35,000 miners and there is a serious shortage of open-top equipment to haul coal. Every fuel user must exert his greatest effort to effect fuel economy and every engineer owes it as a public duty to render his utmost assistance to this end. In no small measure the symposium which follows should help in the conservation movement.

CONTRIBUTED DISCUSSION

On this and the following pages are published selections from the discussions received in response to the questionnaire issued for the Fuel Session of the Spring Meeting. These are grouped under the several headings to which the subject matter applies. In preparing the material for publication duplicate matter was eliminated so far as possible, and the whole is printed in concise form, so that it may be used for reference purposes with the greatest possible facility.

The topics upon which discussion was solicited are as follows:

1 What Are the Economic Effects of Impurities in Coal?

2 To What Extent Is Fuel Oil Likely to be Used as a Substitute for Coal?

3 How Can Soft Coal Be Burned Without Smoke in Marine Boilers?

4 What Are the Possibilities in the Direction of the Utilization of Anthracite Wastes?

5 What Instruments Are Useful and Desirable in the Boiler Room as Aids in Saving Coal?

6 What Is Essential to the Economical Operation of Hand-Fired Boiler Furnaces When Using Soft Coal?

7 To What Kinds of Plants and Coals are the Different Types of Mechanical Stokers Respectively Adapted, and What Is the Limiting Factor to Their Use in the Small Plant?

8 What Experience Have You Had in the Use of Wood as Fuel? To What Extent Is Wood Available as a Fuel?

9 What Coal Economies Can Be Effected in Residence Heating?

10 What Coal Economies Can Be Effected in the Small Steam Plants?

11 What Experiences Have You Had With the Storage of Coal?

12 (*a*) To What Extent and Where Will the Gas Producer be Used to Produce Economies?

12 (*b*) To What Extent is Natural Gas Being Used as a Fuel for Power Purposes?

12 (*c*) What is the Relative Economy of the Locomotive of 1900 and Today?

12 (*d*) What Proportion of the Coke is Made in By-product Ovens?

12 (*e*) What are New and Important Developments in Methods of Burning Coal?

12 (*f*) What Economies have Resulted from Recent Practice in Making Brick Settings Leakless?

12 (*h*) Is Automatic Air Supply Correctly Proportioned to Coal Supply Possible?

12 (*l*) Miscellaneous—School Heating—Insulation—Smoke Prevention.

Preceding the contributions on the specific topics of the questionnaire, are three discussions of an introductory character which were presented at the meeting by their authors. The first, by David Moffat Myers, Advisory Engineer of the Fuel Administration, outlines the work of fuel conservation which is being undertaken by the Government: the second, by E. L. Cole, of the Fuel Administration of Pennsylvania, tells of the effective work in that state, the source of our anthracite supply, to secure clean coal; and the third discussion, by Alfred C. Bedford, President of the Standard Oil Company, deals with the supply of fuel oil.

In presenting his discussion, Mr. Cole interspersed his remarks with definite statements regarding operators and dealers who had been penalized for delivering inferior coal, and left the impression strongly in the minds of his audience that the Pennsylvania Fuel Administration had the question of a proper quality for the anthracite supply well under control. Following his remarks resolutions were passed, given on page 616, in which those present warmly pledged their support to the Pennsylvania Administrator and heartily approved his accomplishments.

THE GOVERNMENT'S PLAN FOR FUEL CONSERVATION

By David Moffat Myers[1]

As a member both of The American Society of Mechanical Engineers and of the United States Fuel Administration, it gives me pleasure to report the positive and progressive measures which have been taken by the Government for effecting fuel conservation in power plants and on railroads since the last annual meeting of this Society, in December, 1917. At that meeting, in my paper on Preventable Waste of Coal in the United States, a saving of 50 to 100 million tons per year was shown to be possible, together with suggestions as to measures for effecting this economy. I am not overstepping the mark when I state that the national program which I will outline to you, was planned, presented and organized by members and committees of the national engineering societies.

As a result, a Fuel Engineering Division was formed in the United States Fuel Administration in Washington, under its Bureau of Conservation. This division comprised two depart-

[1] Advisory Engineer of the U. S. Fuel Administration. Mem. Am. Soc. M. E.

ments—Railroads and Industries; the latter covering all power plants not belonging to railroads. The railway department was placed in charge of one of the highest authorities in the field in the country, Major Edward C. Schmidt, U. S. R., Mem.Am.Soc.M.E., who was transferred by Secretary Baker to the U. S. Fuel Administration. Major Schmidt devised and developed a plan of organization which was the work of a master mind. It was authorized by the Fuel Administration and endorsed by Mr. McAdoo's special representative. The Railway Administration determined to administer the program through its own organization, whereupon Major Schmidt was given over to the other administration, for the continuance of the work.

At present, therefore, the Fuel Engineering Division devotes itself exclusively to the work of conservation of fuel in stationary power plants, and in the efficient use of steam after its generation. The organization comprises the central office at Washington, with an administrative engineer appointed (or to be appointed) in each coal-using state, attached to the Federal Fuel Administration of that state. The Administrative Engineer has a consulting board of competent engineers, and a staff of technical and clerical assistants and inspectors.

The plan of organization involves centralization on essential fundamentals only. These are uniform for all states. All other features are localized and extremely elastic in their numerous ramifications. This adopted principle renders the plan workable and effective under widely varying local conditions and circumstances.

The fundamentals of the national program are as follows:

a Personal inspection of every power plant

b Rating and classification of every power plant in the country, in five classes, depending upon the thoroughness with which the owner conforms to the recommendations of the U. S. Fuel Administration

c At the discretion of the Federal Fuel Administration, the supply of coal to any needlessly wasteful plant may be curtailed or stopped.

The plan is now in operation in Pennsylvania, the largest coal-consuming state, and also in Connecticut. Other states which have come in but in which the Administrative Engineer is not yet appointed, are Massachusetts, New York, New Jersey, Illinois, Michigan, Wisconsin, Indiana and Missouri.

For the office of Administrative Engineer, men are required of great organizing and administrative ability. For New York State, Mr. Edward N. Trump, Mem.Am.Soc.M.E. and vice-president of the Solvay Process Company, has patriotically accepted the nomination. Mr. Thomas R. Brown, the first Administrative Engineer actually appointed, is in charge of the western district of Pennsylvania. The second appointment was that of Mr. W. R. C. Corson for Connecticut, an officer of the Hartford Steam Boiler Insurance Company.

The standard recommendations of the United States Fuel Administration are substantially as follows:

a Fuel. That means be provided for measuring and recording fuel used each shift or day

b Water. That boiler feedwater be heated by exhaust steam or waste heat, and measured

c Air Supply. That a correct amount of air be supplied to the fuel, and that proper means be provided for measuring and regulating the draft

d Clean Heating Surfaces. That boiler heating surfaces be kept clean inside and out

e Boiler and Furnace Settings. That the furnace and setting be kept in good repair, and free from air leakage

f Insulation. That exposed steam surfaces wasting heat by radiation be covered with suitable insulating material

g Engine-Room and Heating System. That wherever possible, exhaust steam be utilized to the exclusion of direct steam from the boilers. (The plant should be designed and operated to produce no more exhaust than can be efficiently utilized in heating and process work)

h Supervision. (1) That a competent employee or committee be detailed to supervise the work of fuel conservation in the boiler and engine plants; and (2) that a competent committee be appointed in charge of the work of fuel conservation in the buildings and shops outside of the power plants.

To assist in this work, the United States Fuel Administration has prepared a fifty-minute film of moving pictures, showing good and bad operation in the steam-boiler plant, methods of testing boilers, fuels, etc. These pictures will be available to each state, in connection with their publicity and educational propaganda.

The Fuel Administration is also preparing a series of official bulletins on engineering phases of steam and fuel economics. Some of these are now in press.

They will include: Boiler and Furnace Testing; Flue-Gas Analysis; Saving Steam in Heating Systems; Boiler-Room Accounting Systems; Saving Steam and Fuel in Industrial Plants; Burning Fine Sizes of Anthracite; Boiler-Water Treatment; Oil Burning; and Stoker Operation.

In addition to this service, a list of competent engineers has been prepared in Washington for each state, and is available for use of the local administration. As the work develops, still further constructive assistance is contemplated for helping owners to bring their plants up to a high plane of economy.

LIMITING COAL IMPURITIES IN PENNSYLVANIA

By E. L. Cole[1]

Prior to the world war the capacity of the bituminous and anthracite mines in the United States to produce fuel was so much in excess of the demand that competition was an ample and certain factor in assuring the marketing of coal containing only a minimum of impurities.

With the steadily increasing demand for fuel, caused by the rapid development of war industries, there was a noticeable increase of the amount of impurities in anthracite and bituminous during the winter months of 1917.

These facts were known to the Fuel Administration, but because of the clamor among consumers, domestic and industrial, which was accentuated by weather conditions, for any sort of coal, action was deferred at that time. However, friendly suggestions were made to operators in the hope that the quality of coal would show improvement.

It was a vain hope.

During the Arctic-like weather of the second half of last winter the demand for coal skyrocketed to a point never before reached in this country. At the same time, the quality decreased with amazing rapidity, aggravating the existing fuel famine to a degree not readily credible.

The tonnage of inferior coal that was delivered in January was so large as to cause the Fuel Administration to take action. Dr. Garfield, National Fuel Administrator, assigned Mr. James Neale, of his staff, to assist the Pennsylvania Administration in providing and applying remedial measures in the anthracite fields.

[1] Secretary Conservation Division, Federal Fuel Administration for Pennsylvania.

Mr. Neale conferred with Mr. William Potter, State Fuel Administrator for Pennsylvania. With the aid of three gentlemen, who are the Fuel Chairmen in Luzerne, Lackawanna and Schuylkill Counties (Messrs. Tudor R. Williams, A. C. Campbell and Baird Halberstadt), an investigation was carried on into the amount of impurities being shipped to market.

The Fuel Administration then formulated rulings limiting the percentage of slate, bone and under sizes that would be permitted by the Government in all sizes of anthracite. Inspectors were appointed in the three counties mentioned with authority to condemn all coal found below standard. The writer was directed to supervise the inspection of coal at destination points within the State.

Effectiveness of Inspection and Penalties Imposed

The effectiveness of the inspection at the mines and destination points may be indicated by the report for May. These show that less than one-half of one per cent of the daily anthracite production of more than a quarter million tons was condemned by the Federal Inspectors for the month of May. This coal was condemned at the mines, and reprepared for delivery. The vast improvement can be better visualized when it is recalled that more than 50 per cent of the marketed tonnage during January and February contained excessive amounts of impurities.

During the inspection at destination, a car of buckwheat, containing 45 per cent of impurities, was delivered at a textile mill in Philadelphia. The fireman was unable to keep steam above 55 lb., normal steam pressure being 80 lb. Production at the mill fell off 30 per cent and the cost of removing ashes increased 300 per cent. The coal company was compelled to rebate to the mill owner 50 per cent of the cost of the coal, together with an equal percentage of the freight and cartage costs.

Operators who deliver coal containing excessive amounts of impurities have been subjected to various penalties. Some cars were ordered hauled to the dumping grounds in Philadelphia; others were donated to hospitals and other non-profit-making institutions. A few cars were delivered to churches. Many cars enroute to market were diverted back to the mines. In all cases the producing companies were compelled to pay the freight and other charges, and donate the coal. This action by the State Fuel Administrator had a tremendous moral effect upon the producers, and strengthened the arms of the Federal Inspectors at the mines, because publicity was given each case.

Many bituminous as well as anthracite operations have been closed because of the inferior coal shipped from them.

It is the observation of the Fuel Administration that steam sizes of anthracite containing 40 per cent of impurities are so inefficient in generating steam that the cost of such fuel is commercially prohibitory.

Allowable Limits for Impurities

Steam size of anthracite containing not more than 20 per cent aggregate impurities enable firemen to maintain maximum steam under the most difficult conditions. When the amount of impurities exceeds 20 per cent, there is at once a noticeably increased amount of fuel required to maintain normal steam pressure. In addition to this, there is an increase of 10 per cent in the cost of fuel when the percentage of impurities is increased from 20 to 25 per cent, and a further increased cost in the removal of ashes.

However, expert firemen obtain fairly good results with anthracite steam sizes containing as high as 30 per cent of slate and bone, but the fuel costs show an increase of 25 to 37 per cent above the cost of the same size fuel containing only 15 per cent of impurities.

Any steam anthracite containing more than 30 per cent of slate or bone is too expensive for the manufacturer to purchase today, according to our observation. All steam coal containing more than 20 per cent of impurities is condemned when it comes under the observation of the Fuel Administration. This is so even when it is found at destination points in Pennsylvania.

Impurities in Domestic Sizes of Anthracite

The effect of increase in impurities in domestic sizes of anthracite is much more marked than in steam sizes. The domestic sizes include pea, nut, stove, egg and broken coal.

Excellent results are obtained with pea coal containing 8 to 10 per cent of slate and the same amount of bone. That is a total of 16 lb. of impurities in 100 lb. of coal.

When the amount is 11 to 12½ per cent of slate, satisfactory results are obtained but ashes must be removed at more frequent intervals, and more attention given to the fire. At the same time, there is an increase of at least 5 to 8 per cent in the cost of fuel. This applies equally to this size of coal in use of low-pressure and high-pressure service.

Pea coal containing 20 per cent of slate is worthless for low-pressure boilers. In high-pressure practice, fairly good service can be obtained, but ashes must be removed at more frequent intervals and more attention be given to the fire. At the same time, there is an increase of at least 5 to 8 per cent in the cost of fuel.

In high-pressure practice, fairly good service can be obtained with 25 per cent of slate, but the cost of such fuel is virtually prohibitory. The larger the size of anthracite, the lower must be the percentage of impurities to obtain maximum service. No shipments of pea coal with more than 12 per cent of slate are permissible.

Chestnut gives best results when impurities do not exceed 5 per cent of slate and an equal percentage of bone (bone contains 50 per cent of carbon). Any increase above this figure is marked by inferior service. At 15 per cent fires must be carefully attended, or it will be necessary to relight them twice within 24 hours. Chestnut coal containing 20 per cent of slate is so inferior that any price for such fuel is exorbitant. All nut coal containing 7 per cent of slate is condemned by the Fuel Administration.

Stove coal containing 5 per cent of slate and 6 per cent of bone gives maximum service. At 6 per cent of slate and 7 per cent of bone, the result is increase of 8 per cent in fuel costs. This size coal containing 8 per cent of slate and 9 per cent of bone shows the maximum possible amount of impurities that can be used by domestic consumers, discounting the high cost of such fuel. Any percentage above this renders the fuel worthless.

Egg coal should not be used when the amount of slate is more than 4 per cent and 5 per cent of bone. This size of coal is difficult to burn unless it is virtually free from slate. Our standard permits 2 per cent of slate and the same of bone, and because of the size of this coal (it is the size of an average fist) the slate can be readily removed by the consumer. It is much better to do so than to obtain inferior results by shoveling the dirty coal into the furnace. It may be stated that the amount of slate allowed in this coal is only equal to one piece of slate in 100 lb., and two pieces of bone in the same weight.

Broken anthracite must be virtually free from slate or bone. Even in foundry practice, as well as domestic service, it is necessary to remove all slate from this coal before it can be

use. It can be readily perceived that this is imperative when the present schedule only allows 1 per cent slate and 2 per cent bone. This is less than the weight of a piece of bone or [illegible] size of fuel. During January many cars of broken anthracite were shipped from the mines into Philadelphia containing from 12 to 25 per cent of slate.

Imperative Need of Schedules for Limiting Impurities

There is a serious lack of authoritative data on the subject of schedules for impurities. It can be stated without question that bituminous containing more than 2 per cent of sulphur should not be used for locomotive purposes. Two and one-half per cent is the maximum that most standard railroads accept. More than 8 per cent of slate and other impurities makes the coal dear at any price. It is expected that rulings standardizing the quality of bituminous will be issued at an early date.

The essential need of authoritative data on the subject of impurities is emphasized by the attitude of some producers. Last Monday, the president of one of the largest anthracite-producing companies urged that the percentage of impurities in anthracite be increased 2 per cent above the existing standard.

When told that this will result in delivering annually to consumers, at least 1,500,000 additional tons of slate and dirt, at the highest prices ever obtained in the markets, one will readily agree that it is imperative that incontrovertible data should be at hand to sustain and make permanent the present standards governing anthracite deliveries.

To haul the proposed 2 per cent increased allowance of impurities would require about 40,000 railroad cars for a period extending from two to ten weeks, in 50 trains of 80 cars, each pulled by an equal number of locomotives, employing the necessary train crews.

The benefit of delivering one and a half million tons of slate and dirt would result in adding to the profits of producers to the extent of at least six million dollars!

The plea for this proposed allowance was based entirely upon the decreasing labor supply and the increasing needs for anthracite, but, as shown, to permit additional impurities would really increase the volume of fuel production but decrease the value of fuel delivered to consumption points. The Fuel Administration for Pennsylvania is giving serious consideration to some other method of increasing production without increasing the amount of impurities permitted in coal.

Any honest suggestion for increasing anthracite production by lowering the standard of preparation should be accompanied with an offer to reduce the market price in exact ratio to the decreased fuel value of the product.

What the Society Can Do

At this point it may be well to offer the suggestion that this Society take up the task of obtaining data on the commercial cost of impurities of fuel. Recommendations should then be formulated by this Society to the Fuel Administration, that may crystallize into legislative enactment that will make it a crime for unscrupulous producers to unload on consumers inferior product, in much the same way as manufacturers of food are prohibited from delivering to our tables product unfit for human consumption.

The mining and transportation of coal requires a vast army of workers. The quality affects every person in this great country. Is it not a question worthy of the most serious consideration that men of science can give it?

To this end, the writer is authorized to say that William Potter, Federal Fuel Administrator for Pennsylvania, pledges himself and his Administration to aid any measure undertaken to insure to consumers, industrial and domestic, reasonably clean coal as a permanent institution in the United States.

Because the anthracite production is confined to Pennsylvania, the responsibility for overseeing the quality of production rests largely on the shoulders of State Administrator Potter. And it is his task to see that the vast tonnage, reaching almost to 80 million tons, from the Pennsylvania mines shall be of a quality that will enable our manufacturers to produce the essential commodities of life with a minimum amount of waste, at the prices fixed by the Government.

The Administrator invites the patriotic support of this Society in his task of keeping the quality of coal delivered to our hearthstones at a high standard, so that the home fires in the United States may be kept burning brightly while we wait the return of the "boys" who have crossed the sea to battle with the Hun that man may work out his destiny free from the shackles of despotism.

THE FUEL-OIL SITUATION

By ALFRED C. BEDFORD[1]

The opportunity presented to me as Chairman of the National Petroleum War Service Committee to appear before you is one which I welcome and appreciate most heartily. But if you have been looking to the Petroleum Committee for an easy and quick solution of your fuel problems by the proffer of all the fuel oil you want to take the place of coal and other fuels, I am afraid I am due to disappoint you. I am here rather to plead for special economy in the use of fuel oil and for its use only where, from the nature of the work, you cannot properly use coal.

Do not think me an alarmist. I am not trying to warn you of any petroleum or fuel oil famine. But we are all one in our wish to help win the war, and, with that end in view, we want to adjust our available resources and supplies as effectively as we possibly can to the needs of the war.

What are these needs in regard to fuel oil? First and foremost is the Navy, and in the Navy for the war purposes which we are now considering, I include oil-burning cargo ships and transports, as well as the battleships, destroyers and submarine chasers.

Fuel oil is hardly less important for our ocean-going steamships, where one of its great values lies in the saving of space and weight, making possible the carrying of much larger cargoes than where room otherwise is given up to bulky coal supplies.

Our shipyards are rapidly reaching the point where large numbers of vessels will be launched. Careful computation shows that three oil-burning ships of a given tonnage of, say, 6000 tons each, will yield the same efficiency as four ships burning coal of a like tonnage. The tremendous importance of this fact of efficiency is shown when one realizes that three hundred oil-burning ships will carry the same cargo as four hundred coal-burning ships of the same size.

Meantime, the needs of our Allies have to be met, and exports of fuel oil have been for many months, and may be expected still to continue, on an ascending scale. When you add to these the requirements of the essential war industries for tempering, annealing, and other processes, for which coal is less suitable, you will realize the tremendous volume of the demand which simply has to be met.

[1] President, Standard Oil Company.

In 1917 our consumption was in excess of our production and importations of crude oil from Mexico, and it is fair to assume an increased consumption in 1918. Our production does not at present measure up very well to these anticipated demands, but, realizing the situation, oil operators everywhere are keen to develop it with all possible dispatch.

While fully cognizant of the important needs of fuel oil as related to the manufacturing industries, the point must be emphasized that it is impossible to take oil for any one specific purpose without exerting a detrimental influence on some other branch of industry. A very large volume of oil is being used today in the manufacture of gas, and much gasoline is obtained from what would otherwise be fuel oil. The demands for gasoline, however, are such that I must again earnestly urge upon every consumer the imperative necessity of conservation. Indeed, it may become necessary to enact definite and drastic regulations to restrict its needless consumption.

The oil men have organized so as to render the most efficient service, first, in supplying the full needs of the Government and the Allies, and second, in taking care of the ordinary business condition of the country along the lines of priority as laid down by the Fuel Administration.

What then are the conditions governing the present supplies of fuel oil?

So far as the Atlantic Coast is concerned, transportation is at the root of all of our troubles. While hundreds of thousands of barrels of petroleum are available in Mexico, and thousands more might be shipped from the Gulf ports, there is no way of getting these supplies North in the quantities needed. There is a shortage of shipping and the Government has found it necessary to requisition a large percentage of all the tankers in service. The pipe lines are running to capacity, and railroad conditions make it impossible to obtain any material relief by the use of tank cars. We are therefore face to face then with the necessity of making the available supplies of fuel oil along the Atlantic Coast cover the present ever-increasing essential demands. Coal can be obtained. The output of coal can be increased. But the supplies of fuel oil here at present cannot.

The consequence is we must ask the factories here in the East to burn less fuel oil, or none at all where it is possible to burn coal without interfering with the efficiency of the processes involved. Particularly, fuel oil should not be used under steam boilers, either stationary or locomotive. For metallurgical work in small forges and in large forge furnaces, and those used for annealing, etc., oil has its legitimate and essential place, though even here I would urge all the economy possible. But the ordinary user of heat apparatus for the production of steam power will do well to consider coal as his best source of supply, and disregard for the time being the possible advantages of oil.

Considerable difficulties were experienced in many quarters last winter, owing to the limited oil storage provided by consumers and to the irregular running of tank cars. I would therefore urge oil users to plan at once to increase their storage capacity to at least 60 days' supply, and to see that this storage, when completed, is kept full.

1 What Are the Economic Effects of Impurities in Coal?

Incombustible in fuel has a detrimental effect upon furnace operation out of all proportion to the percentage of refuse contained. It has been claimed that when coal contains 40 per cent of refuse it becomes valueless as fuel. Recent conditions have afforded opportunities for interesting observations in this connection. What has been your experience?

W. S. Gould.[1] During the last two years, as prices have mounted higher, the quality of the fuel shipped to market has decreased until lately the lack of quality of the so-called coal available to the power plants of the country has become a decided menace not only to our economic development but to the safety of the nation. It is incumbent upon every one to become familiar with the dangers of the situation and to use whatever influence he may have to force an immediate change in this aspect of industrial activity.

It makes no difference how much our railroad equipment is increased, it makes no difference what prices are fixed by the Government for coal, nor how many rules and regulations are issued by the Fuel Administrator, so long as drastic and effective steps are not taken to insure the proper preparation of the coal mined and shipped.

Efficiency Loss from Ash

The Bureau of Mines estimated that the ash of coal mined in 1917 had increased 5 per cent for the whole country, and that this increase in the ash content meant a further loss of 7.5 per cent in the efficiency of the power plants. Some of the mining districts show a much higher increase in this one element in coal. However, taking the Bureau of Mines estimate, this means in figures of tonnage, that while we produced and shipped 544,000,000 tons of fuel in 1917, the tonnage was equal in effective power-producing qualities to only 476,000,000 tons of the 1916 quality. In other words, in 1917 we mined and shipped about 41,000,000 tons more of material than in 1916 to do 27,000,000 tons less work. Assuming that the work done by the 544,000,000 tons of poor coal was all we had to do, we mined and shipped some 70,000,000 tons simply to make up for the inferior quality. This is the real cause of our coal troubles.

Shipment of Weathered Coal

This, however, is not the whole story. While the increase in the ash content was fully equal to 5 per cent, the decrease in the heat was considerably greater than 5 per cent, this decrease being due to the fact that millions of tons of weathered coal were shipped—pillar and outcrop coal and refuse from mine dumps—all of which was considerably lower in heat in proportion to the ash content than would have been the case if the coal had been freshly mined from the seam. The Fuel Administration originally encouraged these "wagon mines," the number of which increased enormously, directly cutting down the available fuel.

Influence of Sulphur on Clinker

In addition to the well-established loss in efficiency and capacity of our power plants, due to the higher percentage of the ash impurity, we should not lose sight of the further loss in efficiency and capacity due to the increase in the sulphur

[1] President, Fuel Engineering Company of New York, New York. Assoc.Am.Soc.M.E.

content of coal. Sulphur in coal affects the economy of the stokers by forming clinkers, which hinder the proper distribution of air. This improper distribution may be excess or deficiency of air.

It has been found that while the drop in the combined efficiency of the boiler and furnace averaged about 0.5 per cent for each per cent of sulphur between 0.5 and 6 per cent, the general drop in boiler capacity is about 1.5 per cent for each per cent of sulphur. The increased amount of clinker, due to the higher sulphur percentages, is doubtless responsible for this drop in the capacity, reducing the rate of combustion and therefore capacity. This loss is in addition to the losses estimated for increase in the ash impurity and the relatively greater loss in heat due to weathered coal.

Before 1916 eastern coals that carried sulphur in excess of 3 per cent were not common. Since that time the cases of 5 and 6 per cent sulphur, and some almost incredibly high, have steadily increased, until during the last winter it has been quite the exception to find coals with less than 2 per cent.

Then there is the damage that sulphur causes to the tubes, plates and grates of the equipment—a damage that is usually difficult to measure, especially since it is generally unexpected by the plant engineer, or comes when he has no time to make exact calculations or cannot get information as to his coal.

Just two examples of the many cases that have come under our own observation may be given:

a A plant equipped with Model stokers had been using a certain coal which did not average high in sulphur—about 1.60 per cent, but of a character that often causes trouble under similar conditions. The plant had been running wild, with a low rate of efficiency, and there had been no special trouble with the grate bars, which had stood up for weeks. Better operating methods were inaugurated, and the grate bars began melting at an alarming rate, some in about a week. Ordinarily, the cause of this trouble would have been laid either to the operating methods, and therefore a necessary evil, or to the grate bars. We selected, through our Library of Coal Records, a coal of equal heating value but without the characteristics of the coal being used at the plant, and the trouble with the grates ceased.

b Another case was in a plant with flat grates, hand-fired, and running at a low rate of combustion. This plant had been using a coal which was excellent so far as ash and heat were concerned, but which averaged about 2 per cent sulphur. The boilers not being forced, there had been no appreciable damage from the sulphur in the coal. A new lot of coal arriving, showing about 3.50 per cent sulphur, but otherwise being about as usual, I suggested that, with their operating conditions, they would probably find little trouble from clinkering, incidentally remarking that the only probable damage would be to their equipment. The superintendent asked if that were not more or less imagination, so I suggested his making a simple test of the point. One boiler was carefully cleaned and practically new grates installed. It was arranged that the 3.50 per cent coal should be used exclusively under this boiler for one day, and then the fires pulled and an estimate made of any damage that could be observed. A few days later we received a letter from the superintendent stating that the test was run as directed, and that "after four hours the grates were entirely destroyed."

WALTER N. POLAKOV.[1] The value of coal as used for power production is chiefly determined by its steaming capacity. Generally, there are two reasons for the condemnation of steam coals:

a When the composition and peculiarities are unfit for *existing* equipment

b When impurities make it unfit for *any* equipment.

Coals that are unfit for existing equipment or requirements should not be purchased at all, as they may be used to advantage elsewhere. The opinions on the subject advanced by miners, dealers, purchasing agents and accountants should be submitted for final disposition to engineers who are guided by facts.

Coals with a high percentage of non-combustibles were used by the author last winter in both hand- and mechanically-stoked furnaces. For instance, a mixture of 1 part run of mine and 5 parts of anthracite screenings was observed to show never less than 60 per cent of boiler and furnace efficiency. This mixture contained:

Ice and water	15 per cent
Earthy matters	28 per cent
Oxygen	2 per cent
Total	45 per cent

RESULTS FROM IMPURITIES IN COAL

From a large number of observations with coals contaminated with non-combustible impurities that are thrown on the market by some dealers at the risk of the country's liberty and honor, several conclusions may be drawn:

a While the efficiency of steam generation with so-called war coals drops from 10 to 25 per cent, the improved boiler-room management based on task work with bonus invariably more than offsets this loss. (Fig. 1.)

b The steaming capacity of coal drops along a parabolic curve; i. e., with the increase of ash content the evaporation drops more rapidly in the beginning and more slowly when ash percentage is getting high. (Fig. 2.)

c From Fig. 2 it appears that the increase of ash content from 14 to 18 per cent reduces the evaporation per pound of coal from 9 lb. to 8 lb. of steam (11.1 per cent), whereas further drop of evaporation from 8 to 7 lb. per pound of coal (12.5 per cent) corresponds with the increase of ash content from 18 per cent to 28 per cent.

It should be noted that these data are obtained from a number of hand-fired plants using mixtures of hard and soft coal for a period of over 18 months. The means of recording the performances were in all cases most rigorous, specialists taking continuous checks on accuracy, firemen trained and methods of firing constantly adjusted to secure the best possible results. While the deviations of results with each kind of coal are sometimes large, due to difference in plant equipment and degree of training of firemen, the tendency of retarded drop of efficiency with higher percentage of ash remains noticeable throughout.

d While extra cost of haulage and extra expense for the labor of handling coal and furnace refuse are easily estimated, the more important, though less noticeable, loss is due to difficulties connected with the admission of the proper amount of air into the furnace. If this is judged by the rate of firing (lb. per hr.), excess of air is inevitable with coals high in ash. Similarly, if direction is given by draft indications, extra resistance of fuel bed is liable to mislead the fireman. Again, if adjustments are based on gas analyses, the improper velocity of gases

[1] Consulting Engineer, 31 Nassau St., New York. Mem. Am.Soc.M.E.

through the boiler may lower the efficiency of heating surface for the sake of high furnace efficiency, ultimately at the expense of combined efficiency. Also, losses are incurred by more frequent cleaning of fires.

e By far the greatest economic effect of impure coals is the misuse of rail and water facilities for transporting the harmful, or, at best, useless, ingredients. The National

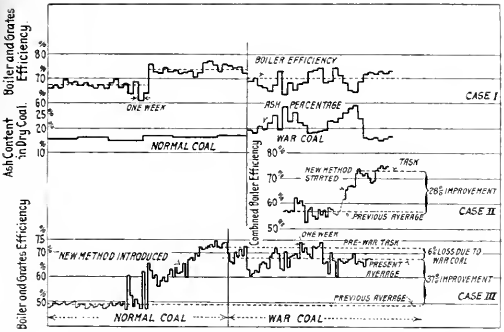

FIG. 1 EFFECT OF IMPURITIES IN COAL ON BOILER EFFICIENCY IN TYPICAL POWER PLANTS

Note: Task Work with Bonus more than offsets the harmful effect

Coal Association in a statement issued April 28, 1918, announces that "Interference with the war program is almost inevitable throughout the East, unless there is a readjustment soon of traffic over Eastern railroads." Decrease in production of coal because of car shortage is estimated by the same authority at about 20 per cent.

f Instead of thus harassing the Government in its task of operating railways and jeopardizing the country's pro-

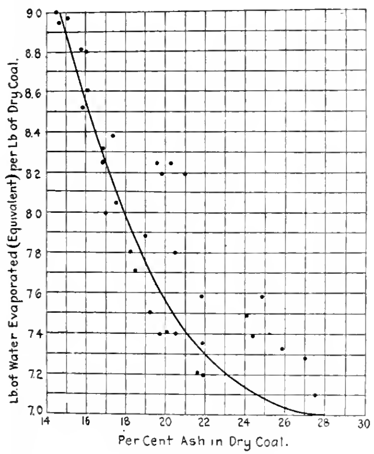

FIG. 2 RELATION BETWEEN ASH CONTENT AND EVAPORATION

duction at this grave moment, the coal producers could disprove the charge of disloyalty by more careful preparation of coal at the mines. Cleaner coal will, as we have seen, not only release large parts of the rolling stock engaged in transporting dirt and slate, but also reduce the tonnage required for steam generation.

g It is to be remembered, however, that half-measures toward preparation of cleaner coal at the mines will not go half way in ameliorating the present car shortage and furnace wastes. By reducing ash percentage from 28 to 21 per cent, only seven cars out of every 100 will be released, yet by removing also the other half of impurities from coal (*i. e.,* placing the quality of coal on pre-war standard) the need will be satisfied with 78 cars out of every 100 now tied up.

To sum up, the vicious economic effect of impurities in the war coal can be overcome as follows:

a A twenty per cent car shortage may be taken care of by releasing 22 per cent through reinstatement of previous quality of coal preparation.

b Further conservation of coal is possible by adopting more scientific methods of power generation and management of plants.

CARL J. FLETCHER.[1] During last winter much coal was wasted throughout Indiana due to the forced change in fuel. There are three very marked differences between the coal mined in Indiana and the coal mined in eastern Ohio, Pennsylvania and West Virginia: first, the amount and quality of the volatile matter; second, the liability to clinker; third, the form in which the impurities occur in the coal as delivered at the boiler room.

Regarding the volatile matter, the eastern coal is higher in hydrogen, making the volatile gases more easily combustible, also less in volume. The principal trouble in burning Indiana coal lies in lack of combustion space, which is necessary for the burning of very high-volatile coal, and a proper distance from the fuel bed to the comparatively cold boiler plates, which robs the furnace of heat and does not allow a sufficiently high temperature for the combustion of all the volatile matter.

Second, the clinkering of coal, when western coal has been substituted for eastern coal, is due primarily to the fact that there is more iron pyrites in Indiana coal. Iron pyrites can be successfully burned without objectionable clinkering under proper conditions. More draft is required to burn Indiana coal, both to keep the grates cool and to get a proper mixture of the volatile matter with oxygen. It often happens that in planning for a change to Indiana coal the grate surface is enlarged, reducing the available draft over the fire, when the proper procedure in this case would be to increase the force of draft.

Regarding the difference in the form of impurities in eastern and western coal, the impurities in Indiana coal appear mostly as shale, which cannot be burned; whereas, ash in the eastern coal is generally evenly distributed throughout the coal, and when eastern coal is burned it is a comparatively easy matter to free the fuel bed of ash. Shaking grates, such as are suitable for eastern coals, generally fail when applied to western coal. It does not do any particular harm to stir and mix some coals, while other fuel beds must not be disturbed. To burn Indiana coal it is necessary to have a type of grate with at least 50 per cent air space, and a grate which will crush the larger pieces of impurities and remove these impurities with a minimum disturbance of the burning fuel.

C. E. VAN BERGEN.[2] The value of coal producing 40 per cent ash depends, first, on the price of coal; second, on the expense of placing it on the grates; and third, upon the cost of removing the 40 per cent ash. We estimate that such a coal

[1] Fuel Engineer, Knox County Coal Operators' Association, Indianapolis, Ind.
[2] Vice-President and General Manager, Duluth (Minn.) Edison Electric Co.

will evaporate, under ordinary conditions, 3 lb. of water.

Our records show, that the coal we used from November 1, 1916, to March 1, 1917, evaporated 7.62 lb. water per lb. coal and contained 10 per cent ash. From November 1, 1917, to March 1, 1918, our coal contained 17 per cent ash and evaporated 6.69 lb. water per lb. coal. An increase of 7 per cent in ash content resulted in a loss in evaporation of 12.2 per cent.

W. L. Abbott.[1] In experiments made with a chain-grate stoker, using Illinois coal mixed with various percentages of ash, the capacity and efficiency of the unit dropped gradually with an increase of ash up to 35 per cent, after which they declined rapidly to zero efficiency and capacity with a fuel containing 40 per cent ash. The fuel would still burn, but the boiler would not generate steam. The fuel used in the test was made by mixing various amounts of ashes with a clean pea coal, the ash content of which was about 8 per cent. Thus, in the final test, the coal containing 8 per cent of ash was mixed with an additional 32 per cent of impurities. A different furnace or stoker might have given a somewhat different result, but it is questionable if any other form of stoker would have handled a fire containing that great amount of readily fusible ash.

Results obtained from this series of tests, which were made by mixing ash with the coal, correspond with results obtained by the Bureau of Mines in tests made in St. Louis using coals with an inherent ash content ranging up to 25 per cent, above which point the Bureau's tests did not go.

In a gas producer a fuel mixture of the kind first described would, no doubt, have given some useful results. A blast furnace always operates with a fuel mixture containing more than 40 per cent of non-combustible. If a coal contained as much as 40 per cent ash, it would not be marketable, and might rather be called a bituminous shale. Marketed coal contains between 2 per cent and 15 per cent ash, as extremes, but is usually below 10 per cent. If the fuel mixture carries more, it is due to impurities which are associated with the coal; for example, a coal seam analyzing 10 per cent in a seam sample may produce mine run containing 15 per cent ash.

With increasing ash content there is a decreasing boiler efficiency and an increasing cost of the steam produced, and while coal containing nearly 40 per cent of ash may produce some steam, it is rare indeed that it is economical to use coal containing as high as 20 per cent ash.

H. Kreisinger.[2] In the outline of this topic is a statement that when a fuel contains 40 per cent refuse the fuel becomes valueless. This statement cannot be applied generally as there are places where such fuel has economic value. In power plants located near the mines, washery refuse containing less than 50 per cent combustible can be used profitably, especially if the furnaces are designed for burning such fuel.

Some time ago the Bureau of Mines made a boiler test with washery refuse containing 41.8 per cent of ash, 10.8 per cent of moisture, 47.4 per cent of combustible. The test was made under a 200-hp. Heine boiler set up with ordinary hand-fired furnace with plain grate. About 75 per cent of the rated capacity of the boiler was developed with average over-all efficiency of 47.5 per cent. Of the 47.4 per cent of combustible in the fuel, 8.6 went with the ashes into the ashpit, an equivalent of 22.5 was absorbed by the boiler, an equivalent of 10.4 went up the stack with the gases, and the equivalent of 5.9 was lost by radiation, incomplete combustion, and moisture in fuel. The largest loss was up the stack due to large excess of air. The draft was 0.92 in. at the base of the stack, 0.06 in. in furnace, and 0.75 in. pressure in ashpit. The average thickness of fuel bed was 16 in. The fire was cleaned every hour. On account of the necessity of this frequent cleaning the average capacity fell below the rating of the boiler, although between the cleanings of fire the capacity developed was above the rating. It was also due to this frequent cleaning that the stack losses were high.

The essential requirement for the economical burning of high ash fuels is a continuous and automatic removal of ash from the furnace, so that the operation of the boiler need not be interfered with by frequent cleaning of fires.

A few weeks ago the Bureau of Mines received a letter from the president of a mining company, who was planning a furnace for burning washery refuse running about 40 per cent of combustible. This is a step in the right direction; the only place where it may be profitable to burn washery refuse or any other low-grade fuel is right at the source of such fuel so that the freight on the high ash is eliminated from the cost of the fuel. It would be wrong under the present railroad-car shortage to ship high-ash coal from the mines. At present the production of the coal mines is about 30 per cent below normal, and most of the deficiency (about 26 per cent) is caused by shortage of railroad cars. Therefore, the available railroad cars should be used only for hauling clean coal.

B. S. Murphy.[1] The following notes are based on data from the Hudson & Manhattan R. R. Co., and especially from its Jersey City power station, which is an anthracite-burning steam-electric plant for an electric railway

The boiler equipment consists of nine 900-hp. Babcock & Wilcox boilers, eight hand-fired and one equipped with a Coxe mechanical stoker.

The fuel is anthracite of the small sizes. Our practice is to use Nos. 3 and 4 buckwheat mixed with bituminous and some No. 1 buckwheat, this latter with no soft coal added. All fuel, 115,000 tons of anthracite in 1917, came from the same contractor, and approximately all of it originated from the same collieries, so that the combustible portion of the coal

TABLE 1 CALORIFIC VALUE OF COAL AS FIRED, B.T.U.

Year	Minimum	Average	Maximum
1911	11,230	11,523	11,750
1912	11,050	11,428	11,650
1913	11,450	11,741	12,000
1914	11,550	11,912	12,050
1915	11,550	11,712	11,900
1916	11,150	11,563	11,850
1917	10,850	11,170	11,350
1918 (3 mos.)	10,750	10,900	11,150

should be relatively the same. On the graph, Fig. 3, I have plotted the calorific value of the fuel by months in 1916 and 1917 with the first three months of 1918. In Table 1 are given the yearly averages and the maximum and minimum months during the year.

An ash analysis gives relative values for the ash content of coal, but the true test is the proportionate amount of furnace refuse as compared with coal fired. Such a figure, taking into account the unconsumed carbon as well as the ash and other incombustibles for the amount and kind of ash, has a great

[1] Chief Engineer, Commonwealth Edison Co., Chicago. Mem. Am. Soc. M.E.

[2] Engineer, United States Bureau of Mines, Pittsburgh, Pa. Mem. Am. Soc. M.E.

[1] Superintendent of Power, Hudson & Manhattan Railroad Company, Jersey City, N. J. Mem. Am.Soc.M.E.

bearing on the fuel in the ash, especially for hand firing. The average values of this for 1917 and 1918 are shown in Fig. 4.

From the foregoing it is evident that there has been a marked deterioration in our coal. The resultant economic effect I have shown in Fig. 4, which gives the average relation between the calorific value of the fuel as fired and the relative overall plant economy. This has been plotted by the relative percentages, that is, assuming that the best coal we could

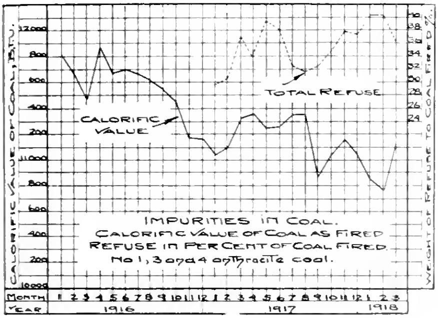

FIG. 3 SHOWING FLUCTUATION IN HEATING VALUE AND REFUSE CONTENT

expect would give a plant economy of 100 per cent, then a coal of 10,500 B.t.u. will give but 53 per cent of this value, and extending the curve it becomes zero at about 9,000 B.t.u., or the effective range is from 9,000 to 12,000 B.t.u. In figuring the effect of a decrease in calorific value of the coal under consideration, this range should be used and not the whole range down to zero B.t.u.

EFFECT OF HIGH ASH

Some of the poorer coals have ash by analysis as high as 24.45 per cent, with 10,294 B.t.u. calorific value of wet coal, while the better ones have only 9 per cent with 12,000 B.t.u., or a 15 per cent difference. On the calorific-value graph this is plotted, and though the curve is not extremely accurate, it would indicate that the limit for our coal was reached with about 30 per cent ash, this having a greater effect on the mechanical manipulation of the fires than on the lack of heat value.

The above is based on hand-fired operation where the impurities content and kind of ash has a much greater influence than with stokers. The railroad load having marked morning and evening peaks is subjected to this much more than a plant with an average all-day load. The presence of impurities builds up the fires so rapidly that at times it is difficult to get through the service period without cleaning and necessitates the carrying of high ashpit pressures, at times 7 in. water gage, to burn the fires. Another noticeable feature that we have found with the No. 1 buckwheat is the formation of a light, puffy ash that builds up the fires so rapidly that they last only about three-quarters of an hour between cleanings, while an analysis of this same fuel shows but 16 to 17 per cent (gravimetrically) of ash, or a normal ash content, again showing that too much dependence cannot be placed on laboratory analysis for the effect on the fuel of the ash. As a rule, with anthracite the ash does not fuse into large, hard clinkers found with many kinds of bituminous coals; but even this has been noticed during the past winter, some of the clinkers being so large and so hard as to necessitate their removal through the fire doors instead of through the ash hopper.

Unconsumed Carbon in Refuse. In our station it is necessary to force the boilers during the service hours to 140 to 150 per cent rating. To do this with good firemen and good coal is not difficult, but when the impurities increase and the quality of men falls off it is extremely hard, one affecting the other. It is necessary with the good grades of No. 3 buckwheat to level fires about every eight minutes, and with the high impurities and uneven spreading it should be done every three or four minutes. This is heavy, hot work; it is much easier to "bail" in coal, and the result is that the fire continues to build up because the ash and coked coal are covered with green coal until the fire becomes so heavy that it is impossible to get air through it. Cleaning then wastes a large amount of unconsumed carbon to the ashpit. The magnitude of this loss is shown in Table 2. With good fuel and well-trained, willing firemen this has been brought down to less than 20 per cent.

TABLE 2 [illegible]

M[illegible]	[illegible] Per Cent
[illegible]	11.[illegible]
[illegible]	[illegible]
M[illegible]	[illegible]

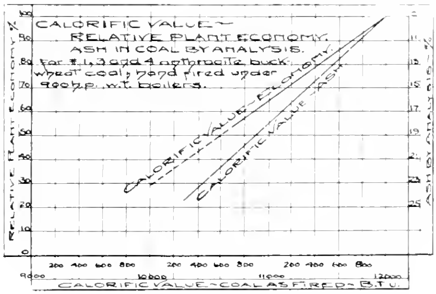

FIG. 4 INFLUENCE OF ASH CONTENT AND HEATING VALUE OF COAL ON PLANT ECONOMY

Summary. Summing up for the conditions as outlined for hand-fired boilers with the present grade of firemen available using Nos. 3 and 4 buckwheat coal with a relatively small percentage of bituminous, we find the following:

Calorific value, low limit, 10,200 B.t.u.; ash, high limit, 30 per cent, depending upon the behavior of the impurities.

Effect on Plant Economy: An increase in consumption per kw-hr. of 53 per cent from 12,000 B.t.u. to 10,500 B.t.u. coal. More coal is consumed, more coal is handled to the bunkers and to the fires and more refuse removed, increasing the unit cost of power.

Effect on Personnel: Much hard work for firemen with the result that the better men leave for easier work, poorer men hired who use proportionately more coal and consequently make more work for themselves.

Capacity: The capacity of a plant is limited by the small evaporation per pound of coal and the much shorter periods between cleanings.

Remedy. If the amount of impurities and the correspondingly low calorific value cannot be remedied at the mines, where some of this should be eliminated, then the remedy at the fire room is the increasing of the bituminous-coal content in the mixture, the introduction of mechanical stokers and the training of firemen, if the men can be induced to stay long enough to be trained.

R. H. KUSS. Close observation supports the following views:

It is feasible to arrive at accurate conclusions on the subject of comparative performances in well-conducted plants only, since ash-variation effect is obscured when accompanied by operation slovenliness.

The well conducted plant employs its available draft intensity to advantage, meaning by this that the unit rate of capacity tends to be such as to demand strict attention to tightness of settings, baffle repairs, cleanliness, etc., resulting in a comparatively high rate of combustion where slovenly methods are not permissible.

A marked increase of ash content in the coal compels a reduction in the usual unit capacity rate due to greater grate-refuse resistance.

A corollary effect is to carry thinner active fuel beds, attended with unevenness of air distribution through like grate zones in order partially to overcome the disadvantages of lower capacity rates.

With a surplus of draft the ill effects of ash increases can readily be overcome, though plant practice as to firing methods must be modified to suit.

Where extra draft intensity is employed to overcome increased fuel-bed resistance due to extra ash, the necessity for setting tightness is increased.

The usual condition is that available draft intensity is deficient, and there is no choice but to operate at lower capacities, thereby causing plant standby fuel losses due to radiation, banking, blow-downs, soot blowing, combustible in the refuse, etc., to increase.

The writer customarily attributes one-half of one per cent as a justifiable decrease in efficiency for every one per cent increase in ash content, but believes this to be a fair figure only when the increase does not exceed ten per cent of the total in ash content as revealed by a chemical analysis of the coal as fired.

A. S. VINCENT.[2] The building of which I have charge is the largest apartment house in the world, occupies a whole block, has 175 families and is thoroughly equipped with a high-class isolated plant. Our horsepower-hour outputs for 1916 and 1917 were almost identical, and yet for 1917 consumed nearly 1000 tons more than we did in 1916, due only to the inferior grade of coal. In other words, the coal consumption in 1916 was about 7000 tons and in 1917 it was 8000 tons. This plant is equipped with everything an engineer could desire to enable him to keep plant records.

Our cost per boiler horsepower-hour in 1916, including all overhead charges, was $0.0114 and for 1917 was $0.017, due almost entirely to the excess coal used and at a cost of more than double the 1916 cost.

ALBERT A. CARY.[3] In an investigation made in a number of the largest power houses in the East during the latter part of 1917 in the interest of fuel conservation and its bearing upon the transportation problem, I found that over 30 per cent of all transportation facilities carrying bituminous coal were burdened with unnecessary impurities. By unnecessary impurities I mean those above the normal ash which had been carried in the coal when the power houses were obtaining their coal under specifications defining the minimum B.t.u. per pound of coal and maximum ash content acceptable.

A. J. GERMAN[1] (Oral). Our experience with the impurities in coal has been interesting. We at first had trouble unloading the coal in that the foreign matter in the coal broke the crusher gears. More trouble is given when the coal comes into the automatic stokers. Then there is the further damage done to the furnace side walls and to the bridge walls. When about to unload coal we try to pick out the slate and rock on top of the car. We picked up pieces last winter as large as 4 ft. in length, 2 ft. in width and 5 in. in thickness. We picked out 9000 lb. of such material from three forty-five-ton carloads.

We use coal crushers with one set of rolls with bearings having spiral springs so that the rollers may give way and pass a too solid piece of material, such as rock and slate. Nevertheless, we had considerable trouble with the breaking of the crusher. To avoid this we put in relays with an automatic overload release. This stopped the trouble, which may be considered to have been rather severe inasmuch as we broke six gears, three shafts and a number of bearings last winter. We use a chain-grate stoker, and we have found that the great increase in the amount of dust in the coal allows a considerable quantity of the screenings to fall through the grate. We catch these in a hopper placed under the front of the stoker.

R. J. S. PIGOTT[2] (Oral). In connection with the points brought up with regard to the effect of the increase of non-combustible material in coal, it is quite true that both the efficiency and capacity are seriously affected in hand-fired plants. It is found, too, that with the proper operation only capacity is seriously affected. In two well-operated plants, the efficiency of the boiler room has not been seriously affected by bad coal; but the capacity and maintenance of the equipment are affected. The increase in ash cuts down the heat value, or B.t.u., that can be developed per sq. ft. of grate per hour. Of course, the increase of ash simply cuts down the B.t.u. that one can get into the furnace per sq. ft. of grate. The trouble is that many plants, due to the large increase in ash, have to run close to their safe margin of capacity, and, as it is difficult, at this time, to get additional apparatus, the trouble is a serious one. Therefore it is the hand-fired plant that suffers most seriously from this condition, and it is that plant to which the Fuel Administration will have to give the greatest amount of help.

P. W. THOMAS.[3] The incombustible portion of the coal limits the actual amount of heat contained in one pound of coal: its nature determines the percentage of contained heat which will be available for initial furnace temperature, and the components of ash have more bearing upon stoker design and furnace design than those of the combustible portion of the coal.

[1] Consulting Engineer, Chicago, Ill. Mem. Am.Soc.M.E.

[2] Superintendent and Mechanical Engineer, The Belnord Apartments, New York City. Assoc. Am.Soc.M.E.

[3] Consulting Engineer, New York. Mem.Am.Soc.M.E.

[1] Waterbury, Conn.

[2] Consulting Engineer, Bridgeport Brass Works, Bridgeport, Conn. Assoc. Mem.Am.Soc.M.E.

[3] Fuel Engineer, Central Coal & Coke Co., Kansas City, Mo.

The following functions of the stoker are affected by the quantity and nature of the ash:

a Weight of coal fed per unit of heating service per hour
b The character of the fuel bed
c The coking time of the combustible coal
d The nature of the coke residue
e The proper diffusion of air admitted
f The actual mechanical performance of both moving- and stationary-stoker metal.

The design of the furnace is greatly affected by the nature of the ash and should be such as to avoid the following defects:

1 Impregnation of firebrick with slag formation
2 The building up of the smaller particles of fusible ash in the furnace, by which the throat is restricted.

Another item of consideration with respect to the ash, especially in horizontally baffled boilers, is that the velocity of the gases through the first pass must either be slow enough to deposit the ash particles in the combustion chamber or sufficiently strong to carry them toward the last pass to a lower temperature. If deposited in the first pass in a high temperature, they will build on the tubes and bottle the furnace.

To our minds, then, the stoker should be selected after an investigation of the ash in the coal to be used. A typical analysis of fluxing ash is given below:

Silica as oxide	43.50
Alumina	17.10
Ferric oxide	28.10
Calcium oxide	5.30
MgO	0.75
Sulphur (sulphide occluded in CaO)	2.75
Carbon dioxide	trace
Carbon unburned	1.90
Alkali	trace
Moisture	trace
	99.40

Probable fluxing temperature, 2138 deg. fahr.

(Cosgrove states that silica melts at 3227 deg. fahr. A silicate formed by the combination of FeO and SiO fuses at 2318 deg. fahr., and if part of this silica is replaced by 16 per cent CaO, the resulting iron-lime silicate will fuse at 2138 deg. fahr. The above ash, if considered from the standpoint of these three metals, contains 57 per cent silica, 37 per cent iron, 16 per cent calcium.)

If the slag is allowed to accumulate in any receptacle such as a dump grate or ash pocket, its peculiar viscous nature will invariably cause trouble. Sooner or later the mechanism of the ash dump will clog, with a resultant shutdown for repairs to both ash pocket and grate.

If any of these coals is carried on a thick fire, an inversion or disturbance of the fuel bed will precipitate an ash run in the fuel bed proper. The slag is so heavy that I have known it to settle down into the tuyere boxes against a pressure of 5 in. of water, and within two hours close the entire air supply of the furnace.

Once the air is shut off, the condition becomes aggravated in the following manner: The pyrite FeS_2, instead of oxidizing to the relatively harmless ferrous oxide, reduces to ferrous sulphide, FeS, which has the same fluxing temperature as the ferrous lime silicate, 2138 deg. fahr., but when the FeS melts, it runs over the metal of the furnace and destroys it. Troughs and dead plates are warped and wasted. A run of molten iron sulphide through a grate of any type will in a few hours carry enough metal from the stoker to the ashpit to shut the boiler down.

2 To What Extent Is Fuel Oil Likely to be Used as a Substitute for Coal?

Information is desired as to present use, advantage found, probable available supply, etc.

Ernest H. Peabody.[1] At the end of 1914, the total aggregate world output of oil since 1857 had reached the enormous total of about 5,500,000,000 bbl. (of 42 U. S. gal. each), of which the United States had produced about 60 per cent. By the end of 1916 this had risen to 6,478,944,229 bbl. In 1916, it is estimated, there were produced 460,639,407 bbl., of which the United States produced 300,767,158 bbl., or 65 per cent.

The data in Table 3 are from the preliminary report of the U. S. Geological Survey, and show that in the year 1917 the production in the United States had increased some 14 per cent over 1916, reaching the record-breaking total of nearly 342 million barrels.

Forty Per Cent of Oil Available for Fuel Purposes

At least 40 per cent of all the crude oil produced will be available for fuel purposes. Notwithstanding the great amount required for war purposes, particularly in the Navy and the rapidly increasing merchant marine, it is well worth asking whether or not oil fuel can be obtained for steam production on shore.

No definite statement can be made as to the availability of oil in any particular locality, especially under the existing conditions. At all times, in fact, this is purely a local question. In California, until recently our largest oil-producing state, and where no coal of importance is mined, oil will doubtless continue to displace coal. In Pennsylvania, on the other hand, there are great coal deposits, while the oil produced is of a variety exceedingly valuable for refining purposes, so that coal as fuel holds decided superiority over oil except for special uses. In other portions of the country the balance may fall either way—as the production and the demand vary and as the transportation problem may determine. It would

TABLE 3 FUEL-OIL PRODUCTION BY DISTRICTS IN 1916 AND 1917

Field	1916	1917
	Barrels	Barrels
Appalachian	23,009,455	24,600,000
Lima—Indiana	3,905,003	3,500,000
Illinois	17,714,235	15,900,000
Oklahoma—Kansas	115,809,792	147,000,000
Central and Northern Texas	9,303,005	11,000,000
North Louisiana	11,821,642	8,700,000
Gulf Coast	21,768,096	24,900,000
Rocky Mountain	6,476,289	9,200,000
California	90,951,936	97,000,000
Other Fields	7,705	....
	300,767,158	341,800,000

[1] Consulting Engineer, Babcock & Wilcox Co., New York City.

seem as if the Middle West should be well supplied with oil, as Oklahoma now produces more than one-fifth of all the oil in the world. Oklahoma wrested the production laurels from California in 1915.

The Mexican production, while already very large (nearly forty million barrels in 1916), has been restricted on account of a deficient amount of tonnage to take the oil away. With adequate shipping facilities it is probable that the Mexican fields will constitute the natural source of oil-fuel supply for New England and the Atlantic states. There is one well alone in Mexico, the Cerro Azul, estimated to have flowed 263,000 bbl. a day, and it is interesting to speculate on what these fields may finally produce.

All indications point to the probability that there are enormous quantities of oil yet hidden in the earth's crust to be one day brought forth by the prospector.

Care Required to Prevent Waste of Oil

A coal fire in the hands of a lazy or incompetent fireman may indeed fall far below the desired standards of excellence; but it can only reach a certain minimum level of efficiency, and then it will go out. Coal is, in fact, of such a nature that it will quietly stand a certain definite loss in economic results, and then it will quit.

With oil there is no limit to the possible wastefulness that may exist. Give it poor burners, improper furnace conditions or not enough draft, and it will smoke and sputter and drip oil and waste itself away, but never give up. Give it too much air, a hundred times too much, and the fire will burn, the oil will disappear, the flame will be bright, there will be no smoke; but the waste may be so great that the boiler will not make enough steam to run the feed pump, even with the best furnace and burner arrangement.

It is approximately true that 1 lb. of oil equals $1\frac{1}{2}$ lb. of coal in actual steam-making results. Roughly, this is equivalent to saying that 200 U. S. gal. of oil equals one ton (2240 lb.) of coal, or one ton of coal equals about $4\frac{1}{2}$ bbl. of oil.

A very handy rule, but like the rest only approximately correct, is this:

> When the price of coal in dollars per ton (2240 lb.) is double the price of oil in cents per U. S. gallon, the cost of fuel for producing a certain boiler capacity will be the same for both fuels. Thus two-cent oil equals \$4 coal, or four-cent oil equals \$8 coal.

This rule takes into consideration the probable increased boiler efficiency obtainable with oil, but makes certain assumptions concerning the heat values of the two fuels and the weight of the oil per gallon which, while generally representative, may or may not be correct in any specific instance.

Generally speaking, one oil burner will be required for, say, 350 to 400 boiler hp., and one oil fireman can attend to about ten burners.

Reliable tests with oil fuel have shown that the boiler efficiency (i.e., the percentage of heat units in the oil which is actually absorbed by the steam leaving the boiler) may be as high as 83 to 84 per cent, although 78 to 80 per cent may be considered as good work, or even 75 per cent, in regular operating conditions. With coal fuel, while reports have been published by some pseudo authorities showing over 80 per cent, the writer believes that such high results with coal can only be obtained with very large boiler units and the most efficient mechanical stokers. Certain it is that in hand-fired plants, 75 per cent is about the maximum, while 65 per cent may be considered very good average work.

The advantage possessed by oil in respect to increased efficiency is due primarily to the small amount of air required for complete combustion in excess of the theoretical amount. This may be reduced to 10 per cent with oil, while the best tests with coal, hand-fired, show about 50 per cent, and good every-day working conditions run as high as 80 or 100 per cent.

Maintenance Less with Oil than with Coal

Maintenance charges are decidedly less than with coal. It is true that higher furnace temperatures with oil as a rule require a better quality of firebrick, and danger may result to boiler heating surface with improper furnace arrangements and burners. These points are easily cared for.

The theory of burning oil is different and radically distinct from that controlling the burning of solid fuel. Pulverized coal of course in some respects closely approaches the character of burning oil, but coal fired by hand or by stokers remains substantially at rest during combustion, and the air is brought to it. In the case of oil, the fuel is moving and the air moves with it.

In varying the rate of combustion of coal, the amount and velocity of the air through the fuel bed is altered—the intensity of the draft is increased or decreased. In the case of oil, the amount of fuel itself and the rate at which it enters the furnace must be varied, and the amount of air entering with it must be increased or decreased to preserve the proper ratio.

The lighting of an oil fire is a simple process. The oil pump is started to give the necessary oil pressure at the burners. The draft is opened to provide sufficient air for combustion. A lighted torch is then placed directly under the burner tip, and the oil is then turned on. If the oil is at the proper temperature and the atomizer is working properly, the spray at once bursts into flame. The spray must never be started without first lighting the torch; i.e., no oil must be injected into a "dark furnace," for if it is, an explosive mixture may be formed in the furnace which will cause damage if ignited.

There is little or no difference in the action of compressed air and steam in atomizing oil as far as boiler work is concerned, and if the air is compressed to over 30 lb. per sq. in. there is no special difference in the design of the burner itself.

So far as the steam-boiler furnace is concerned, however, the prospective user of oil may forget the air atomizer, the one instance in which its use might be considered being that in which the saving of fresh water (consumed by the steam atomizer) is a matter of importance. And in this case a mechanical atomizer will probably do the work effectively, and will be preferred.

Selection of Type of Burner

As between the claims of the steam atomizer vs. the mechanical atomizer, the issue is not as clear cut. On board ship, except in the case of harbor vessels or those making port every day, the steam atomizer has given way to the mechanical atomizer, where the saving in fresh water for the boiler makes the use of the latter type practically imperative.

There is practically nothing to choose between the two types in operating results under equivalent conditions. The steam atomizer is, however, more flexible, i.e., the individual burner has a greater range in capacity; it costs less to install, notwithstanding that it requires two lines of pipe (oil and steam), whereas the mechanical uses only one, and that for the

oil. It is more readily applied to a coal-burning furnace, and conversely the furnace is more quickly converted back again to coal. It requires a lower oil pressure and not so high a temperature for viscous oils. It will also, in general, require less draft to operate. Furthermore, where special arrangements of burners are required, as in the case of the so-called "back-shot" burner (placed at the rear of the furnace), the steam atomizer is susceptible of a wide range in design which has been found useful.

Oil Pressure and Temperature

For steam (or air) atomizing burners, oil pressures of 25 to 50 lb. at the pumps are adequate, and under certain conditions even less pressures. Overhead tanks a few feet above the burners, feeding the oil by gravity, have been employed, but this is inadvisable on account of danger of fire, and pumps are usually employed. Mechanical burners require pressures of 50 to 250 lb. at the burner tip, 200 lb. being a favorite pressure for the designer. The wide range of pressure is useful in adjusting the burner capacity. A steady oil pressure is a necessity for oil burners, a vital necessity for mechanical burners. Therefore large air chambers on the oil line are needed if the usual duplex reciprocating pump is used. Rotary pumps are being introduced in the Navy, and recently the screw pump has come into vogue. These pumps give a steady pressure of oil with little or no air cushioning, and the screw pump, particularly, seems to possess great possibilities for this work.

The matter of heating the oil is rather of a mechanical nature as its importance bears on the viscosity of the oil rather than on any thermal advantage. Steam atomizers will handle more viscous oil than the mechanical type, therefore steam heaters using exhaust steam from the pumps and capable of heating the oil to 100 deg. to 125 deg. fahr. are usually satisfactory. The mechanical burner requires that the viscosity of the oil be reduced to 8 to 10 deg. Engler to spray properly, and this means that the oil (according to its viscosity) must be heated to 120 deg. to 280 deg. fahr. The latter temperature is required for heavy viscous oils that are appearing on the market to a greater and greater extent. In a mechanical-burner installation it is evident that the oil heater is a most essential part of the equipment.

Importance of Air Regulation

To a certain extent the amount of air being delivered to an oil fire is indicated by the color of the flame, a very bright, intense white (so desirable with coal) usually indicating that too much air is being used, with a resulting loss in efficiency. Judging the fire by the flame, however, is only approximate; and it is better to resort to the simple device of diminishing the air supply until a light brown haze appears at the top of the chimney. This is preferable to a clear stack, as the latter gives no indication of excess air. The light haze is not at all objectionable but represents good conditions, provided—and this is a most important point—the smoke which produces the haze does not come from one or two burners only, while all the rest are working with oil. Complete combustion in the furnace (that is, combustion in which all the carbon is burned to CO_2 and no CO is present) will give an analysis with coal in which the CO_2 content, plus the free-oxygen content, will add up considerably higher in amount than an analysis of the products of similarly complete combustion of oil. The same percentage of CO_2 in the gas sample from coal indicates a much greater excess of air over that theoretically required than when oil is being burned. However, complete combustion of oil can be secured with a much lower amount of excess air than coal fuel; and it happens, therefore, that 14 per cent CO_2 in both cases represents the same satisfactory conditions in the furnace with both fuels.

The amount of air theoretically required for the complete combustion of fuel oil of course varies with the composition of the oil, but it may be considered that about 14 lb. or 18 cu. ft. at 60 deg. fahr. represents the average.

Boiler Furnace for Oil Fuel

In oil burning, "furnace volume" possesses a function similar to that of "grate area" in burning coal fuel. The rate of combustion of oil per cubic foot of furnace volume may be increased or decreased according to the intensity of the draft. A large furnace is necessary, therefore, if the draft is low, and the furnace can be made smaller if the draft is increased. This effect of furnace volume on the rate of oil combustion is often ignored or misunderstood; but it is of prime importance.

A high furnace temperature promotes the combustion of oil. Owing to the less quantity of excess air, oil furnaces are usually higher in temperature than those burning coal, so that good-quality firebrick with a fusing point at least 3000 deg. fahr. should be used. Notwithstanding the higher temperature, if the burners are set and operate properly so that no flame impinges on the wall and no hard carbon is deposited, the wear and tear should not be great.

W. N. Best.[1] The direct answer to this inquiry is: First, in whatever equipment oil as a fuel is found to be cheaper than coal; second, whenever by its use an increased output is secured; third, wherever a superior quality of metal is produced; fourth, to safeguard against shutdowns in power plants through shortage of other fuels; and fifth, to carry peak loads in power plants.

We will first consider oil in power plants. If the coal used has a calorific value of 14,000 B.t.u. per lb. (good bituminous coal) it requires 147 gal. of oil to represent a long ton of coal (2240 lb.), the oil having a calorific value of 19,000 B.t.u. and weighing 7.5 lb. per gal. With oil at 5 cents per gal., this would be equivalent to coal at \$7.35 per ton delivered in the coal bin. The larger the power plant, the more attractive is oil fuel, owing to the fact that one man can fire and water-tend twelve 300-hp. boilers. There are no ashes to handle and cart away. Of course the saving on all labor such as extra firemen and ash handling will vary in accordance with the number and size of boilers in the plant. I only mention this as a concrete illustration as to how an engineer can calculate the cost of the two fuels, so that anyone can definitely determine if oil is attractive or not. The data used has been compiled from hundreds of tests.

In the eastern part of the United States oil as a fuel is rarely found to be as cheap as coal when used exclusively as a fuel in boilers; but last winter's experiences fully demonstrate the necessity of having coal-fired power plants equipped with oil as an emergency fuel owing to the uncertainty of the coal supply, and also the delay in delivery occasioned by the shortage of coal cars. It is the writer's opinion that no power plant today is safe without apparatus for the use of oil as an emergency fuel. Also, oil may be used as an emergency fuel to carry peak loads on either hand-fired or stoker-fired boilers. The liquid-fuel-injecting apparatus may be placed in the side wall of the boiler, midway between the bridge wall and

[1] President, W. N. Best, Inc., New York, N. Y.

front-end setting or may be placed in the front-end setting and will not interfere with the fireman or stoker. A lever is used to operate the slide gate which admits the air to support combustion, independent of the air admitted through grates or stokers; thus, if it is desired to operate the oil burner at 15 per cent of its capacity, the gate is only opened sufficiently to admit just enough air for the perfect combustion of that amount of fuel in combination with the coal. It can be so operated that no superfluous air is admitted into the firebox by simply moving the lever to any position required. As soon as the supply of coal is entirely exhausted, the grates or stokers can be covered with cinders and oil burned exclusively. When a supply of coal is again secured, the cinders or ashes can be removed, the burner shut off and the air gate closed while only coal is again burned.

There are thousands of boilers in power plants and in gas works where to carry peak loads oil or tar is burned in combination with coal, breeze, etc. Also in power plants where bagasse is used as a fuel often oil is necessary to aid that fuel in obtaining the full rating of the boiler. Oil is an ideal fuel for this purpose, for by its use one can control and maintain the steam pressure as desired. It ordinarily requires three gallons of oil to each ton of bagasse burned.

I believe all marine boilers now burning coal should be equipped with oil as an emergency fuel, especially should this fuel be used in the time of war, for by its use in combination with coal the boilers can be operated at 200 per cent overload in a few minutes, thereby increasing the speed of the vessel to its maximum.

In forging plants oil should be used as fuel, for thereby the manufacturer secures the maximum output and a better quality of metal. In this practice 80 gal. of oil are equivalent to a ton of good coal.

In heat-treating furnaces (low temperatures) 72 gal. of oil are required to represent a ton of coal of the calorific value referred to. Since it is true that steel is only as valuable as it is heat-treated, oil is superior to coal, for by its use in modern furnaces any temperature required can be attained and maintained at the will of the operator, and an even distribution of heat obtained over the entire charging space of furnace.

In foundry practice oil is an incomparable fuel for core ovens, and in steel foundries for mold-drying ovens, etc.

In chemical plants where accuracy of temperatures is very important, especially in the manufacture of dyes, oil fuel is a necessity.

In welding flues 58 gal. of oil represent a ton of coal (all coal and oil referred to here have the same calorific value). This is due to the fact that it is necessary to coke a coal fire before welding two pieces of metal together, and in this process of coking the coal all the volatile gases are wasted.

In conclusion, I would say that owing to the superior qualities of oil, it belongs to that portion of the manufacturing world having forging and heat-treating shops, foundries melting various kinds of metals, and power plants for which an emergency fuel must be provided. I am confident that when the war is over the nation having control of the most oil wells will be the largest manufacturer in the world; and if Germany controls the oil fields of Roumania, and the Baku fields of Russia, our country's greatest competitor in the manufacturing world will be Germany, although we (the United States) now contribute 62 per cent of the world's production of crude oil. We must conserve this fuel and only use it where it can best serve the nation.

R. J. S. Pigott. One very important point militating against the substitution of fuel oil for coal, (even if a supply were obtainable, which it is not), is the relative price of fuel oil and coal per million B.t.u. In all but the most favored localities, coal is about one-half, or less, the cost of fuel oil per million B.t.u. For instance, at Bridgeport in 1915, coal was $4 a ton (14,250 B.t.u.) and oil 4 cents per gal. (19,000 B.t.u.); the relative cost was 12.65 cents per million B.t.u. for coal and 29 cents per million B.t.u. for oil. Any one contemplating the substitution of oil for coal would be faced with a doubled cost of steam production. The saving in labor due to elimination of coal- and ash-handling is insignificant. The difference in efficiency is now next to nothing, since the development of the underfeed stoker has put the coal-fired boiler practically on a par at all points with oil.

One very large source of waste, and an immense opportunity for saving, lies in our industrial heating processes. We have vast amounts of coal, oil and gas used in factory processes for heat-treating, annealing, pit fires, forge furnaces, etc., in nearly all of which cold work is introduced directly into an intensely hot chamber under direct flame, and no attempt whatsoever made to use the heat in the flue gases.

In connection with the writer's work at the Remington Company, we tested several types of oil-fired forge furnaces, as well as gas-fired brazing and other small-operation furnaces, finding the efficiency between 10 per cent and 15 per cent. In some cases, surface-combustion or semi-surface-combustion furnaces of our own design were substituted for Bunsen-flame types, cutting down gas to one-third, and in two cases, to one-fifth the former amounts. We should by all means employ preheating methods in our shop operations, making use of the familiar countercurrent principle so universally adopted in such heat-transfer apparatus as condensers, feed heaters and boilers. There is no question but that we could at least double the present poor efficiency of our usual primitive shop furnace.

Referring to the coal situation, the admirable work of Mr. Potter and Mr. Cole in Pennsylvania should have the hearty support of this Society, since it is a method of curing the cause, not the effect,—which eases the situation both from the coal burner's point of view and that of the transportation company. I therefore respectfully submit the following resolution:

Whereas, A large proportion of the shortage of fuel is due to the reduction of capacity and efficiency occasioned by the increase in non-combustible impurities in the coal as furnished from the mines, due chiefly to negligence on the part of the operators; and to the consequent increase in tonnage hauled for a given total heating-value.

Whereas, Mr. William Potter, Fuel Administrator of Pennsylvania, has taken effective steps to force the proper cleaning of coal by establishing inspection at the mines, standards of quality and punishment for infraction; be it

Resolved, That the members in attendance at the Spring Meeting of The American Society of Mechanical Engineers indorse and support the action of the above-mentioned Fuel Administrator of Pennsylvania.

C. H. Delany.[1] To engineers on the Pacific Coast where fuel oil has for many years been the only fuel available, the problem at present is, what fuel can be substituted for fuel oil, rather than to what extent can fuel oil be substituted for coal.

[1] Pacific Gas and Electric Co., San Francisco, Cal.

During the past two years the price of fuel oil on the Pacific Coast has almost trebled, and in the Northwest its use has practically ceased, other fuels being substituted for it.

In California, where there is practically no coal available, the use of fuel oil still continues, but as the consumption at present is considerably greater than the production, it is questionable how long its use can be continued without restrictions.

Oil-Fuel Shortage Will Grow More Acute

The situation will shortly grow worse on account of the immense quantities of fuel oil required for the Navy, especially for the large number of destroyers that are now being built. It seems, therefore, that unless there is a considerable increase in the production of fuel oil, it is useless to discuss the possibility of its being substituted for coal; however, there is always a possibility of new oil fields being opened up.

In Table 4 a comparison is given of fuel oil with coal of heating values varying from 10,000 to 15,000 B.t.u. per lb. The heating value of the oil is given as 18,500 B.t.u. per lb., which is a fair average value for California oil, the variations from this value being small. It is well known that with good grades of semi-bituminous coal better boiler efficiency can be obtained than with the low-grade western coals, and to make this comparison fairly correct for the different grades of coal, an efficiency of 60 per cent has been assumed for coal having 10,000 B.t.u. per lb., and 75 per cent for coal having 15,000 B.t.u. per lb., with intermediate values for the coals that lie between these extremes. As the heating value of coal is invariably given on the basis of dry coal, and as coal when purchased invariably contains a considerable proportion of moisture, it has been assumed that the coals considered in this comparison contain 6 per cent moisture. In the case of fuel oil the water content does not usually exceed 1 per cent and this value has, therefore, been used in the comparison.

TABLE 4 COMPARISON OF FUEL OIL WITH COAL OF VARIOUS HEATING VALUES

(Coal containing 6 per cent moisture)

	Coal						Oil
B.t.u. per lb. dry fuel	10,000	11,000	12,000	13,000	14,000	15,000	18,500
Boiler efficiency, per cent	60	63	66	69	72	75	78
Dry fuel per boiler hp., lb.	5.58	4.82	4.22	3.73	3.32	2.97	2.32
Fuel as fired per boiler hp., lb.	5.94	5.13	4.49	3.97	3.53	3.16	2.34
Coal equivalent to 1 bbl. oil (42 gal.), lb.	851	737	645	570	506	454	....
Price of 1 ton (2000 lb.) of coal equivalent to oil at $2 per bbl., dollars	4.70	5.43	6.20	7.03	7.92	8.82	
Price of 1 bbl. of oil equivalent to coal at $5 per ton, dollars	2.13	1.84	1.61	1.42	1.26	1.13	

The comparison given here considers only the actual value of the fuel itself. An oil-fired plant is considerably cheaper to build than a coal-fired plant, due to the lack of coal-handling apparatus, mechanical stokers, etc.; furthermore, the labor in the oil-fired plant is much less than in a coal-fired plant, consequently the actual comparison for any particular plant will be somewhat more favorable to oil than is shown in Table 4.

Fig. 5, which extends the information contained in the table to other prices of coal and oil, will serve as a rough guide for those who contemplate changing from one fuel to the other. The efficiency of 78 per cent for oil firing assumed in these calculations can be readily maintained in normal service provided proper attention is paid to the furnace design and the regulation of the fires.

Automatic Regulation of Fire

One of the greatest advantages of the use of oil as fuel is that it is possible to regulate the firing entirely automatically. It is well known that in the modern power plant the efficiency obtained depends very largely on the personal element in the fireroom. This personal element has been largely eliminated in the engine room by making automatic the regulation of modern prime movers. In the fireroom, however, it is customary to depend entirely on the judgment of the fireman to regulate the supply of air that will insure commercially perfect combustion and give the highest efficiency. By making this regulation automatic the method of operating the plant changes, for it is then only necessary to adjust the fires at the start, and if the automatic regulator is reliable, it will keep the fires in proper adjustment for all loads.

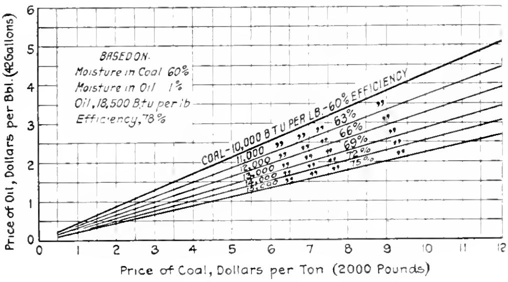

Fig. 5 Comparison of Fuel Oil with Coal of Various Heating Values

Automatic regulators are now on the market for oil burning which regulate the quantity of oil, the quantity of atomizing steam and the quantity of air required for combustion. While the main advantage of the automatic device is that it insures the boiler operating at maximum efficiency at all times, it also has the advantage of causing considerable saving in labor.

This advantage will be especially true in the case of small isolated plants where the firing is of poor quality and where the cost of labor is large in proportion to the quantity of fuel burned, and it is in these small plants scattered throughout the country that the greatest benefit would be derived if it were possible to substitute fuel oil for coal.

W. G. Williams.[1] Prior to 1915 fuel oil offered coal keen competition in many parts of the country, but war conditions have placed a different aspect on the situation, and it is safe to say that the present conditions are far more likely to prevail after peace is declared than that pre-war conditions will obtain.

The requirements for petroleum products of the lower end points necessarily keep pace with the growth of the internal-combustion engine; that the production of crude petroleum has not kept pace is evidenced by the reduction of crude in storage. In 1916 there were 162,000,000 bbl. of crude in storage, and

[1] Efficiency Engineer, Empire Gas & Fuel Co., Bartlesville, Okla.

at the present rate of reduction this reserve will be exhausted in 1919.

According to available information, slightly over 300,000,000 bbl. of crude oil were run through American refineries in 1917, and from this 102,000,000 bbl. of gasoline and kerosene, and about 150,000,000 bbl. of gas oil and fuel oil, were produced. This fuel oil (considering gas oil as fuel) corresponds to a coal production of $37\frac{1}{2}$ million tons, which is hardly to be considered in comparison with the actual and known potential production of coal.

Ships May Demand All Fuel Oil Produced

Certain localities and requirements make the use of other than liquid fuel practically out of the question. On the Pacific Coast oil will be used to the exclusion of coal until one of two things occurs—production of crude petroleum falls off, or a method is discovered of converting the output of crude into gasoline. In the marine industry oil is practically the ideal fuel, and with the enormous increase in shipbuilding in the United States it is not too conservative to say that our fuel-oil output is destined for almost exclusive use on shipboard.

It is true that the maximum output of the Mexican fields is still an unknown quantity, and that the known oil fields are only a small part of those yet to be discovered, but against this must be considered the proven life of the fields, and the efforts to convert crude petroleum into gasoline exclusively.

With the gigantic strides that are being made in the application of internal-combustion engines for motive power, the effort to produce a corresponding increase in the fuel for these engines is taking two forms, namely, an increase in production of crude, and of gasoline from the crude. How little these efforts are being rewarded is shown by the decrease in production in the Kansas, Oklahoma, and Texas fields of 82,000 bbl. per day since last October, and the practical failure of the "cracking" processes so far developed.

Any calculations based on the use of petroleum as fuel are, however, rendered valueless by the fact that any hour of any day may witness the development of a new oil field which will produce petroleum in such quantities that its use as fuel would largely supplant coal. The exhaustion of known fields is no bar to the discovery of new and larger producing areas, and I believe it is a wise engineer who keeps this possibility in mind, just as he would the ultimate development of a small steam plant into one of a size to eventually accommodate automatic coal-handling and firing equipment, and I believe this is particularly applicable to those of us doing business west of Pittsburgh.

C. W. Koiner.[1] No relief can be looked for in the East from the substitution of fuel oil for coal except for ocean-going vessels and, possibly, to a limited extent, for the reason that this oil would have to come from the southern and Mexican fields and the conditions in Mexico are so chaotic that the full supply of oil that these fields are capable of putting out cannot be depended upon.

Hydroelectric Plants Interconnected

Practically all hydroelectric plants in California have been linked together from the southern to the northern part, a distance of approximately 800 miles, with a view of eliminating oil-burning plants wherever possible. The oil reserve in California has, during the months of January, February and March, been drawn on to the extent of 1,655,000 bbl. The month of April, however, shows a little improvement. The production has been increased and the lack of shipping facilities for carrying the oil to its destination has prevented the reserve being depleted as much as during the past year.

Vast Deposits of Oil Shale

Guy Elliott Mitchell of the United States Geological Survey, in an article in the *National Geographic Magazine* for February, 1918, stated that the total production of petroleum in the United States up to 1918 was 4,255,000,000 bbl. In regard to future production, he estimates that the total amount in the ground, some of which lies very deep, is about 7,000,000,000 bbl. This is small compared with the quantity of oil that can be extracted from our oil-shale deposits. He tells us that American deposits of oil shale will supply enormous quantities of oil in the future. It is estimated that 20,000,000,000 bbl. can be obtained from the oil shale in Colorado alone; that certain ranges of mountains in which these deposits are located carry thick beds of rock that yield 30 to 100 gal. to the ton. The shale deposits of Indiana are estimated to carry 100,000,000,000 bbl. of oil. There are also deposits in Wyoming, Nevada, Illinois, Kentucky, Ohio, Pennsylvania, Tennessee and West Virginia; therefore our oil supply for the future is assured, even though we fail to develop additional oil territory other than the shale deposits.

Victor J. Azbe.[1] Fuel oil is the ideal fuel for boiler purposes. It gives high boiler efficiency, high boiler capacity, rapid regulation, low cost of handling, low cost of firing with hardly any disadvantages, but it should not be burned in localities with a coal mine only 30 miles off. In the southern states, especially Texas, plants are equipping to burn lignite in preference to the present expensive fuel oil, and those which are not should be made to do so.

Lignite is the best fuel to be burned in territory where available. Very good results can be obtained with it and 12 per cent CO_2 maintained without difficulty. With intelligent firemen in charge as high boiler efficiency will be obtained with lignite as with coal and it has not been unusual for the writer to obtain 65 per cent combined efficiency with ordinary return tubular hand-fired boilers; and with proper design boilers can be forced far beyond rating with lignite.

The value of wood as fuel also is not realized, and as an example I will mention a certain plant in Louisiana that burned oil for years at 80 cents per barrel. All at once the cost of oil increased to $1.40 and they began burning wood and during the next fiscal year the cost of fuel per unit of output was far less than with oil at 80 cents. To think of this and then of the enormous quantities of wood wasted throughout Mississippi and Louisiana and other states makes a man realize how unadaptable we are.

H. A. Barre.[2] Oil is practically the only fuel used for power purposes in California, except for a small amount of natural gas.

Originally it was burned as it came from the wells, but of recent years the crude oil is all topped for the lighter constituents, and the residual only, having a gravity of 14 deg. to 18 deg. B. used for boiler fuel. The unit of measurement is the barrel of 42 gal. weighing about 335 lb. and containing

[1] General Manager, Municipal Lighting Department, Pasadena, Cal.

[1] Junior Mem.Am.Soc.M.E.; Engineering Dept., Anheuser-Busch Brewing Asso., St. Louis, Mo.

[2] Southern California Edison Co., Los Angeles, Cal., Mem.Am.Soc.M.E.

from 6,000,000 to 6,200,000 B.t.u. Compared with 12,000-B.t.u. coal, one ton of 2000 lb. equals nearly four barrels of oil.

Before the war the price for favorable delivery points, such as tidewater and pipe-line terminals, was 60 to 70 cents, equal to \$2.40 to \$2.80 coal. At present the market is about \$1.45 per barrel, equivalent to \$5.80 coal per short ton.

These figures are not entirely just as a comparison, since the expense to store and fire oil is much less than for the corresponding thermal equivalent of coal. There are no ashes to dispose of, and ease of control in firing admits of higher operating plant efficiencies. The same amount of investment will therefore produce higher thermal efficiencies than with coal.

Two large and comparatively modern plants have been for some years under the writer's observation. One of these is of 40,000 kw. capacity, having three 5000-kw. engine-type units, installed in 1906, which are seldom used, and two 15,000-kva. turbines installed in 1910 and 1911. The other is of 47,000 kw. capacity, having one 12,000-kw., one 15,000-kw., and one 20,000-kw. turbine. This is much the better plant.

These two plants are a part of a large interconnected system having a total capacity of nearly 200,000 kw., and run in conjunction with a number of water-power plants.

They serve three functions—(1) As a steam reserve for breakdown of lines and other plants; (2) To supply kilowatt-hours during the season of low water; (3) To care for increases in load until these reach sufficient magnitude to justify bringing in additional water power.

The annual loads and load factors are, therefore, of an erratic nature.

The operating conditions for several years past are shown in Table 5.

TABLE 5 OPERATING CONDITIONS WITH FUEL OIL

	40,000 KW.			47,000 KW.		
Year.	Kilowatt-Hours Output.	Bbl. of Fuel Oil.	Kilowatt-Hours Per Bbl.	Kilowatt-Hours Output.	Bbl. of Fuel Oil.	Kilowatt-Hours Per Bbl.
1911....	126,377,000	574,178	220.03	....	.....	....
1912....	150,801,000	732,444	206.00	50,300,000	240,537	209.0
1913....	163,015,000	756,652	215.44	94,046,000	439,454	214.0
1914....	18,588,000	161,190	115.30	74,812,000	347,008	215.7
1915....	5,274,000	88,576	59.50	77,556,000	328,749	236.0
1916....	3,785,000	81,783	46.30	45,360,000	218,235	207.5
1917....	4,930,000	83,692	58.80	133,528,000	562,177	238.0

It will be seen that the best annual operating results have been approximately as shown in Table 6.

In both these tables the results are net after accounting for station auxiliaries; that is, the measurements are oil delivered to the stations and kilowatt-hours output at the station feeders.

TABLE 6 BEST OPERATING RESULTS

Plant	Kilowatt-Hours per Bbl.	B.t.u. per Kilowatt Hour	Per Cent Efficiency
40,000 Kw.	220	27,300	12.5
47,000 Kw.	240	25,000	13.67

Some oil-burning plants having a high load factor have recently been put into operation in Arizona, operating at about 19,000 B.t.u. per kw-hr., or nearly 18 per cent efficiency.

In these two plants a 600-hp. B. & W. or Sterling boiler will carry with auxiliaries about 1000 to 1100 kw. of station output.

The arrangement of the furnace is more important than the type of burner used.

The oil is usually atomized by steam. The resultant spray is burned by mixing with the proper quantity of air also distributed evenly throughout the firebox without directly striking the surfaces of the tubes and furnace walls, but also without permitting the occurrence of blank spaces which might admit a surplus of air.

There are several types of burners, between which there is little to choose. Any of them that will properly atomize the oil and distribute the flame are satisfactory. The two extremes of the scale of desirability are, on the one hand, the burner which, by the use of a slight excess of atomizing steam, gives steady and reliable service, and, on the other hand, the one where the steam passages are reduced to just the amount necessary for atomization, but which must be watched a trifle more carefully on account of plugging up at times with dirt or carbonized oil.

The steam consumption of the former type is not over 4 per cent of the boiler output, and of the latter slightly less.

The most important instrument for oil burning is a window in the roof, through which the boiler-room engineer can see the top of the stack. Smoke, of course, is always a loss, and when firing up cold boilers cannot be avoided. A more serious loss, however, is excess of air, and this can occur with a perfectly clear stack. The best firing will be done by increasing the amount of air until the smoke stops and then cutting it down slowly until a slight haze of smoke shows.

In the larger plants, of course, more scientific methods are available. Steam-flow meters, venturi meters on unit groups of boilers, and the customary stack instruments are used and pay better returns than perhaps any other part of the investment, provided always that the information obtained from them is used for the immediate correction of any deviation from normal conditions.

3 How Can Soft Coal Be Burned Without Smoke in Marine Boilers?

The avoidance of smoke would decrease the radius of visibility of our ocean carriers by many miles and greatly reduce their liability to attack by submarines. If efficiency is improved incidentally it means much more than the mere coal saving.

Albert A. Cary. It has been repeatedly asked how to avoid the production of smoke from the steam-generating equipments of transatlantic vessels under the present conditions of submarine menace. It is an extremely vital question which has seemed to evade its answer most adroitly. After having studied this matter carefully for some time, in the light of almost 30 years' experience with most of the special furnaces and smoke-suppressing devices in this country, and many of those abroad, I can state without qualification that this trouble *can* be met, practically and satisfactorily, provided our marine friends are willing to meet us half way in their new constructions and make a compromise between old, time-honored marine-boiler practice and successful land practice.

Although an innovation, this does not mean drastic changes from their present form of steam-generating equipment; it simply means getting sufficiently away from the furnace practice long followed which has caused the submarine-signaling smoke nuisance.

The question submitted in this topical discussion is very simple and direct, and equally direct answers might be given.

by stating: suppress the fires in the furnace by firing in such small quantities as to prevent the emission of smoke; or, secure *complete* combustion in the furnaces and combustion chambers. The first-named method, of course, must result in a serious loss of the vessel's speed. The second method gives the only wholly rational solution of the trouble.

The average types of marine boilers with their present form of attached furnaces make it well-nigh impossible to secure complete combustion within the furnace in such a way as to suppress smoke without sacrificing efficiency. On the other hand, it is possible to make rational changes in the steam-generating equipments for *new* ships so as not only to suppress the smoke nuisance, but to carry vessels through the danger zone at their highest speed.

To accomplish this highly desirable end by working along the lines of the latest successful developments in land practice, we shall probably require 4 ft. more headroom, in which to place the boilers, but even should 5 ft. be demanded, the tremendous advantage gained would far offset any objections that could be raised to this innovation in the marine-boiler practice of the past.

EXAMPLE OF A STATIONARY INSTALLATION APPLICABLE TO MARINE PRACTICE

To illustrate, I will refer to an equipment for stationary boilers in which I have been interested from a purely professional standpoint, and which can be practically adapted to marine service in new vessels to secure high rates of coal consumption without producing smoke.

Eighteen stokers have been operating 500-hp. boilers 24 hours per day continuously for two years, at 50 per cent above their rating, with average grades of eastern bituminous coal of no better quality than is used by transatlantic ships. They have been continuously burning from 42 to 45 lb. of coal per sq. ft. of grate per hour, with a clean smokeless chimney and have shown an easy forcing capacity when over 60 lb. of this eastern bituminous coal is burned per hour per sq. ft. of grate.

The coal is fed from the hopper to the fuel bed in a steady flow in such manner as to avoid the trouble usually following its coke formation and the troublesome caking, and then it is moved along the grate automatically so as to constantly drop its ash directly down to the grate surface where the cool entering air keeps the temperature of the ash below its fusing point, thereby avoiding the formation of obstructing clinker.

The resulting ash is dumped into an ash-sealed pit where it is water cooled and an automatic ash-removing device carries it forward into the front ashpit without disturbing the ash seal and without disturbing the draft conditions of the furnace.

The deep fuel bed is always kept in an open porous condition over its entire surface like a huge sponge, thus requiring a light air-blast pressure, seldom exceeding 1-in. water pressure and allowing each stoker to be operated with an individual disk fan (requiring but little power to operate) instead of the usual heavy steel-plate, forced blast fan with its voluminous air ducts. The result is not only a saving in power required for operation but also a material saving in space requirements.

With the clinkering trouble in firebed, side and bridge walls thus avoided, hand cleaning of the firebed is almost entirely done away with while the firebed is easily kept level and of uniform thickness by an arrangement of the automatic-feed device.

Adjustment of the rate of coal feed is quickly and easily changed (along with the speed of the fan) and thus, with the free-burning firebed conditions existing, a jump from low to high steaming capacity in the boiler is obtained in a very few minutes.

With such exceptional fuel-burning conditions under marine boilers, the production of smoke would be prevented by securing practically complete combustion in the furnace, and the highest steaming capacity of the boiler obtained to take the vessels through the danger zone at high speed.

With the coal supplied to the furnace by simple conveying apparatus and with ash delivered from the ashpit automatically by the stoker and conveyed overboard automatically, hand manipulation can be almost entirely done away with and a happy solution secured of the present difficulty in getting the greatly needed expert firemen.

OSBORN MONNETT.[1] As to whether soft coal can be burned without smoke in marine boilers, there can be but one answer: Yes. As a purely engineering problem it is feasible. Of the methods tried for this work the underfeed principle has been best adapted. With this method the headroom and ashpit facilities may be cut to a minimum and the auxiliary machinery required is comparable to that ordinarily used for forced draft hand-fired furnaces. Furthermore, this principle of burning soft coal is well adapted to the character of the load (variable speed, etc.) and handles to good advantage the class of coal customarily used for marine purposes on our eastern seaboard. Theoretically, all points are in its favor.

Moreover, considerable practical experience has been gained with underfeed stokers in marine work in the past ten years. A number of marine installations are operating successfully today, among which might be mentioned the following: steamer *Sprague*—6 Scotch marine boilers—12 stokers; tug *Perfection*—1 marine firebox boiler—1 stoker; tug *Mollie Spencer*—1 marine firebox boiler—1 stoker; dredge *Wm. O'Connell*—2 double-end Scotch marines—8 stokers; steamer *Gamma*—6 tubular boilers—6 stokers; dredge *Hecla*—2 Scotch marine boilers—2 stokers; Ward Engineering Co. steamers—2 Ward marine water boilers—4 stokers; Holland-America Line steamer, *Frederick VIII*—8 Yarrow boilers—16 stokers.

These installations, all of the Jones underfeed type, cover a wide variation of marine service from dredges and river steamers to transatlantic liners, and all types of boilers, including Scotch marine, marine firebox and water-tube boilers, of both straight- and bent-tube varieties.

The problem is not so much a mechanical one as it is one of the human element. Put one man (fourth engineer) who is familiar with this type of equipment on duty on each watch and no difficulty need be experienced. The necessary men could be recruited from the large number of power plants in this country now using underfeeds.

As far as hand firing with Scotch marine boilers is concerned, experience has been discouraging. The writer once succeeded in operating smokelessly a steamer so equipped, without any apparatus, simply by changing alternate fires. It happened that the boilers, two in number, were equipped each with three corrugated furnaces, all discharging into a common combustion chamber. The volatile matter from the fresh fire was consumed by the hot gases from the other two fires. With two furnaces the results would have been less satisfactory, and with separate combustion chambers (a common construction) impossible.

The idea in hand-fired furnaces has been to mix the gases, after they pass the bridge wall and while they are at a high temperature, with an auxiliary supply of air, and so accomplish complete combustion. Experiments have been made in

[1] American Radiator Company, Chicago.

Chicago harbor with brick arches, baffles and other constructions calculated to do this, but the small space available in the Scotch marine boiler has prevented satisfactory results. In fact, the writer's experience with forced draft, induced draft, special air admission, preheated air, panel doors, steam jets, induction tubes, stack blowers, hollow bridge walls, etc., etc., has led to the conclusion, more strongly than ever, that some type of underfeed stoker is the logical answer to the Scotch marine boiler problem.

In water-tube boiler construction, such as has been adopted by the Emergency Fleet Corporation, there is more opportunity to do things and it is not unreasonable to hope that a satisfactory hand-fired furnace for these units will be developed.

H. B. Oatley.[1] At or above the normal rate of operation, the burning of soft coal with the complete elimination of smoke, if not impossible, is an extremely difficult problem. A great deal, however, can be done to approach this desired state of perfection.

Conditions which will secure proper combustion may, of course, be provided on new ships and we are led to expect well-designed boilers, furnaces and uptakes on the ships now building. On existing vessels, however, unfavorable conditions may exist with respect to the proportions of air openings through the grates, volume of furnaces and combustion chambers, area for gases through fire tubes and around water tubes, and finally areas of uptake, breeching and stacks. The means for heating the air supply, in forced-draft installations, may have been inadequately proportioned. It is very desirable—in fact it is imperative—to improve these conditions to the greatest extent possible. It is probable that to correct these conditions, so far as the boiler itself is concerned, would be prohibitive on account of delay and expense in installing new boilers. Grates, uptakes and the air-admission channels, however, may be corrected in a short time and at a reasonable cost.

The personnel in the fireroom is a prime factor in the success or failure of any boiler plant. It must be realized that the rapid expansion of our shipping requires recruiting of men with little or no experience in the fireroom. Great effort and expense are justified in giving all possible training to the fireroom crews.

Steam economy is a big factor in the elimination of smoke, because it results in reduction in the amount of fuel used and reduction in the rate of combustion.

Improvement in marine steam plants, considering the present use of triple-expansion engines, turbines, feedwater heaters, well-lagged steam pipes, etc., presents fewer opportunities than in other lines. In the use of superheated steam, however, marine power plants in this country are considerably behind the merchant marine in other leading countries. There are opportunities for reducing the fuel used by upward of 12 per cent, and naturally a *greater* percentage reduction in the smoke produced. This is particularly applicable to existing ships as the necessary installations may be made at moderate cost during an overhauling. A reduction in the fuel used would make suitable many plants that have restricted areas through which the gases pass, and permit of greatly improved combustion.

For existing ships there is a greater reduction in smoke to be expected by the more economical use of steam, at least under present conditions, than by any other means.

M. C. M. Hatch.[2] Soft coal can be burned without smoke in marine, as in all other boilers and furnaces, up to the point at which the furnace volume becomes too small to allow for proper air-mixing and combustion space for the volatile hydrocarbons contained in the coal. This varies, of course, with designs, but the limits imposed by the unavoidable restrictions in designs for marine work make it most difficult to force high ratings from such boilers, under hand-fired conditions, without smoke.

The earlier in the combustion process that intimate mixture of air and volatile gases occurs and the smaller the volume of excess air necessary to complete combustion and hold down furnace temperature to workable limits, the greater is the amount of coal that can be fired (and consumed) per unit of time per unit of furnace volume without smoke, and hence the higher the rating which the boiler can deliver.

Coal, in pulverized form, induces the desirable intimate mixture of gases and air very early in the process of combustion and it has been shown, as it is logical to expect from the very nature of its burning, that less total air is needed per unit weight of fuel, than with hand firing. In support of this it has been repeatedly shown, in locomotive and stationary practice, that smoky coals can be burned smokelessly at very much higher rates of combustion than possible under any other conditions. The logic of the case and the facts in other services all point to the conclusion that soft coal, in pulverized form, can be burned in marine-boiler furnaces at much higher rates than will ever be possible to attain with hand firing, and that smoke will be eliminated or very materially reduced. To just what point the furnaces could be forced, in any individual instance, depends, very largely, on their fundamental design and volume, but in any case the smoke thrown would certainly be much reduced by the use of pulverized coal.

Henry Kreisinger. Perhaps the best way of burning soft coal in marine boilers without smoke is to do away with hand-fired furnaces and install mechanical stokers or pulverized coal.

For smokeless combustion, two requirements are essential: first, the volatile matter must be distilled at a uniform rate; second, the distillation must take place in the presence of large amounts of free oxygen so that the volatile matter can be burned before the smoke is formed. These requirements are not satisfied in the hand-fired furnace. On the other hand, most of the mechanical stokers, as well as the powdered-coal furnaces, furnish means of satisfying these two requirements.

In the hand-fired furnace the distillation is rapid immediately after firing and most of the volatile matter is distilled during the first half of the firing cycle. It is difficult to supply enough air during this period of rapid distillation without having too high an excess of air after the distillation has been nearly completed, unless the air supply is varied in such a way that it is at all times nearly proportional to the amount of volatile matter that is being distilled. Such variation of air would require close attention on the part of the fireman and is hardly practicable aboard a ship where firemen are changed frequently.

In the hand-fired furnace the distillation of the volatile matter takes place in the absence of oxygen, and the volatile matter is broken down by heat into soot and light hydrocarbons. The fresh coal is placed on top of the fire and moves down towards the grate. The air is fed from below through the fuel bed in the opposite direction to that of the coal. Before the air reaches the distillation zone at the surface of the fire, all the oxygen is used up in burning the carbon in the lower

[1] Lieutenant, U. S. Naval Volunteers; Chief Engineer, Locomotive Superheater Co., New York. Mem.Am.Soc.M.E.

[2] Locomotive Pulverized Fuel Company, New York.

layers of the fuel bed. The sooty smoke is formed at the surface of the fuel bed because there is no oxygen to burn the volatile combustible, and because the latter is subjected to high temperature; it is not formed by sudden cooling.

Most mechanical stokers feed the coal into the furnace at a uniform rate so that the volatile matter is distilled also at a uniform rate. It is therefore comparatively easy to adjust a uniform supply of air to the volatile matter to insure its complete combustion without a too high excess of air.

Furthermore, with most of the mechanical stokers the air and the coal are fed into the furnace in the same direction, so that at the point where distillation takes place the air contains nearly 20 per cent oxygen. On account of this large percentage of free oxygen the combustion of the volatile matter proceeds to completion without deposition of soot.

What has been said about the mechanical stoker is true of the pulverized-coal burner. The coal and air are fed into the furnace together at a uniform rate so that the two can be easily adjusted to the proper proportion. The volatile matter is distilled from the small particles of coal while the latter are surrounded with an atmosphere containing nearly 20 per cent of oxygen.

With the pulverized coal a large part of the mixing of the combustible with the air can be done outside of the furnace. Thus the combustion space of the furnace needs to do only the burning and little mixing. Something similar to this is being done in the gasoline engine. Only the burning is done in the combustion chamber, the mixing being done in the carburetor. High temperature is of lesser importance. Complete combustion can be had in the gas-engine cylinder in spite of the fact that the walls of the combustion chamber are water-cooled.

Carrying on the mixing outside of the furnace deserves full consideration in the case of marine boilers, because the restriction of space on board ship makes large combustion chambers prohibitive.

HAYLETT O'NEILL (Oral). For the past two months I have been running tests of marine boilers using pulverized coal at New Haven, Conn. We have been able to burn this fuel without smoke, and have obtained just as much speed and power as with the regular oil-burning equipment aboard this ship. The boilers are of the Normand express type, with a very small furnace particularly unsuited to such fuel as powdered coal. I believe that the future will see much work done in marine practice in the way of substituting coal for oil, inasmuch as the fuel in the form of coal will cost about one-half or even one-third what the oil will cost.

[On board the boat mentioned by Mr. O'Neill a mixture of powdered coal and fuel oil is used—32 per cent of the mixture being coal, 95 per cent of which passes through a 200-mesh screen. The coal remains suspended for many days without settling so seriously as to interfere with operation. The usual mechanical Navy burner is used without alteration. The volumetric heat value of the mixture is about the same as that of the straight oil with an average good coal because of the greater density of the coal. If this mixture of oil and coal proves to be successful, it would, of course, if widely applied, go a long way toward relieving the consumption burden now imposed on our fuel-oil resources.—EDITOR.]

JOHN S. SCHUMAKER[2] (Oral). In the Assabet mills, Maynard, Mass., about twenty-one Manning type boilers were used to burn New River coal. The furnaces of these boilers have no firebrick, and, ordinarily, considerable smoke was formed in the combustion of the coal. It may be interesting to know that this trouble was practically eliminated by the introduction of air above the fire. The fire doors were at first left on the latch, that is, left open a trifle, and later, as a permanent arrangement, 5-in. openings were introduced in each door. These openings, when properly regulated, greatly reduced the smoke.

4 What Are the Possibilities in the Direction of the Utilization of Anthracite Wastes?

What success have you had in burning anthracite slack or culm? Do you mix it with soft coal and in what proportions? What sort of grate do you use and what is your practice with regard to thickness of fire, draft, rate of combustion? Can the mixture be burned in a stoker?

JOHN E. MUHLFELD.[1] The indications are that during the current coal year (April 1, 1918, to March 31, 1919), about 80,000,000 tons of anthracite coal will be mined for distribution as compared with 77,000,000 tons during the past year, of which latter amount about 5,500,000 tons were exported. Of this year's output probably 25,000,000 tons will be steam sizes, leaving 55,000,000 tons for domestic and specialized uses.

New England alone will require about 13,000,000 tons of anthracite, exclusive of steam sizes, whereas, according to the Anthracite Committee of the United States Fuel Administration, its allotment is now placed at about 10,500,000 tons.

The exclusion of almost one-half of the 18 states in the Union from participation in this year's anthracite-coal production, and a shortage of 25,000 to 50,000 men from the number normally engaged in the anthracite mining field, in combination with the lack of water and rail transportation facilities, establishes the immediate necessity for reclaiming and utilizing every ton of anthracite silt, slush and culm that is now being produced or which is stored above ground.

CONSUMPTION OF ANTHRACITE AT THE MINES

As about one ton of anthracite coal is now consumed at the mine in the production of steam to mine each 8 or 9 tons produced, the logical use to which these waste sizes should be put is in the production of power, heat and light at the mines. By this procedure useful by-products of from 11,000 to 12,000 B.t.u. heat value per pound—which are now being wasted by diversion to streams, back filling into abandoned mines, or by dumping in culm banks, and which represent about 10 per cent of the total tonnage mined—can be made to release from 85 to 90 per cent of the commercial-size anthracite that is now being consumed for mine steam generation for use in locomotives and at industrial plants located nearest the points of production. In other words, in the production of 80,000,000

[1] Pres., Locomotive Pulverized Fuel Co., New York. Mem. Am.Soc.M.E.

[1] Larchmont, N. Y.

[2] S. D. Warren & Co., Cumberland Mills, Me. Assoc.-Mem.Am.Soc. M.E.

tons of domestic and steam anthracite during the current coal year, the reclamation and utilization of the silt, slush and culm by-product for mine-operation purposes would release about 8,000,000 additional tons of steam-size anthracite that could be diverted to commercial use, and more than make up the shortage in supply.

It should be remembered that the only cost for this additional tonnage would be the means required for its reclamation and for its preparation and use, as the labor, material and plant for mining are now being employed in its production.

By pulverizing this by-product anthracite and burning it in suspension, as oil or gas is burned, it can be used for stationary-boiler purposes without the admixture of any other fuel, and easily produce from 100 to 150 per cent of the rated boiler capacity. For locomotives it can be utilized by mixing 60 per cent with 40 per cent of any gas or soft bituminous slack or screenings available, then pulverizing, and burning it in suspension.

Burning Anthracite in Suspension

The ideal means for preparing and disbursing this fuel would be to install preparation plants at the collieries, from which both locomotives and stationary power plants could be supplied, thereby relieving railway facilities, locomotives and cars otherwise required for its transportation. Such utilization would also avoid the use of cars and vessels for hauling fuel with a relatively high percentage of non-combustible. Every ton of anthracite to be shipped by rail or water for any considerable distance should have not more than 10 per cent of ash and impurities and be of the best quality possible to conserve the already overburdened transportation facilities.

Here are millions of tons of anthracite coal that average higher in heat value than the average run-of-mine bituminous coal in Michigan, Illinois, Iowa, Missouri, Kansas, Oklahoma, Texas and other points of the West from which about one-third of the bituminous coal supply is now being produced, and for which anthracite by-product, man and machine power, mining equipment and supplies are being used daily in its production, with the resultant waste of output for want of installation of proper means for its effective and economical utilization.

These by-products can be reclaimed and utilized for what it now costs to place them on the dump or to pump them back into the mines, and by proper preparation and burning in suspension—as with oil or gas—there will be the additional power-plant advantages of reduction of man power, greater boiler capacity, better control of steam pressure, elimination of banked fires, decreased ashpit handling, elimination of fire cleaning and of metal work in the furnace, better combustion, and lower fuel losses.

Furthermore, with the relatively low volatile nature of these waste by-products, which require a temperature of between 550 and 600 deg. fahr. to produce combustion, there will be no difficulty in handling or storing fuel after pulverized, in any manner desired from the standpoint of loss of heat value or spontaneous combustion.

At present the bituminous coal supply is only running at from 75 to 80 per cent of production, due largely to shortage of from 10 to 15 per cent in the car supply. As the anthracite supply of commercial steam sizes is also inadequate, unless some means is immediately adopted to provide for the reclamation and utilization of useful mining by-products, we can expect the same hardships on the people and the manufacturing industries as obtained last winter.

W. S. Hachita.[1] The anthracite industry is located in the northeastern part of the state of Pennsylvania. The area underlaid with anthracite is approximately 800 square miles. Roughly the field is divided into four parts: namely, the northern field, comprising the Carbondale, Scranton, Wilkes-Barre and Nanticoke districts; the northern middle field, or Hazleton district; the southern middle field, including Mahanoy City, Shenandoah, Mt. Carmel and Shamokin; and the southern field, consisting of Lansford, Pottsville and Tremont districts.

In preparing anthracite, there are two kinds of waste produced: first, fine material, the largest pieces of which are no bigger than 3/32 in., which is so fine that, heretofore, it has been considered unmarketable; second, rock refuse. The latter material has been picked out during the process of preparation. The production of culm at present is approximately $7\frac{1}{2}$ per cent of the total output.

Culm Production in Tons

The average culm production from the beginning of the industry to the present time (1820-1918) is about 15 per cent of the tonnage mined. According to the statistics, the anthracite mined and shipped from 1820 to January 1, 1918, amounts to 2,332,673,250 tons, so that the amount of culm produced during the same period is 349,901,000 tons. Out of this, about 50 per cent has been taken into the mines to support the roof and washed away, leaving 174,950,000 tons available above ground in the whole anthracite field.

The rock refuse, which consists of slate and bony coal, amounts to approximately 10 per cent of the output, or about 233,267,000 tons. The slate which occurs in anthracite measures is entirely unlike that used in roofs, sidewalks, etc. On the other hand, it contains from 28 to 48 per cent of combustible material, while the bony material contains from 45 to 70 per cent of combustible. The rock banks, composed of slate and bone, contain at least 50 per cent of the heat in commercial anthracite. At the present, rock refuse is not utilized as fuel in the anthracite field.

The fine material which is locally known as culm slush, or silt, contains 70 to 85 per cent of combustible material. It is therefore a good fuel, provided proper means of burning it can be used. During the last sixty years, a large amount of experimenting has been done with a view of utilizing this material.

A thorough research, relative to the utilization of anthracite culm was made by the Lehigh Valley Coal Co. in 1913, at the Spring Brook boiler plant, near Hazleton, Pa.

For this purpose there were arranged a battery of four cylindrical boilers, 33 in. in diameter and 30 ft. long; one smoke stack, 33 in. in diameter and 33 ft. high; a total grate area of 132 sq. ft., having air space of 19.8 sq. ft., or 15 per cent of the total area.

The fuel was burned under forced draft of ½-in. water gage. The mixture consisted of culm and bituminous coal. In the test, the fuel was fired in alternate layers of bituminous coal and culm, also a thorough mixture of both fuels in various proportions. It was soon found that a thorough mixture of culm with bituminous coal was the better method and this method was therefore used throughout the tests.

Mixtures of Soft Coal and Culm

The first series of tests consisted of 30, 50, and 70 per cent of run-of-mine coking coal mixed with 70, 50 and 30 per

[1] Lehigh Valley Coal Co.

cent of culm from the Hazleton Shaft Colliery of The Lehigh Valley Coal Co. The second set of tests consisted of a mixture containing pulverized bituminous coal. The biggest pieces of soft coal in the mixture were not larger than 2 in. in diameter. Both fuels were thoroughly mixed in the above proportions by the use of shovels, and fired. The result of these tests shows that, in every case, the pulverized bituminous coal produced the better results.

The non-coking bituminous coal was also tried but it did not produce the same results as those produced by the coking coal. The reason why the coking coal is better adapted to mix with the culm lies in the fact that the coking coal fuses at a comparatively low temperature and the fusion takes up the particles of culm, forming a homogeneous mass of fuel which burns uniformly. The results of these tests show that a mixture consisting of 30 per cent of culm and 70 per cent of coking bituminous coal produced a water evaporation equal to that evaporated by the straight bituminous coal. It was also noticed that the mixture was easier to burn than soft coal alone. This is due to the fact that when soft coal alone is burned, the fuel bed becomes a hard, coked mass requiring considerable poking to effect complete combustion, whereas in the case of the mixture, the coked fuel is more easily handled by the fireman. It was also noticed that the fuel produced little smoke.

In September, 1917, E. E. Loomis, president of the Lehigh Valley Railroad Co., was informed by F. M. Chase, vice-president and general manager of the same company, about the formula of the mixed fuel with the view of burning the mixture on stoker engines. It was then decided to try it on big freight locomotives running between Hazleton and Lehighton, a distance of 26 miles. In this test, the fuel consisted of 30 per cent culm and 70 per cent of stoker coal or slack. The train was made up of 50 cars of coal hauled from Hazleton to Lehighton and returned to Hazleton with 65 empty cars. There was no trouble experienced in the test and later evaporation tests made on locomotives using the mixed fuel and straight bituminous coal.

More Steam with Mixed Fuels

The results of these evaporation tests showed that the mixed fuel produced approximately 30 per cent more steam than straight bituminous coal although the calorific power of the latter was considerably greater than that of the mixed fuel. This is due to the fact that the complete combustion of the hydrocarbon is possible in the mixed fuel, whereas, in burning straight bituminous coal, the greater part of these valuable hydrocarbons are lost as smoke.

B. S. Murphy. Our plant was designed to use the small sizes of anthracite coals and under normal conditions we have no difficulty in doing so even with the No. 4 or dust. The increase in the impurities with a relative decrease in calorific value due to colliery methods, such as mining, failure to wash in the larger sizes, such as No. 1, the large amount of shale and pebbles in the so-called river coals, dredged coals, etc., has placed a different aspect on the problem; but one that can be solved successfully for such plants as are now equipped or will procure the necessary equipment.

The coal used varies from straight No. 1 buckwheat to No. 3 and No. 4, the latter, or dust, using the recommended A.S.M.E. scale, being that passing through a 3/32-in. opening. Our so-called No. 3 has from 45 to 60 per cent dust and the No. 4 over 60 per cent and up to 85 per cent through 3/32-in. screen.

Influence of Size of Coal

It is most desirable from both an economic and operating standpoint to adhere to one size of coal for as long time periods as possible. It is impossible to maintain good economy when the run of coal for the boilers changes continually from the smaller to the larger size and back again, for an entirely different method of manipulation is necessary. On the other hand, if the fuel is a well-mi ed one, say one as follows: 15 per cent of No. 1, 20 per cent of No. 2, 40 per cent of No. 3 and 25 per cent of No. 4, and remains as such, it can be handled well and in fact is easier to handle than the No. 3 for poor firemen.

The reason for the mixture of bituminous coal with the anthracite is twofold: (*a*) to act as a binder and (*b*) to increase the calorific value. With the large size, No. 1 buckwheat, our practice is to add no soft coal. Here we find that the soft coal is a detriment, forms clinker with the impurities and makes the firing more difficult.

With the small sizes the primary function with the good coals—11,500 B.t.u. to 12,000 B.t.u.—is to act as a binder to hold the fire on the grates, and with the poor coals to increase the calorific value as well.

The amount necessary to bind the fuel varies from 5 to 10 per cent, say 7.5 per cent as a mean; this again will depend, however, on the quantity of the No. 4 size. The smaller the coal particles the greater the amount of bituminous required, until with the straight No. 4, say 80 per cent, from 15 to 20 per cent should be used.

Another use for the bituminous coal is the "building of bottoms" in the fire and the repairing of holes. This is especially true with the untrained firemen, and our practice is to have a small bunker of bituminous on the fireroom level where the men can get a few scoopfuls from time to time for this purpose.

Bituminous Mixing

It is of the utmost importance to have the bituminous well mixed with the anthracite, for the better the mixture the less required and the better the economy. In small plants where the coal is brought to the fires in barrows it should be turned in on the floor similar to mixing concrete.

Our practice at the present is crude and consequently does not give the best results. The coal is delivered in bopper-bottom cars, a predetermined number of buckets of bituminous is added from a storage pile on top of the car, by means of a locomotive crane. The coal is then dumped on conveying belts delivering the mixture to a crusher and thence to the overhead bunkers. In the summer this method works fairly well, but in the winter, with the coal frozen, the soft coal may be delivered to the bunkers some 30 or 40 min. before the coal in the car is all unloaded, because the pockets thaw first and the soft coal goes through a long while before the ends of the car thaw enough to flow. This results in uneven distribution about the boilers, some chutes having far too much soft and others not enough. Here again the emergency bunkers on the fireroom level come into play.

An element that enters into hand firing of small anthracite sizes is the vast formation of soot or flue ashes. It is necessary to carry considerable draft and the result is that some of the combustion is similar to that of powdered fuel; it never reaches the grates after leaving the fireman's shovel, it either ignites and burns in the air or is brought over to the rear connections in the form of coke. The greater the rating, the larger the soot deposits due to the greater draft neces-

sary; but even working the boilers at light loads, a very large amount is formed. Our boilers were designed with this in view and have a large space in back of the bridge wall to allow this soot to accumulate, and soot pipes extending down into the ash cellar to allow it to run directly into the ash cars; our economizers are also equipped with soot pipes for this purpose. With the No. 4 coal and insufficient soft coal in the mixture, we will build up soot four or five tubes high between cleanings of soot hoppers, or in six hours.

To give an idea of the magnitude of this, we have had months when the weight of the soot removed was 10 per cent of the weight of the coal fired; this is exceptional, and it should be from 6 to 7 per cent. It may be of interest to note that at times an analysis of the soot shows a slightly higher calorific value than the coal it was made from, due to the fact that the soot is principally coked coal without impurities. We have attempted to burn this but with no success. However, if a small briquetting plant with a cheap binder were available, it could be done successfully. The soot formed by the stoker is naturally but a small percentage of that in the hand-fired boiler.

The gates are the inclined dumping type, with an area of 190 sq. ft. per boiler of 900 hp. The air spaces are 20 per cent with one and 9 per cent with the other.

Thickness of Fire

Our practice is to carry as thin a fire as possible without danger of blowing through and forming holes. The thickness of fire hinges on the formation of a good bottom after cleaning, say about 3 to 5 in. thick, and then building up as slowly as possible. We clean before the service hour and start cleaning again as soon as the peak is over, some two hours if the fires will stand that long. The thickness of the fires at the time of cleaning is problematic, depending on the load carried and the coal; we have had them from 20 to 24 in. or even heavier, but 16 to 18 in. will be nearly an average.

The amount of draft available is of the utmost importance as it is impossible to use the small sizes without a high ashpit pressure. At our Terminal Building in New York we can carry the normal load, somewhat below boiler rating, with natural draft, but here, on account of the great height of the stack, about 320 ft. above the top of the grate, we have an unusual condition: when the boilers are brought to rating the natural draft has to be augmented by blowers. At the Jersey City Power Station we use from 2½ to 3-in. water gage between loads and from 4 to 7 in. during the peaks, depending upon load and condition of fire.

The rate of combustion varies with the load and coal. During our peak hours, with poor coal we burn from 40 to 60 lb. per sq. ft. per grate per hr., while for the whole 24 hr. the rate will be from 20 to 25 lb.

We have but one stoker installed at the present, a Coxe (chain grate), but we are now equipping all of our hand-fired boilers with this type of stoker.

Handling Frozen Coal of Fine Grades

An important consideration in the use of culm for fuel is the thawing of coal during the winter months if the coal is delivered to the plant in cars. On account of its compactness the moisture freezes to a hardness equal to that of lean cinder concrete and a dull-point chisel is necessary to cut it. If a thawing house is not available, special provisions will have to be made. Our practice is to use from 8 to 12 thawing pipes per car, 1¼-in. extra heavy pipe fittings with cap and tee at upper end, a drive point at the lower end and the lower portion of the pipe above the drive point perforated with a large number of small holes. The pipes are entered in the top of the pile in the car and after the thawing begins are driven down from time to time with a wooden maul. The pipes connected in series are fed with 140-lb. superheated steam. It requires from two to six hours for this and then the car is brought over the unloading hopper. The car hopper will be iced so badly that it also will have to be thawed, especially the operating mechanism. To do this we use portable nozzles made up of three 1-in. pipes clamped together with a common steam connection to a rubber steam hose, the outlets of the pipes staggered to make an equilateral triangle and bent at right angles to the body of the pipe. This will thaw the car-door mechanism within a few minutes, so that the doors can then be opened. The worst frost will be found here on account of the drainage accumulation at the low parts, but about ten minutes with two nozzles will start the coal running in the worst car, opening a hole to the top of the car and allowing the coal thawed by the top pipes to run out. It must be borne in mind, however, that this will require a large amount of steam; we find this equivalent to 10 tons of coal per 24-hr. day for from 12 to 18 cars unloaded. It is also necessary to have quite a gang of men working in the car; we use from 4 to 8 to the car because considerable picking is necessary where the coal adheres to the metal sides of the car.

Storage of Anthracite Coal

We attempt to keep from 13,000 to 14,000 tons of small-size anthracite in storage at all times and find that there is no deterioration after at least two years' storage. The greater part of our coal is stored outdoors and this does not change at all. Some 2,600 tons have been stored for one year in overhead storage bunkers where the summer temperature becomes very high. When we had occasion to use it last winter, it had naturally become very dry and powdery and formed somewhat more soot than the new coal; otherwise it gave satisfaction.

W. G. Diman.[1] We have at the plant of the Amoskeag Manufacturing Company 185 Manning boilers of which 169 are running today; all boilers are fitted with Jones underfeed stokers. About two years ago we began to get small quantities of anthracite screenings and refuse; the amount has been increasing until we are now burning hard coal of No. 2, No. 3 and bird's-eye sizes straight under 135 boilers, and hard coal mixed with a small percentage of soft coal under the other boilers.

When we began to receive the hard coal we experimented with various mixtures, but finally used the fuel straight on each to get comparisons of the various grades to assist us in buying. We found that with the regular installation of the Jones stoker the coal was pushed over on to the dead plates and lay idle there with no chance for air to mix and consume the coal. When the buckwheat was hot, it acted like sand and the tuyere blocks on the side of the retorts had a tendency to blow the coal over to the side and pile it up. In order to make an even fire and to get better distribution of air for burning, we put in pin-hole dead plates with about 270 ¼-in. holes, or a total increased air area of about 14 in. The plates were not faced off but were rough castings, which allowed considerably more air to get into the fire. I think still better results would be obtained if we cut off some of the air spaces in the tuyere blocks and added air space in the dead plates. This would

[1] Supt. of Power, Amoskeag Mfg. Co., Manchester, N. H.

reduce the open spaces in the bed caused by the tuyeres' blowing away the coal and produce a more even fire. Some of the coal drops into the pits, which have to be cleaned out to prevent their burning and forming explosive gases.

We carry a light fire, about 6 in. to 8 in. thick, which allows the air to get through. About 2 in. water pressure is carried at the tuyere blocks and no draft in the uptake. We burn about 600 lb. of coal per hour or about 26 lb. of coal per sq. ft. of grate. The larger the grate and the easier the fire is run, the better the results.

We have had to run anthracite coal as high as 25 per cent in ash. When doing this we have considerable trouble with the fires and handling the ashes. We find that the more we handle the fires the greater the loss. We cannot get efficient results out of coal containing much more than 20 per cent ash and if we should get coal containing 40 per cent ash it would be useless to us. In view of the transportation problem and freight rates, the place to burn any coal having about 25 to 30 per cent ash is at the mines, where they can equip to burn the specific fuel which is produced.

The following notes show what results we obtained from our tests, all of which ran 12 hours. Each lot received is tested before and during shipment to see if its quality compares favorably with other coal of the same kind.

An average of 20 tests of straight soft coal of different qualities gave an efficiency of 76 per cent with an evaporation from and at 212 deg. per lb. of dry coal of 10.7 lb. The ash averaged 8 per cent. These tests were made without any perforations in the dead plates.

One test of mixture made with two-thirds soft coal and one-third buckwheat gave an efficiency of 74.7 per cent with an evaporation of 9.93 lb. from and at 212 deg. per lb. of dry coal; and the ash averaged 11.4 per cent. This gave a good fire but, of course, required a little more work and attention from the firemen. The load could be easily carried under these conditions.

An average of two tests of mixture made with one-half bank coal and one-half soft coal gave the following results: efficiency, 58.3 per cent, evaporation from and at 212 deg. per lb. of dry coal, 6.97 lb.; ash, 19.73 per cent. This coal was somewhat dirtier than the average and required considerable work from the firemen. We burned about 670 lb. of coal per hour and ran about 93 per cent of the boiler's rating. The results of all our tests with culm prove that it is much below buckwheat and smaller sizes in evaporation and the only way to get it on a basis with buckwheat is to increase the soft coal percentage, which of course increases the mixture price. It would take three parts soft to two parts culm to equal two parts buckwheat and one soft.

An average of two tests made with a mixture of two-thirds buckwheat and one-third soft coal gave an efficiency of 66.2 per cent with an evaporation of 7.96 lb. of water from and at 212 deg. per lb. of dry coal; ash, 14.83 per cent. These two tests were made on a little better grade of bank coal. We burned 676 lb. of coal per hour, and obtained 95.1 per cent of the builder's rating. The boilers are of 150 hp. each. We used a draft in the tuyere blocks of 1.59 in. and 0.07 in. in the uptake. When burning this mixture, the fire burns well but needs close attention. A light fire must be carried.

An average of eleven tests of anthracite refuse, which includes bank coal and culm (no soft coal used), gave the following results: efficiency 55.7 per cent, evaporation from and at 212 deg. per lb. of dry coal, 6.75 lb.; ash averaged 17.8 per cent. We consumed 628 lb of coal per hour, obtained an average of 78.4 per cent of the builder's rating and used 1.86 in. of water pressure at the tuyeres. This was an experimental mixture made to see what it would do.

An average of seven tests with prepared anthracite screenings of No. 2 and No. 3 buckwheat and bird's-eye without any soft coal gave the following results: efficiency 59 per cent, evaporation from and at 212 deg. per lb. of dry coal, 7.47 lb.; ash averaged 14.5 per cent. We consumed 742 lb. of coal per hour, obtained 96.7 per cent of the builder's rating and used 1.73 in. of water pressure at the tuyere blocks.

We made one test using one-half culm and one-half buckwheat, which gave an efficiency of 53.2 per cent and obtained an evaporation of 6.13 lb. from and at 212 deg. per lb. of dry coal. The ash averaged 21½ per cent. We consumed 680 lb. of coal per hour and obtained 72 per cent of the builder's rating. To do this we used 1.87 in. draft at the tuyeres. The culm, of course, has a tendency to pull the buckwheat down.

In order to burn anthracite screenings and refuse successfully under our conditions, a Coxe stoker specially built for this grade of coal should be used, or a small amount of soft coal must be mixed in. This mixture must be maintained at all times and the better the mixture the better the results of combustion, for the successful burning depends entirely on the mixture. In our case the coal is dumped in as it comes and we have to take it as it comes. It cannot be burned successfully by having a run of say two hours on hard coal and then a run with a mixture of hard and soft coal. The whole thing is to have a uniform mixture in order to make a steady fire.

Some of the buckwheat clinkers and some of it will break up into smaller pieces, mixing with the fire, which makes it hard to clean. The fire should not be disturbed any more than possible. It is not good judgment to use a slice bar more than is necessary. The fires should be kept medium and the hoe should at all times be able to touch the grate. When hot, this class of coal resembles sand and a hoe can easily move it when necessary and handle the dirt. The lighter the fire, the better are the results. Unless the firemen are watched they tend to carry heavy fires with more draft. With an 8-in. fire we can easily burn 1000 lb. of coal per hour using a 2-in. draft at the tuyeres. The coal should run as even in size as possible.

We can burn screenings successfully if we obtain 20 per cent soft coal. It is more economical to burn straight soft coal than screenings, unless the equipment is installed for the burning of this class of coal. Two years ago last April we ran on soft coal only. We burned that month 10,352 tons of coal as against 13,689 tons of practically hard coal (about 20 per cent of soft coal) this last April. Our steam load this year was 369,512 kw. hours less for the month of April, or about 12 per cent of the total steam load.

If we take hard coal at $6.25 per ton and soft at $10 it would make the balance in favor of soft coal, provided the load was the same and we took into consideration the added cost for boiler-house labor and handling ashes.

We recently got a cargo of Dominion coal which apparently is high in volatile. We burned this with buckwheat, a quarter of Dominion soft coal and the rest buckwheat, and we secured the best results that we have ever had. Dominion coal burned straight is poor coal because it clinkers badly, but it has a tendency to mix with anthracite, and the anthracite holds down the volatile elements.

William P. Frey.[1] There is only one kind of anthracite waste, and that is material containing 35 per cent or more of incombustible, be it chestnut coal or No. 4 buckwheat. Since

[1] Fuel Engineer, The Lehigh Coal & Navigation Company, Lansford, Pa.

the development of the process of cleaning No. 4 buckwheat (through 1/8-in. round mesh and over 1/16-in. round mesh) and No. 5 buckwheat (through 1/16-in. round mesh) these two products have gained a firm foothold and have come to stay.

No. 3 buckwheat and No. 4 buckwheat are two excellent stoker fuels, if there is a proper stoker installation. No. 5 buckwheat is too light for stoker firing and should be briquetted. To the users of soft coal, hand- or stoker-fired furnaces, I cannot too strongly recommend mixing No. 3 buckwheat or No. 4 buckwheat with their bituminous coal. The curves, Figs. 6 and 7, clearly indicate the possibilities of these mixtures for stoker practice although they pertain only to hand-firing practice. All prices are based on the following scale:

Buckwheat No. 1—$4.10 per long ton f.o.b. mines
Buckwheat No. 2—$3.30 per long ton f.o.b. mines
Buckwheat No. 3—$2.15 per long ton f.o.b. mines
Buckwheat No. 4—$1.25 per long ton f.o.b. mines
Buckwheat No. 5—$1.00 per long ton f.o.b. mines
Uncleaned Silt—$0.65 per long ton f.o.b. mines
Bituminous run of mine—$3.40 per short ton f.o.b. mines.

Firing of Anthracite Buckwheats

Table 7 represents the attempt to tabulate in an easily understandable form the practical operating condition of industrial power plants with highly varying loads. As it was found that a rate of combustion of 25 lb. of dry coal per sq. ft. grate surface was very economical for all sizes, this rate was adhered to as closely as possible by adjusting the speed of the grates and the air supply. As a rough guide for the boiler operatives the blowers have to be set to deliver 20 cu. ft. of air per maximum horsepower. The air control goes hand in hand with the CO_2 recorder readings that read 12 per cent on the average and the stack temperatures which are to be kept below 500 deg. fahr. If the stack temperatures are high, the speed of the grate must be increased, the thickness of the coal fuel bed reduced, the air pressure under the grate lowered, but the rate of combustion maintained as constant as possible. It is very important to understand that the figures given in the column for grate travel in feet per hour are relative to 25 lb. of coal per sq. ft., which means that if the grate runs at 16.2 ft. in case of No. 3 buckwheat, the bed must be carried 6 in. thick. If it is desired to carry only 4 in. the speed of the grate must be increased 6 : 4 = 1.5 times to keep the same rate of combustion. It has to be understood, too, that 25 lb. per sq. ft. is by no means the highest possible rating. The maximum rating obtainable according to our experience is:

No. 1 Buckwheat—40 lb. per square foot per hour
No. 2 Buckwheat—35 lb. per square foot per hour
No. 3 Buckwheat—30 lb. per square foot per hour
No. 4 Buckwheat—27 lb. per square foot per hour
Uncleaned silt and No. 5 Buckwheat—25 lb. per square foot per hour or less.

These figures apply to a Coxe stoker with 7 per cent air space in the grate.

Good practice will keep the air pressures in the tuyeres as near as possible to 1 in. at the stoker front, graduating down to 0.2 in. at the refuse end of the grate.

The operating equipment includes: automatic feedwater and damper regulators, recorders of steam flow, CO_2, feedwater temperature, steam pressure, and stack draft; draft gages and long-distance thermometers.

Firing of Anthracite and Soft Coal Mixed

Buckwheats No. 3 and 4 are well adapted for mixing with soft coal if they are clean and the mixing is well done. These two conditions are absolutely essential and cannot be emphasized enough. The method of firing need not be changed, although there should be a tendency to fire thin and to damp off. The green coal should be thrown on when the fire is white hot, after leveling, for instance, and then there will be a very pronounced coking effect that will bake the No. 4 buckwheat to a coarsely granulated fuel of about pea-coal size. The fire must be kept loose at all times and will stand very hard blowing.

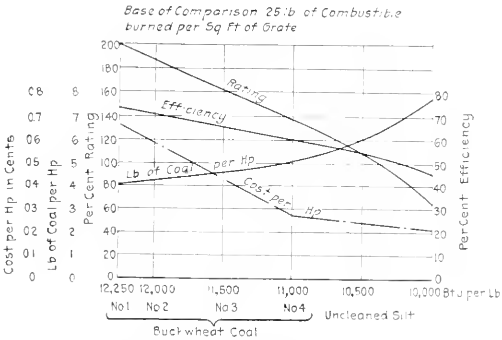

FIG. 6 PERFORMANCES TO BE EXPECTED WITH VARIOUS BUCKWHEAT GRADES

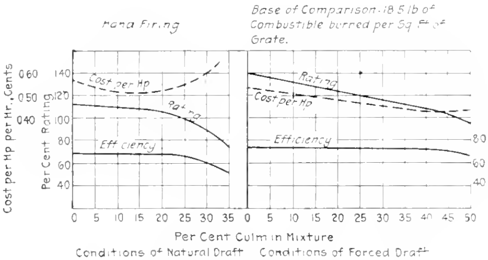

FIG. 7 PERFORMANCES WITH MIXTURES OF NO. 4 BUCKWHEAT AND SOFT COAL, HAND-FIRED

Almost any good grade of grate bar is suitable, up to about 3/4-in. openings, provided enough kindling is left on the grate after cleaning to cover the grate. The most gratifying feature of the mixture burning is that it does away with all hard clinkers, which is especially welcome in stoker practice, particularly in underfeed stokers.

The curves in Fig. 7 above show the results obtained in burning soft coal mixed with No. 4 buckwheat in a hand-fired Newburgh fire-tube boiler. The rate of combustion (amount of coal to be shoveled) was kept constant. All coal was crushed to smaller than 1 1/2-in. round mesh.

Briquetting of Anthracite Waste

Either No. 4 buckwheat, or No. 5 buckwheat, or the two mixed, or uncleaned silt, can be briquetted successfully. Anthracite briquetting has passed the stage of experimentation. The binder material is available, and with the concurrence of all concerned, not a pound of anthracite waste should go down

the rivers again. That briquetting is a commercial success is proven by the fact that it raised the price of No. 5 buckwheat from 65 cents to \$1, leaving still a small margin of profit, and by the ever-increasing output of our Lansford experimental plant, which shows the following tonnage figures:

1915— 3983 tons
1916—11,194 tons
1917—31,034 tons
Jan. to April 30th, 1918—18,500 tons

TABLE 7 OPERATING RESULTS OF ANTHRACITE BUCKWHEATS

750-HP. MAXIM BOILER—COXE TRAVELING GRATE. AVERAGE STEAM PRESSURE 125 LB.

	No. 1 Buckwheat	No. 2 Buckwheat	No. 3 Buckwheat	No. 4 Buckwheat	Uncleaned Silt
Average hp. of test ...	1500	1395	1200	1010	495
Maximum hp. of test.	1750	1600	1400	1100	650
Average per cent rating	200	186	160	134	66
B.t.u. per lb. of dry coal	12250	12000	11500	11000	10000
Combined efficiency of boiler, furnace and grate, per cent...	74	70	65	61	45
Equivalent evaporation from and at 212 deg. per lb. of dry coal, lb.	9 35	8 77	7.7	6.9	4 6
Dry coal consumed per hp. per hr, lb..	3 69	3 93	4 48	5.00	7 5
Dry coal per sq. ft. grate surface per hr, lb..	25	25	25	25	25
Boiler hp. per sq. ft. grate surface.	6 8	6 36	5 5	4 9	3 3
Grate travel in ft. per hr..	16 6	16 5	16 2	15 2	11 1
Cost per hp. per hour in cents..	0 67	0 58	0 43	0 27	0 21

NOTE—Last figures correspond to prices at the mines and have to be adjusted to meet the various freight rates.

CONCLUSION

To the careful reader it will be evident from the preceding that it is not only desirable to burn cleaned No. 4 buckwheat, but it is at the same time most economical if ample grate capacity is provided; and there will go hand in hand with it the preparation of No. 4 buckwheat, and the washing and concentrating of No. 5 buckwheat, which can be briquetted to a very valuable fuel, relieving some of the domestic sizes. But the results obtained show still more conclusively how important it is to use proper methods of firing and mixing, and the prime importance of keeping the market free from all fake products of unclean No. 4 or No. 5 buckwheat, uncleaned silt, or low-grade briquets.

G. H. SHARPE.[1] The Derby Gas Co., Derby, Conn., endeavor to provide, during the season of open navigation on the Housatonic River, an ample reserve stock of bituminous coal to carry the electrical department through the winter and early spring. The demands during the past winter exceeded the estimate, owing to the emergency power supplied to Waterbury, Conn., and to tide over it was decided to accept an offer of about 11,000 tons of No. 2 and No. 3 buckwheat, on which deliveries started in the latter part of March. The 11,000 tons were purchased under three contracts, the average analysis of which is about as follows:

Ash, per cent...........................	20.52
Moisture, per cent.......................	8.20
B.t.u. dry	11,587
B.t.u. as received.........................	10,638

An average of 7000 lb. of buckwheat is loaded from the storage pile into a truck, and the truck is then filled up with bituminous, giving about 55 per cent of buckwheat per load. This is dumped at the power station, passing through a crusher and conveyor, and into the bunkers, resulting in a uniform mixture. From the overhead bunkers, the coal is delivered through a traveling weigh larry to multiple-retort underfeed stokers serving two 600-hp. Babcock and Wilcox boilers. The mixture is, as stated, about 55 per cent No. 2 and No. 3 buckwheat.

The fire carried is much thinner than with bituminous, and with a 2½- to 3-in. draft. The output of the boiler is reduced because of the lower heat value of the fuel.

The clinkers and ash are increased, resulting in a marked increase in cost of operation, as ashes are loaded by hand to trucks, pending completion of the new boiler room; but clinkers are more easily broken, so that less coke is lost in cleaning the dumping grate.

We are burning 2.20 to 2.21 lb. of coal per kw-hr. at the switchboard, with a maximum output of 6800 kw. and an average of between 5000 and 5500 kw., giving an overall plant efficiency of about 11.9 per cent.

The buckwheat costs \$1 less than the bituminous, but the increased cost of ash disposal and lower heat value do not warrant additional purchases. The stokers handle the 55 per cent mixture readily, and I have no doubt that we could have made an equal showing, based on heat values, with 75 per cent or even 85 per cent of buckwheat.

R. SANFORD RILEY[1] (Oral). We in the stoker business who are primarily interested in the burning of bituminous coal are frequently asked as to the amount of anthracite coal that may be mixed with bituminous. To answer this question intelligently, we should know the characteristics of both the bituminous coal and of the anthracite coal that the questioner has in mind. The proportions mentioned by the previous speakers are very good; we find that up to 30 per cent of anthracite may be used.

Nearly all stoker manufacturers are advocating the necessity for large stokers. We think that the stoker is really the limiting factor. The maximum of stoker capacity should be put under the boiler. The reason for this is that the boiler investment cost per horsepower is very much greater than that of the stoker. I would like to emphasize that the mixture of anthracite and bituminous must be thorough; one cannot burn first a patch of anthracite and then a patch of bituminous.

E. B. WESSON[2] (Oral). We have a small Manning boiler plant which we fire one-half anthracite and one-half bituminous; and we mix the coal by taking the small industrial dump cars and filling them half full of anthracite, and then at the other end of the trestle filling them with bituminous. The cars are then dumped on the boiler-room floor.

J. M. SPITZGLASS[3] (Oral). It is surprising that in all this discussion so far the boiler has been treated as a consumer, and a bad consumer at that. It seems to be overlooked that the departments that use steam should be checked as to the use they make of it. The instrument that saves the most coal is the one that measures the steam produced by the boiler and the steam that is used by each department in the factory.

[1] Derby Gas Co., Derby, Conn.

[1] President, Sanford Riley Stoker Co., Ltd., Worcester, Mass. Mem. Am.Soc.M.E.

[2] Worcester, Mass.

[3] Vice-President, Republic Flow Meters Co., Chicago. Mem.Am.Soc. M.E.

A. G. Christie.[1] Last winter we purchased a considerable quantity of anthracite "yard sweepings" from domestic coal dealers for use in Taylor stokers under Babcock and Wilcox boilers in our University plant. This coal contained 16 to 20 per cent ash and averaged about 11,000 B.t.u. In general these screenings came from coal mined before the shortage occurred. It could be burned with perfect satisfaction in the stokers even at overloads when mixed as high as three parts of anthracite to two parts of Somerset semi-bituminous coal.

Later several cars of washed culm were purchased with from 25 to 40 per cent ash running 10,000 to 7000 B.t.u. per lb. The ash had a low fusing point and formed immense hard clinkers in the furnace when mixed and burned with semi-bituminous coal. It could only be burned with an equal portion of the Somerset coal when the demand for steam was small. In the furnace the fuel had a dull appearance and the finer particles tended to blow over on to the dump plates. It cascaded badly on dumping and during the removal of clinker. On the whole, we found the culm an uneconomical investment, although the yard sweepings proved economical when purchased at a reasonable price.

Carl Smerling.[1] Anthracite wastes such as culm and smaller sizes of buckwheat can be successfully consumed and burned, using a mixture of 1-3 anthracite and 2-3 bituminous coal, providing the bituminous is of a good coking quality and the fire can be carried 16 to 20 in. deep with natural draft of 0.7 in. at the stack breeching, and maintain a rating of from 125 to 150 per cent. On these conditions the stoker can be operated the same as when burning the straight bituminous coal fire. It is absolutely necessary to have sufficient bituminous coal to raise the temperature of the fire high enough to get all the value out of the anthracite coal.

[1] Pres., Huber Hand Stoker Co., Inc., New York. Assoc-Mem.Am. Soc.M.E.

5 What Instruments Are Useful and Desirable in the Boiler Room as Aids in Saving Coal?

What class of equipment has been of the most value to you, and how?

E. G. Bailey.[2] The answer to this question is: Meters that will actually *assist* the fireman to carry the load required of his boilers and at the same time obtain the maximum efficiency. The old idea of having meters and recorders to "show him up" if he did not do his work well, when he usually did not know how to do it better, is wrong.

The word "meter" is used here in its broad sense to include all instruments, pressure gages, thermometers, etc. down to coal scales and wheelbarrows when they are used to obtain knowledge of the operating and efficiency conditions.

Controllable Losses in Boiler Operation

In selecting meters, the principal object is to obtain knowledge of the boiler capacity and efficiency and also the individual losses, especially those which are controllable. To accurately know the losses is of much more importance than to merely know the efficiency, for efficiency can only be increased by reducing losses, and if one knows that the losses have been reduced, he is positive that the efficiency has been increased. The principal controllable losses in boiler operation are: (1) combustible in ashes and refuse, (2) excess air, (3) unburned gas, and (4) high temperature of flue gases. There are also other factors from an operating standpoint that are of importance, such as the steam pressure, superheat, rate of steam output from each boiler, evaporation per pound of coal, etc.

Meters are divided into four general types. Those which show condition; total; rate; relation.

Meters which show condition include pressure gages, thermometers, water level gages, etc. which in a boiler plant are used to measure steam and draft pressures; steam, flue gas and feed water temperatures; water level in the boiler and other similar factors. These meters may be either recording or indicating.

Meters which give total values or quantities, include coal and ash weighing or measuring devices, also integrator meters for water, steam, etc. These are usually indicating only.

Meters which show rate can be either recording or indicating, and include boiler feed, steam flow, air flow, stoker speed, etc. They may also be combined with integrating meters of the second type.

The three foregoing types are those with which we are most familiar and they have been developed and their general use extended in the same order in which they are named, while from an operating standpoint the value of these different types is practically in their reverse order. For instance, it is better for a fireman to know the rate of steam output from each boiler continuously than to wait until the end of his shift and learn the average rate from a water meter that integrates total only.

Results Should Be Known Promptly

The real valuable results from complete boiler tests, such as those made by Dr. D. S. Jacobus at Detroit some years ago, are not obtained until the many calculations involving averages and totals are made and the relations between the various factors is determined. In other words, the total evaporation or even the rate of evaporation gives no information whatever as to efficiency until we know how many B.t.u. were expended in producing this steam, or at least know how many B.t.u. were lost in making it. Time is an important factor in boiler operation and the fireman should know final results promptly and continuously. It is, therefore, desirable to have meters of the fourth type which indicate and record the relation between certain important factors as well as the condition, total and rate.

One of the important relations desired is that between rate of steam generation and rate at which fuel is burned. With liquid or gas fuels of uniform quality this is possible; but with coal, about the closest approach is the relation between a steam flow meter and tachometer on the stoker drive. The latter, however, is a crude means of determining the rate at which the B.t.u. are supplied to the furnace, and this is the real factor desired. It is doubtful if this will be satisfactorily attained, in the near future at least, due to the varying amount of coal fed per revolution of the stoker shaft and the varying quality of the coal, as well as variations in the amount of coal on the grate.

[1] Assoc. Professor of Mechanical Engineering, Johns Hopkins University, Baltimore, Md., Mem.Am.Soc.M.E.

[2] President, Bailey Meter Co., Boston, Mass., Mem.Am.Soc.M.E.

RELATION OF STEAM FLOW AND AIR FLOW

There is another relation, however, that is analogous to the steam-fuel ratio that is readily obtained and of even greater value. It is the relation between the rate of steam flow from the boiler and the rate of air flow which supports combustion for the generation of this steam. Air is a fuel just as much as carbon or hydrogen, and the amount of air required to develop a given number of B.t.u. is practically independent of the character or quality of coal being used. In fact, there is only 6 per cent difference between the B.t.u. developed per pound of air used to burn carbon and natural gas. This is much closer than most people are able to maintain the excess air in coal fired furnaces. Natural gas is mentioned in this comparison because it contains a higher percentage of available hydrogen than any other commercial fuel.

There is ample evidence available to show that the relation between the steam flow and air flow is of value in assisting the fireman to maintain the most economical fuel bed and prevent undue losses in either excess air, or unburned gases. This relation is also of great assistance to the fireman in obtaining maximum capacity from his boilers, for he quickly learns that it is impossible to make steam without the proper supply of air and if the maximum air supply is equivalent to only 200 per cent boiler rating, then 200 per cent boiler rating is all he can get, unless he is willing to sacrifice efficiency and produce high percentages of unburned gases. Such a loss is plainly shown by this relation as a deficiency of air.

Another important relation in boiler operation is that existing between flue gas temperature and rate of steam output. We have only to refer to data plotted by Mr. Azbe[1] to see that there is a wide difference between results obtained from various boilers in different plants. While this relation depends upon the position of baffling and other features of design, it is perfectly definite for any one design, and a certain flue gas temperature should exist for each rate of steam output. Any deviation from this indicates dirty heating surface or leaky baffles, providing the proper relation exists between the rate of steam flow and air flow. Either a decrease or increase in excess air from the most economical amount will result in an increase in flue-gas temperature, except that a large percentage of excess air will reduce the temperature.

In boiler-plant operation there are several other factors which should be combined to continuously show the relations existing between them for the benefit of the fireman or operating engineer, whereby they can get at the true conditions and their causes with little mental effort and delay. A meter which shows a relation is in reality an automatic calculating machine which takes two or more factors and produces a tangible result, which would otherwise require the reading of two or more instruments and reference to charts or tables.

The question often arises in selecting any of the four types of meters as to whether they should be indicating or recording. Some of the best power-plant engineers were strongly in favor of indicating meters for boiler plant work a few years ago, but have now changed to be the strongest advocates for recorders. Practically the only argument that can be advanced in favor of indicating meters is lower initial cost and the lower cost of operation by elimination of charts.

ADVANTAGES OF RECORDING METERS

Some of the many advantages of recording meters are: Permanent records to show conditions existing throughout the twenty-four hours; averages, totals and operating characteristics may be checked at any subsequent time: and of even more importance is the fact that it helps the fireman to see, not only the conditions at that instant, but also what the conditions have been immediately previous, and thereby ascertain whether they are changing, and if so, in which direction. This alone is of sufficient value to warrant the use of recording meters in practically every instance, providing they are located in the position where the man in charge of operation can readily see the chart record in detail. A water tender will do much better work when he has a recording feedwater meter within sight, than if the recorder were located in the engine room.

The firemen and operating men must have meters which serve as eyes whereby they can see through steam pipes and brick walls, so to speak, and actually know what is taking place. The meters that will give them true pictures in the most realistic and concrete form are the most useful in saving coal.

WALTER N. POLAKOV. While the generation of power, and more specifically of steam, is the domain of the scientifically trained engineer, power-plant practice is conspicuous by the lack of accurate measurement of conditions and results.

Unless the results attained are known, no opinion as to perfection of operation can be formed: furthermore, the practice is necessarily wasteful unless means are available to observe the conditions under which the process is performed. All instrument equipment of the boiler house can, therefore, be grouped into two classes: those for recording the results: those showing the conditions.

A plant of which it is not known how many pounds of coal are used per 1000 lb. of steam, how the load is distributed among the units and throughout the day, etc., by necessity wastes fuel. The knowledge of these data does at least open the eyes of those responsible for its success, and further progress is thereby made possible.

The first group of instruments then comprises:

Quantity
- Recording coal scales
- Recording steam or water meters.

Quality
- Coal calorimeter and moisture scales
- Feedwater thermometer
- Steam pressure gage and thermometer.

The second group of instruments is intended to direct the processes by controlling conditions:

Conditions
- Individual flow indicators
- Individual draft gages
- Individual flue-gas thermometers
- Flue-gas analyzer.

Substitution of flow indicators by coal or oil meters is undesirable, as it leaves obscure the output for given input: draft gages may be substituted by pitot tubes. Other modifications are sometimes desirable, but the above equipment is necessary and sufficient in general cases.

Any investment in instruments is a pure waste of money, and will lead to demoralization unless means are provided for:

a Training men to properly use them
b Stimulating men in the proper use of them
c Complete, exact, and continuous recording.

[1] Power Plant Efficiency, by Victor T. Azbe, Trans.A.S.M.E., vol. 38, 1916, p. 722.

Location and arrangement of instruments should be such as to:

a Permit simultaneous readings and their comparison
b Permit plain view of units from instrument board and vice versa
c Afford an opportunity to use one instrument for diverse units
d Eliminate unnecessary fatigue of observing scattered instruments
e Assure ease and simplicity for testing.

These requirements are combined in the type of instrument boards devised by the author, typical examples of installations being represented in Figs. 8 to 10.

The complete cost of such installations, including labor and material, averages $2000, and the returns secured on this investment are usually equal to or better than told in the following report from a plant using from 150 to 250 tons of coal per week:

" . . . . It is evident that in the four months preceding the installation of the boiler control board, the savings on fuel, due to various steps taken, averaged $435.00 per month, while, in the four months following the installation of the instruments, the savings computed on the same basis averaged $1145.00. In other words, the increased savings, due solely to the *intelligent use* of instruments on the boiler control board, was $710.00 per month, or $8620.00 on the annual basis, which means that the expenditure of $2080.46 for instruments of the said board is an investment which, in our case, yields over 400 per cent return."

The fallacy of economizing on instrument equipment or ignorant attempts to select "the most important" ones has only one rival in absurdity—the tendency of installing instruments without giving the employees the opportunity to use them to advantage. Obviously, the operating men have no time, no ability for research work, and little inducement, to carry out investigations, standardize methods, and set tasks. It should be the duty of the management to give them the necessary training and to assume responsibility for results.

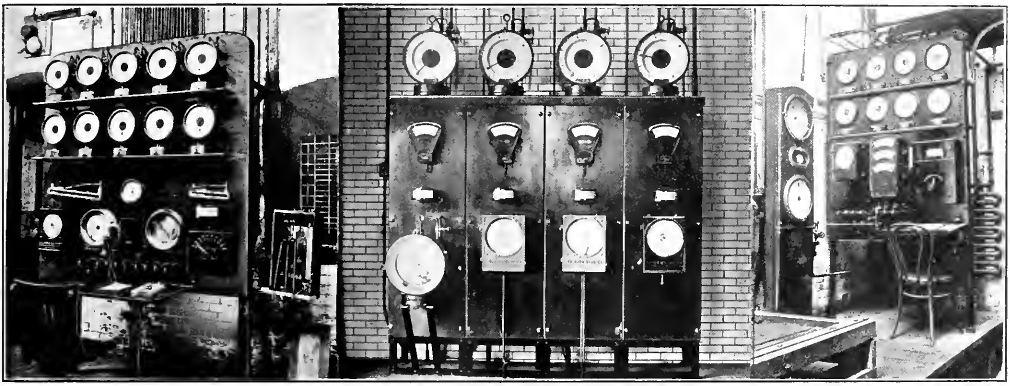

FIG. 8 FIG. 9 FIG. 10
FIGS. 8, 9 AND 10 BOILER AND COMBUSTION CONTROL INSTRUMENT BOARDS

A. R. DODGE.[1] Pressure gages and water-gage glasses are absolutely necessary to the operation of steam boilers. Next in importance is a steam-flow meter for the purpose of showing the amount of steam being delivered by each individual boiler.

Steam-flow meters in service have shown that in nearly every case a battery of boilers as a whole may be generating the required amount of steam, but the several boilers making up the battery fall far short of assuming equal subdivisions of the total.

Steam-flow meters installed on each boiler show at once a boiler which is "loafing," or one being forced too hard, conditions which cannot readily be detected in any other way. With this knowledge the necessary changes can be made in drafts, fires, etc., to equalize the steam output of the boilers. With the outputs equalized the danger of priming and burning out tubes and brickwork, due to excessive overload, is minimized.

Results obtained in many plants prove conclusively that the flow meters are a great aid to the firemen themselves in showing the results of their work. As soon as they learn that the flow meters show them the effect of changing the draft, fires, rate of feeding water, etc., they will be found using them as a working guide.

Holes and dead spots develop in fires, reducing the efficiency of combustion by allowing an excess of air. Should this occur, the steam output instantly drops and with a flow meter installed on each boiler, the fireman is warned that something is wrong.

Flow meters have been the means of indicating many other conditions which seriously affect the economy, such as leaky settings admitting quantities of air, burned-out baffles permitting a short-circuit of the gases, incorrect adjustment of feedwater regulators, or poor hand regulation, etc.

The use of draft gages, CO_2 recorders and a thermometer to show the superheat of the steam, in conjunction with a flow meter, enables the power-plant operator to keep a complete check on the performance of the boilers and furnaces, and to quickly eliminate faulty conditions as they occur and thereby to keep up the efficiency of the plant.

[1] Engineer, General Electric Co., Schenectady, N. Y., Mem.Am.Soc.M.E.

E. A. UEHLING.[1] The continuous CO_2 record shows up the process of combustion for every minute of the day. The indicator at or near the boiler front keeps the fireman continuously informed of what he is doing. It shows him in a few minutes the effect of any change in the rate of fuel and air supply that may be necessary to keep the steam pressure level.

[1] Uehling Instrument Co., Passaic, N. J., Mem.Am.Soc.M.E.

What the CO_2 Shows

In hand-fired boilers the continuous record not only shows whether the proper per cent of CO_2 has been maintained, but also how often the fire was replenished, how long the fire doors were kept open, when the fires were cleaned, how long it took to clean them, and the improvement in the fire resulting from it. With an occasional check analysis by an Orsat the continuous CO_2 record becomes an unchallengeable exposition of combustion efficiency.

Combustion efficiency is the foundation of boiler efficiency, but it does not necessarily follow that maximum combustion efficiency will always result in maximum boiler efficiency. There is another factor of nearly, if not quite equal importance, viz., absorption efficiency. Absorption efficiency depends, first, on combustion efficiency; second, on the relation of heating surface to the rate of combustion; third, the routing of the gases through the boiler; fourth, the cleanliness of the heating surface inside and out, and fifth, air infiltration. The CO_2 meter should therefore be supplemented by at least two other instruments, viz., the pyrometer and the boiler draft gage, preferably the draft analyzer, which shows both the furnace draft (resistance through the fire) and the boiler draft (resistance through the boiler). The pyrometer does not by itself give reliable information, but if its readings are coordinated with those of the CO_2 meter and the boiler draft gage, a complete and reliable control over absorption efficiency is had. The boiler draft gage gives immediate notice of broken down baffling, and in combination with the per cent of CO_2 its readings furnish an approximate index to the rate of combustion.

It would be useful to have, in addition to the above, a steam-flow meter on each boiler, since they would furnish a quantitative check on every boiler and fireman in addition to the chemical and physical qualitative control which I have mentioned as necessary and adequate to attain and maintain maximum boiler efficiency dependent only on plant—fuel—and operating conditions. The installation of a steam-flow meter is therefore to be highly recommended.

It is evident from all this that no boiler plant large or small should be without an Orsat, that the CO_2 recorder should take precedence over other more or less expensive equipment. Although the CO_2 recorder gives all the information necessary to control combustion efficiency, a pyrometer and draft analyzer are necessary in addition to control boiler efficiency. In general any instrument that will give useful information is a desirable addition to the equipment.

Wholesale control by means of water meter and coal weigher is most valuable to the manager in many ways in addition to those already mentioned, and any plant the size of which warrants the expense should install them.

There are many other instruments and apparatus of greater or less importance and utility which the prescribed space and time does not permit me to discuss. I may say, however, that all have their talking points and in a measure fulfil their advocated functions; but since they ignore the fundamental principle of combustion, they cannot give information adequate for complete control over boiler operations.

R. P. Brown.[1] The temperature in the furnace and the distribution of this heat throughout the boiler must be learned and studied carefully. The firebox is at such a high temperature that except for test purposes it is not practical to install an instrument at this point. An electric pyrometer can be used to secure by test the temperature in the firebox using a platinum-rhodium thermocouple, but most frequently the pyrometer is installed so that the temperature of the last pass, or in the uptake, is secured.

The temperatures in the firebox are approximately 2500 or 2750 deg. fahr., which is too high for a permanent installation. In the last pass the temperatures average about 1000 deg. fahr. and in the uptake about 400 or 600 deg. fahr. At these lower temperatures base-metal couples may be installed without danger of rapid deterioration. The temperatures in the last pass and uptake have been found to be comparative to those in the firebox; so that a working temperature is secured to which the fireman can work.

If actual practice shows that 500 deg. in the uptake or a corresponding temperature of 1000 deg. in the last pass of a boiler results in securing the maximum efficiency, then the fireman should use this temperature as a guide. The slightest irregularity in firing or change in furnace conditions are readily noted before the corresponding change in pressure may occur. If the flues are dirty and sooty the heat cannot be absorbed and instead pass up the stack, and a correspondingly high stack temperature is secured. If the baffle walls become cracked or broken down the heat will not circulate properly, and again high stack temperatures.

In addition to the usefulness of temperature and pressure recording instruments, there has recently been evidenced an increased interest in electric tachometers for registering the speed of the shafts on automatic stokers. The rate of firing naturally bears a close relationship to the amount of coal used. A small generator is attached to the end of the stoker shaft by means of gear or sprocket and chain drive. It is so geared that about 15 to 25 volts are generated at a speed of approximately 1000 r.p.m. of the generator. This voltage is carried to the instrument by means of wiring. As this can readily be strung for long distances, the instruments may be located wherever most desirable.

[1] President, Brown Instrument Co., Philadelphia, Pa.

C. W. Hubbard.[1] The evaporation figure might strictly be classed as a "half truth." When this figure has been arrived at, without supplementary data, one man's guess is as good as another as to whether the results obtained are all they should be.

The most useful instruments in the boiler room are draft gages, an Orsat apparatus, a CO_2 recorder, and recording thermometers for the feedwater line and the flue-gas temperatures. In addition to this, systematic tests of coal and ashpit refuse are necessary, for it is obviously unfair to expect the plant to operate at a given standard when it may be, and probably is the case, under present conditions, that the fireman is being furnished with greatly inferior coal.

It has been a common experience of the writer to be able by thus studying the preventable losses in the plant, to make a saving of from 10 to 20 per cent within a period of a month, and when I say 10 to 20 per cent I do not mean in power saving but I mean actual tons of coal wheeled into the boiler room.

R. H. Kuss. The question requires two sets of answers, because for the fuel engineer the entire range of instrument equipment may be made useful, whereas for the operating engineer of the usual grade, a very limited number of instruments are of any special service.

Instruments an engineer can use to advantage are those

[1] Fuel Engineering Co., New York City.

which he can understand: those that prove useful are such as require little attention to keep operating and which reveal maladjustment by simple test. The most useful and simplest instrument for the boiler room is a draft gage, preferably of the differential type. A draft gage or draft-gage system, if continuously used, will show to the careful observer—

a Developments of leaks, uncleanliness, baffle failures, etc.
b Poor fuel-bed construction.

Less difficult to interpret but much less useful than draft gages are thermometers or pyrometers. The difficulties in using pyrometers are those only of placing the bulbs or couples in the proper places so that the indication may be a true one of the condition investigated.

Gas-analysis instruments, while highly necessary for more refined investigations, are so seldom used by operators of plants of the middle or smaller size that as a general proposition it is useless to place them in the operating engineer's hands. The writer strongly endorses the use of coal-weighing and water-measuring systems.

The great difficulty with the subject is that, however useful the instrument may be, the supervising or engineering forces of boiler plants neglect to employ them to an extent their value justifies. The conclusion is inevitable that they should be few in number but of the recording type rather than indicating alone. The reason is that a record affords the opportunity of not only checking up the operating performance while going on, but gives the managerial forces the opportunity of checking up the operating engineering forces.

WALTER E. BRYAN.[1] When a number of boilers are connected to the same stack, it is particularly advisable to have each boiler equipped with a draft gage so that the gas passages can be regulated in the individual boilers with the result that more work will not be required of some boilers than others. Steam-flow meters are also advisable in stations where turbines are used and the flow is not pulsating. Readings of stack temperatures, CO_2, etc., should be taken at intervals, the latter with a view to calling attention to leaks in settings, etc. A recording CO_2 instrument arranged with connections to the various boilers is a valuable adjunct to the fireman.

B. J. DENMAN.[2] I believe the most useful instrument in the boiler room to be the one which indicates the percentage of CO_2 in the flue gas. In larger stations, with boilers of 1000 hp. or more, an automatic CO_2 recorder is justified. In smaller units, each boiler should be equipped with a gas collector and the Orsat apparatus, to determine the percentage of CO_2. Samples should be analyzed at least once during each watch. We regard the steam-flow meter as essential and as important an instrument as an ammeter or a wattmeter on a generator, and even more important from an efficiency standpoint. It is important that efficiencies of all the boilers be known over a wide range of loads and that they be operated at the most efficient point. It is not of much value to determine the efficiency curve unless its indications are followed, and this can only be done by the use of a steam-flow meter. These will show not only the number of boilers to have in service, but the division of the load between the units. With the underfeed type of stoker, we believe it is necessary to have instruments indicating the draft over the fire and at the damper, as with this type of stoker practically balanced draft can be carried, and this is the furnace condition which is most conducive to economy, through a reduction in the infiltration of air. Flue-gas-temperature recorders are desirable, but not essential, as the release temperature will take care of itself, if the boilers are kept clean and operated at the most efficient point, except for short periods during the peak.

A. G. CHRISTIE. Our University plant contains Babcock & Wilcox boilers and Taylor stokers with steam-pressure regulation on the blast and a balanced-draft system on the flue-gas damper. We have found that the instruments which receive the attention of our firemen and enable them to obtain the best results are draft gages on the blast and over the fire, a pyrometer in the breeching and a CO_2 recorder. The latter takes much skilled attention but produces results. We have been experimenting with a new blast regulator which promises to give better results than the usual type. Steam meters combined with coal-weighing devices are most desirable additions to the plant. Then records of coal and water consumed can be posted daily for the information of the fireroom shifts.

C. E. VAN BERGEN. We regard the draft gage as necessary on every boiler. It is not possible for a fireman to know what amount of air is passing through or over his fires, by simply looking at them. A steam-flow meter is valuable in showing the output of each boiler and all plants, except small ones, should have a continuous record of CO_2.

It is our belief that any plant expending $5000 or more per year for fuel cannot afford to be without these instruments. The draft gage has shown us that we formerly did not have proper adjustment of stack damper and ashpit doors. The steam-flow meter has given us valuable information on our monthly and yearly output and the flue-gas analyzer shows us the result of careless firing.

6 What Is Essential to the Economical Operation of Hand-Fired Boiler Furnaces When Using Soft Coal?

Helpful hints as to firing methods, front or side; frequency of firing; management of dampers; cleaning, etc.

HENRY KREISINGER. The right proportion of the air supply to the weight of the coal burned is the most essential requirement in the economical operation of hand-fired boiler furnaces. The removal of ash from the furnace is done with the object of keeping unobstructed the supply of air through the fire. The fireman shakes the grate or cleans his fires because the ash and clinker restrict the supply of air through the fuel bed.

In the boiler furnace about 14 lb. of air are necessary to burn 1 lb. of the average soft coal. This air must be introduced into the furnace in such a way that it is brought in direct contact with the coal and the gases rising from the fuel bed.

[1] Supt. of Power Stations, United Railways Co. of St. Louis. Assoc-Mem.Am.Soc.M.E.

[2] Pres., Tri-City Railway & Light Companies, Davenport, Iowa. Mem.Am.Soc.M.E.

The Bureau of Mines has shown that in the hand-fired furnace, if the fuel bed is level and 5 to 6 in. thick, only about 7 lb. of air can be supplied through the fuel bed to each pound of coal burned. If an attempt is made to force more air through the fuel bed, only the rate of combustion or gasification is increased, and the ratio of the air to the coal burned or gasified remains constant.

The gases rising from the fuel bed contain a large amount of combustible, about 8 to 10 per cent of CO and practically no free oxygen. To burn this combustible an additional 7 lb. of air must be supplied over the fuel bed, and should be supplied in a large number of small streams and as close to the fuel bed as possible, in order that it may be mixed readily with the combustible. This air is introduced through the dampers in the firing doors, through the cracks around the firing door, along the side walls and the bridgewall, in some cases through special openings in the bridgewall, and very commonly through holes in the fuel bed.

Difficulty of Maintaining Proper Air Supply

In hand-fired furnaces it is difficult to maintain the 14-to-1 proportion of air supplied to coal burned, because usually the air is supplied continuously and at a uniform rate, whereas the coal is charged intermittently at intervals of 2 to 20 min. duration. The ash is also removed intermittently at intervals of 3 to 24 hours, depending on its quantity and character. It is this intermittent feeding of coal that makes the proper proportioning of air to coal difficult. From the fireman's standpoint, soft coal consists mainly of two kinds of combustible, namely, volatile matter and fixed carbon. The volatile matter is that part of the coal which is driven off as gases and tars when the coal is heated, whether air is supplied to burn them or not. The fixed carbon is that part which stays on the grate after the volatile matter has been driven off and until burned or gasified by the air flowing through the fuel bed. When the fuel is 5 to 6 in. thick the fixed carbon is not completely burned, but a considerable portion of it leaves the bed in the form of CO. In the first 3 or 4 in. above the grate the carbon burns to CO_2, of which a large part is reduced to CO in the upper layer of the fuel bed.

Thus, immediately after firing while the distillation is taking place, the fuel bed acts both as a gas retort and a gas producer; after the volatile matter has been driven off the fuel bed acts only as a gas producer. Therefore, immediately after firing sufficient air is needed over the fuel bed to burn the gas from the gas retort and also from the gas producer. After the distillation has been completed only enough air is needed to burn the producer gas. With a constant air supply over the fuel bed it is impossible to have sufficient air to burn the gases completely while the process of distillation is going on without having too much air after the distillation has been completed.

Adjustment of Air Supplied to Quantity Needed

In order to have the right amount of air in the furnace at all times, two methods may be used: (*a*) The air supply over the fuel bed may be varied during each firing cycle; or (*b*) the distillation or the gas-retort process may be extended over the entire firing cycle.

There are devices to vary the air supply over the fuel bed automatically which, with proper attention, give good results. However, with the ordinary hand-fired furnace the fireman can approximate their action by cracking the firing door for a short period after firing.

The method under (*b*) is probably more practicable. Each new charge of coal can be heated slowly so that the distillation extends over the entire firing cycle.

With the coking method of firing the coal is placed in large charges on the front part of the grate, where it is heated slowly. When the distillation is nearly completed, the coal is spread over the grate and a new charge placed near the firing door. This method is feasible for heating boilers, but is objectionable for power-plant boilers.

For power-plant boilers the most practical and economical method is to shorten the period of firing so that distillation extends nearly from one firing to another. In order to eliminate the danger of piling the fresh coal on top of coal from which the volatile matter has not been completely distilled, half of the grate area should be covered at a time—the alternate method of firing—and the firing be so timed that half of the grate area is distilling volatile matter all the time. This may require that the firing be done at about 2-min. intervals, or even more frequently. The charges, of course, should be small so that there will be no tendency of the coal to form heaps; they should be spread over the thin spots of the fuel bed, avoiding the thick spots.

Frequent firing reduces the chance of the fuel bed's burning out large holes, which would let into the furnace too large an excess of air. With the caking or coking coals the holes in the fuel bed may not always be due to coal burning out faster in the thin spots, but to shrinkage of the fuel bed, which causes cracks to form. Once a crack is formed, the air rushes through and burns the coal on each side of the crack, rapidly making it larger. This explains why with eastern coking coals it is much more difficult to keep the fuel bed free from holes than with the free-burning coals such as come from the Illinois coal field. Frequent firing and the alternate method, to some extent, reduce the harm that may come from holes in the fuel bed.

Effect of Frequent Firings

Fig. 11 shows the effect of frequent firings of Illinois soft coal on the air supply and the composition of the furnace gases. The points connected with the solid, heavy line are the readings of CO_2 taken with an interferometer, and those with the dotted line the indications of CO_2, shown at the same time by a Uehling CO_2 recorder. The interferometer gives the CO_2 contents in the gases at the instant when the observation is taken, but the Uehling recorder has a lag of about 7 min. and a tendency to average the CO_2 readings over the entire firing cycle. The time of firing is shown by the black rectangles at the bottom of the chart. The interferometer shows plainly very high CO_2 immediately after each firing, followed by a rapid drop. This variation in CO_2 indicates very little or no excess of air after firing and considerable excess immediately before firing. The drop in CO_2 is much more pronounced with the 5-min. firing periods than with the $2\frac{1}{2}$-min. periods, indicating that in the latter case the air supply is kept more nearly proportional to the weight of coal burned.

One-half of the air supply was introduced through the grate and the other half over the fuel bed through fourteen $1\frac{1}{8}$-in. nozzles. Both air supplies were measured. The nozzles were placed in the side walls and injected the air in horizontal streams close to the surface of the fuel bed. The grate area was 30 sq. ft. and the rate of firing was 22 lb. of coal per sq. ft. of grate per hour.

Firing Methods Which Give Good Results

Good results can be obtained with a fuel bed about 5 to 6 in. thick. Heavy fuel beds offer high resistance to flow of air, making it necessary to carry high draft in the furnace and setting. High draft increases air leakage into the boiler setting and causes losses from the large excess of air. Furthermore, thick fuel beds cause excessive clinkering and the high losses connected with the frequent cleaning of fires. Higher rates of combustion can be obtained with thin fires than with thick ones.

The draft damper should be so adjusted that the air supply through the fuel bed is always just sufficient to burn the coal at the same rate it is fired. The accumulation of ash and clinker on the grate will gradually increase the resistance through the fire, and the draft should be accordingly increased. Sudden large changes in the damper should be avoided.

Perhaps the best and most generally used method is where the live coals and coke are pushed or thrown to one side of the furnace, leaving the refuse, which is raked out. The clean grates are then covered with clean fire from the other side of the furnace, which is then similarly cleaned.

I believe that more fuel is wasted by operating with leaky boiler settings than in any other way. All boiler settings, therefore, should be kept up to the highest possible degree of tightness. This can be done by stopping up all of the larger cracks with some good filler and then applying a generous coat of a first-class plastic cement, which will effectually seal all small cracks and pores in the brick. The settings should be gone over at regular intervals by a competent man and repairs made where needed.

The most important thing, however, in the economical operation of hand-fired boiler furnaces, whether using soft coal or

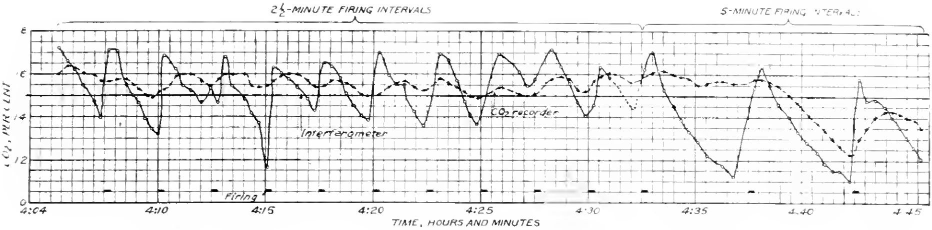

Fig. 11 Chart Showing Effect of Frequent Firings on Air Supply and Composition of Furnace Gases

Fires should be thoroughly cleaned at regular intervals and at times when the load on the boiler is reduced, such as the noon periods. The side cleaning method by which one side of the grate is cleaned at a time is recommended. After cleaning the fire should be built up gradually. A day's shift should start with a clean fire. Perhaps nowhere is a good start of such great advantage as in running a furnace.

Indicating Instruments of Prime Importance

E. E. Hunter.[1] One of the prime essentials to economical operation of hand-fired boiler furnaces when using soft coal is to have boilers and furnaces equipped with the necessary instruments as guides or indicators, of which a reliable CO_2 machine and draft gages are the most important.

The method of firing to be used depends largely upon the quality of coal and upon the nature of the load to be carried. For a steady load a slow-burning coal which cokes nicely may be used to advantage, because there will be no sudden demands for steam and a thick fire can be carried, which should not be disturbed except when absolutely necessary.

On the other hand, with an erratic, unsteady load a quick, flashy coal high in volatile matter will no doubt give satisfaction, and the fuel bed in this case should not be very thick and should be fired lightly and often according to the steam demand.

The alternate method of firing is recommended by some, but I believe the best one is to fire every door, with the fire doors kept open the minimum length of time. The firemen should be given long and careful instruction in the manipulation of the dampers, guided by the draft gages, and should regulate their draft according to the demand for steam.

Fires should be cleaned at a time when there is the least demand for steam, and as quickly and thoroughly as possible.

[1] Chief Engineer, Oklahoma Gas & Electric Co., Oklahoma City, Okla.

some other fuel, is to have a well-trained, efficient corps of men who are heartily in accord with their chief and his policies. This is extremely difficult to bring about, but it can be accomplished by systematic hard work, sprinkled with a little diplomacy. The governing head or superintendent, first of all, should be master of himself. This will command the respect and loyalty of those under his direct control. He should study human nature, for this will enable him to select the class of men who will stand by him. He, in turn, should stand by them, take an interest in their affairs, outside of business, and give ear and patience to any condition arising wherein their interests are involved.

George H. Diman.[1] This is a subject in which I have been very much interested for over fifty years, but I have been discouraged many times by the indifference shown by the managers and owners of power plants. I know of no department in any manufacturing concern where there is as much waste as in the boiler rooms of our manufacturing concerns in New England.

To get good results, the managers and engineers should coöperate. As an illustration of what I mean, let me say that I was employed in 1883 to take charge of eight mills, four woolen and four cotton, under two different agents, with the understanding that I should make a saving without spending any money for new appliances. The first six months before I took charge it cost $36,327.30 to operate the steam plant; the production of cloth was 812,363 lb. Every six months the power-plant cost was decreased, and for the six months ending November 30, 1884, the cost for operating the steam plant was $20,950 and the cloth production was 1,257,353 lb., this increase in output being due to the fact that more machines were running than when I took charge. The reduction of costs was accomplished entirely by systematizing the boiler plants

[1] Consulting Engineer, Wood Worsted Mill, Lawrence, Mass.

and by the aid of the managers of the mills. The same antiquated equipment was used throughout this period.

If I were to hire an engineer to take charge of a steam plant, I should have the man examined to see whether he thoroughly understood the economical burning of coal, and should be very careful to see whether he had tact in regard to handling men. It costs nothing to say "Good morning" to the humblest employee, and it should be remembered that there is just as warm a heart under the ragged shirt as under the best broadcloth.

In all the fifty years that I have employed labor, I have never gone outside the mill gate to hire any men—always promoting the men in the yard. This gives the men an incentive to work. As an illustration, the chief engineer at the Ayer Mills was formerly head fireman at the Wood Mills.

Before touching on the method of firing to secure economy, I will quote a letter from Admiral Cone of the Bureau of Steam Engineering at the time when he was chief engineer in the United States Navy:

Dear Mr. Diman:

We have had yours pertaining to economical burning of coal for some time, for which we thank you. We have already published it in our Bulletin to be used in the Navy. We thank you for helping us along.

Yours respectfully,

H. I. Cone.

So it will be seen that what I am going to say about methods of firing was approved and adopted as indicated by the above letter.

Firing Methods That Have Proved Successful

First, I should have the grates not over 7 ft. in length—$6\frac{1}{2}$ ft. would be better—as it is impossible, if the grates are longer than this, to keep the back end of the fire covered. I should set the boilers no less than 4 ft. above the grates—5 ft. would be better. This insures a good combustion chamber. It will be noticed that the boiler makers use practically the same size of ashpit door with a 250-hp. boiler that they do with a 600-hp. boiler. This gives a great supply of air near the doors, but none in the middle of the grates. I should dispense with the ashpit doors, cutting away the boiler front the full width of the grates. This gives an even distribution of air underneath the grates.

I should start with the fire 14 in. thick and try to keep it the same thickness through the day's run. I find time firing the best, and in our mills in Lawrence we adopted the system of firing every ten minutes, putting on the number of shovelfuls required to keep the fire the same thickness and maintain the power. I find that from 5 to 6 shovelfuls of coal is plenty. It takes about four to five minutes for a man to coal one side of two boilers and level the other side. This gives him five minutes to rest. I would recommend the boilers to be run about 50 per cent above rating. This would insure a very hot fire. Firing one side at a time prevents smoke. We have 44 boilers at our Wood Mills. They fire one-half of these boilers at a time—that is, one side, and level the other side of the same boilers. When they have finished, the men on the opposite side start and do the same. Every man has a chair to sit in, and in a 10-hour run the men are on their feet about half of the time.

I would use a good shaking grate which keeps the fire free from ashes, and would avoid slicing as much as possible, as this makes clinkers.

The dampers should be set so that all of the boilers will have the same draft. If the steam damper is used, I would have this adjusted so that it cannot close tight. When the damper closes tight, the furnace commences to make gas (CO), or utilizes 4450 B.t.u. instead of 14,400 B.t.u. We used to think that we were saving coal with the dampers shut, but we knew little about carbon monoxide then.

I should avoid cleaning the fires in working hours, preferring to clean them when the mill is stopped. If the fires must be cleaned while the mill is running, I would have one side of the fire burned down; clean the refuse and ashes out clear to the bridge wall; throw the coal from the other side that is unburned; coal that over, and when that is kindled up clean out the other side and coal that up. This insures a clean fire all over the furnace.

We hear a great deal about the great loss from opening the doors when hand-firing, but I have not found this to exist. If one will watch the operation of the steam-flow meter, he will find that the horsepower of the boiler does not drop when the fire door is opened. I have had both doors on a boiler open for one minute, and have seen no perceptible difference. The greatest loss comes from the uneven feeding of a boiler with water. I have seen the registration of a meter on a boiler drop from 500 hp. to 250 hp. in one minute, due to the fireman's opening the valve carelessly.

It is very necessary, in order to get economical results either with hand firing or stokers, to keep the boilers and the tubes perfectly clean, and to stop all air leaks around the boilers. On our boilers at the Wood Mills we blow the tubes every eight hours—three times in 24 hours, and open up and wash out the boilers every two months—that is, a certain number every week. We have very good water. If the water were bad, we would have them done oftener. I was once found fault with because the men used so many manhole gaskets, but I told the manager that manhole gaskets were cheaper than boiler makers. I never heard anything more about manhole gaskets.

7 To What Kinds of Plants and Coals Are the Different Types of Mechanical Stokers Respectively Adapted, and What Is the Limiting Factor to Their Use in the Small Plant?

Joseph Harrington.[1] The usual and generally accepted classification of coals from the viewpoint of the mechanical-stoker manufacturer and operative is based on the tendency of coal to fuse together upon the application of heat and form a solid mass, or piece of coke, which is impervious to air at ordinary draft pressures. Those coals which act in this manner are called coking coals, and to prevent this cementing action the fuel bed must be kept in agitation during the period when the tarry element is being formed. This feature has limited the field of the chain-grate stoker and those forms of this stoker which leave the fuel bed entirely quiet have been effectually excluded from the coking-coal territory. For this reason, those stokers which agitate the fuel bed and

[1] Member of Conservation Committee, United States Fuel Administration for Illinois. Consulting Engineer, Chicago, Ill. Mem. Am.Soc.M.E.

those which supply air under artificial pressure have been found most suitable to these fuels.

The success of the inclined and gravity underfeed stokers has been due in large measure to their adaptability to this particular characteristic of eastern coals.

Reclassification of Coals on Ash-Content Basis

Attempts by the manufacturers of this equipment to enter the high-ash and high-volatile regions of the Middle West have developed another significant feature which is becoming all important, and to a large extent is going to supersede the former system of classification. One of the characteristics of Middle West coals is the relatively high ash content. The use of stokers which disturb and agitate the fuel bed has shown in emphatic manner the importance and value of re-classification based on the ash element. This classification may parallel to a large extent that based on the coking qualities of the coal, heretofore regarded as the broadest division. Neither the coking nor the ash features afford a clean-cut and definite line of separation because the coals of the country are of all grades and intermediate qualities, and shade one into another by almost imperceptible gradations. Broadly speaking, there is a very definite difference between the coals found east and west of Pittsburgh.

I would, therefore, reclassify mechanical stokers along the following lines, and consider this classification as vital in their successful application to the immense territory lying west of the Alleghany Mountains:

While there are many variations in the design of stokers, they all fall into one of two classes; first, those having the grate surface immovable, or non-progressive, the fuel traveling bodily over the grate surface impelled either by purely mechanical means, or mechanical means aided by gravity; and second, those having the grate surface movable and traveling at the same rate as the fuel, the latter resting undisturbed thereon. Consideration will show that this is a basic stoker difference and hereafter must be given its full importance or value in assigning a type of stoker to a given region.

As previously stated, coking coals must be agitated during the early combustion stages and it is this which limits the application of the chain grate to the eastern fuels, and not the low ash content which is also characteristic.

On the other hand, those stokers which naturally and inevitably agitate the fuel get into trouble from this very cause when handling the high-ash western coals.

Fuel-Bed Disturbance Important Feature in Stokers

Extensive and careful observations impress me with the fact that the fuel-bed disturbance is and must continue to be the most important single element in mechanical stoking. When these fuels are burned at a rate which produces fusing temperatures in the furnace, the ash will either liquefy or soften so as to be sticky and the slightest disturbance will cause it to ball up and form clinkers of immense size. The more it is agitated, the worse this trouble becomes. At rates of combustion which are possible with the underfeed type of stoker a limit is actually reached, and the fire gets into such condition that operations must be stopped to allow the cleaning of the furnace. Even if it is possible to dump the refuse as formed, ashpit conditions become intolerable and it is almost impossible to remove the ash under these conditions. I am becoming convinced, therefore, that the efficiency of the otherwise highly efficient type of stoker, which we know as the underfeed or inclined type, is largely offset by the unavoidable ashpit losses and the excessive amount of labor which must be expended in removing the hot ash and clinkers, which come from these stokers, and in controlling the side-wall accretions. Observations accompanied by analysis both under test and under ordinary operating conditions show that from 20 to 50 per cent of combustible will be found in the ash, and that this represents anywhere from 3 to 6 per cent of the total coal fired. It is possible to burn such high-ash coals with not to exceed 20 per cent of combustible in the refuse and when conditions are right 10 per cent can readily be obtained.

I should, therefore, like to call attention to this fact and suggest that the ultimately successful stoker for the region lying west of Pittsburgh will be one which does not agitate the fuel, and which discharges the refuse as formed and at the same time does not admit to the furnace more than the usual requirements in the way of air. It is possible to burn these fuels on this type of stoker with the proper amount of air per pound of coal, and when the draft is intensified by mechanical means, rates of combustion in conformity with modern requirements can be developed.

Great stress is invariably laid upon gas analysis, and without question it is a most important index of furnace efficiency. Recent developments, however, have shown another and serious source of loss, which, while it has been recognized, has not been given its proper weight. The ashpit is the source of loss to which I refer and before conservation can properly be carried out, this loss must be largely eliminated.

The answer to the question as to the minimum size of installation which warrants the application of mechanical stokers must be relative and not absolute, since there are at least two variables which enter into this combination.

Any application of mechanical stokers which pays for itself in three years is warranted. Paying for itself may be made up by reduction in the cost of the coal used, in a reduction of the labor required in operation, or both. A stoker will use up its value in fuel three times a year so that it is only necessary to secure a relatively small reduction in the price of coal to show a large profit on the cost of the installation. Labor enters into this proposition almost as importantly as does coal, since the supply of labor is becoming scarce and higher priced every day.

The great thing, however, for the country to consider at present is the opportunity which undoubtedly exists to burn lower grades of coal in a fairly economical manner, by the use of proper stokers, than can be burned in the hand-fired furnace. Coal which ordinarily would be classed as refuse, containing 40 per cent in ash, 7 per cent in sulphur and 15 per cent of moisture as fired, is being successfully burned in more than one plant.

The Field for the Mechanical Stoker

It would be practically impossible to develop rating by hand firing this fuel. If, therefore, the small hand-fired plant ordinarily accustomed to burning a good grade of lump or sized coal can secure a supply of screenings, even though they be of a low order, and provided they can be purchased at a reduced price, it can well afford to install a mechanical stoker. It is recognized that the small stoker costs out of proportion to its active grate area but at the same time the percentage in saving may be greater than in the case of the larger installation because the fact remains that the small installation is usually the worse offender from an economic standpoint.

Authentic cases of 25 to 30 per cent reduction in the cost of coal abound when this change has been made. From a theoretical standpoint, at least, there is no minimum limit in the practical size of steam boilers suitable for the application of mechanical stokers. Merely because stoking has been developed with the larger units is no reason why it should not be developed for the smaller unit, and in consideration of the large percentage of the total fuel supply that is consumed in the very small plant, it is imperative that engineers give this phase of the question their earnest consideration. If the stoker does not exist which is suitable to a 50 or 75-hp. boiler, it must be developed, and my prediction is that it will soon appear on the market in perfected form.

The answer, therefore, to this part of the question is literally that there is no minimum limit to the size of boiler adapted to the use of a mechanical stoker; but interpreting the question as it will ordinarily be, my opinion is that anything over 150 hp. becomes a possible field for the application of the stoker.

J. VAN BRUNT.[1] The selection of mechanical stokers with regard to coal and size and character of plants presents a problem that can only be answered in each individual case, and the proper solution can be reached only when all of the factors entering into the problem are known.

It is hardly advisable to arbitrarily classify plants, stokers and coal and attempt to predetermine on the basis of such classification the proper mechanical stoker. For the purpose of discussion, however, stokers and coals may be classified, and in a general way plants may be divided in four classes: Underfeed stokers; traveling or chain grates; overfeed stokers, and miscellaneous, such as powdered-fuel burners, shovel or scatter stokers, and semi-mechanical grates.

CLASSIFICATION OF STOKER PLANTS

Underfeed stokers are again subdivided into multiple retort as the Riley, Westinghouse and Taylor; single retort with dead grates (Jones), and single retort with inclined moving grates as the Type E. Chain or traveling grates are of two types, differing principally in the fuel-bearing surface. In the chain grate the grate surface is composed of a large number of links held together by through bolts making a broad band of endless chain on which the fuel is carried. The traveling grate, on the other hand, consists of a number of grate bars or sections of grate bars held on cross-members, which in turn are fastened to the driving chains at either side of the stoker. The chains are thus below the fire line, and not subject to the heat as in the chain grate. There is a further division of such grates in forced-draft and natural-draft grates. Overfeed stokers may be front feed as the Roney or side feed as the Murphy and Detroit. The semi-mechanical grates and miscellaneous stokers need hardly be described further.

Coals present such a wide range of qualities aside from their approximate analyses and heating value that it is difficult to present a satisfactory classification.

COAL CLASSIFICATION

We have anthracite, semi-anthracite, semi-bituminous, bituminous, sub-bituminous and lignite. Recently coke breeze has become a recognized boiler fuel. As to size, anthracite steam coals are known as No. 2 buckwheat or rice, No. 3 buckwheat or barley, No. 4 buckwheat or No. 2 barley, and culm and silt, the last-named being a waste product now used as steam fuel only by some of the anthracite coal producers. Anthracites are also free-burning, and non-free-burning, clinkering, and non-clinkering. Soft coal is shipped as run of mine, slack, and nut and slack (also known as stoker coal).

Semi-bituminous and bituminous coals may be coking or non-coking or free-burning, caking or non-caking, high-ash, low-ash, and the ash may fuse at low or high temperatures. Sub-bituminous coal is generally free burning, but may be caking or non-caking, and will have great variation in ash content.

Lignite has the peculiar property of carrying as high as 30 per cent moisture held in the cellular structure of the coal, while in appearance the coal is dry. Its specific gravity is low, and volatile content equal to and sometimes greater than the fixed carbon. Air drying will remove nearly one-half of this moisture, but the lignite slacks badly in the process, breaking up into fine particles, which are extremely difficult to burn.

TYPES OF BOILER PLANTS

Boiler plants for the purpose of this discussion may be divided into four general classes as follows: First, low-pressure heating plants of one or two small boilers, including such small high-pressure plants of similar size as are found in some office buildings and factories where the load is small and the boiler set so low that a satisfactory stoker installation is impossible except at prohibitive expense; second, moderate-sized plants having ample boiler capacity operating at moderate ratings, and not requiring additional capacity; third, industrial plants of large and moderate size, requiring additional boiler capacity, where the labor may be materially reduced by stokers; fourth, central stations or plants having the characteristic load curve of such stations.

ADAPTABILITY OF STOKERS TO DIFFERENT REQUIREMENTS

In the first class of plants stokers are not, as a rule, adaptable to low-pressure boilers because of the fact that power is required to drive the stokers; and no saving in labor is possible, nor can stokers usually be installed except at considerable expense for changing the boiler setting or lowering the floor to secure sufficient height or distance between fire and shell or tubes of boiler. This latter condition also applies to high-pressure plants of similar character.

In the second class, the use of stokers would depend on the labor and coal saving possible. The load conditions and the coal available will determine the type of stoker. For steady, moderate loads and high-ash coal, the chain grate will be satisfactory; for some load conditions and good coal, the overfeed type. The underfeed type would also be satisfactory under most conditions, particularly where the coal is likely to vary in quality from time to time.

For plants falling in the third class, the forced-draft underfeed stoker will generally be found to be the most satisfactory because of its great flexibility, overload capacity and high furnace efficiency over a wide capacity range. This type of stoker will handle practically all coals between and including semi-anthracite and sub-bituminous with an ash content up to 15 per cent, and, except for high continuous overloads, 20 per cent.

For free-burning coal of higher ash content than 20 per cent, the forced-draft traveling grate would be a satisfactory

[1] Chief Engineer, Combustion Engineering Corporation, New York City. Mem. Am. Soc. M.E.

equipment, assuming that adequate provision is made to handle the ash.

Central stations and similar plants in the fourth class are practically forced to use underfeed stokers. Because of the low load factor of such plants it is essential that the stokers be able to force the boilers up to high overloads, 250 to 300 per cent of their rating for the comparatively short peak loads. It is also necessary at times to meet extraordinary loads with but little warning, and for this purpose the forced-draft underfeed stoker, because of its elasticity, is not equaled by any other stoker.

Starting from a banked fire with an underfeed stoker, it is possible to bring a boiler up to 200 per cent of rating in from four to six minutes, a performance not possible with any other type of stoker.

Where the coal has a high ash content and is of low heating value, it may be advisable to use traveling grates with forced draft. Sufficient grate surface can usually be provided to take care of the required overloads. This type does not respond as quickly as the underfeed type to sudden load changes, but where peak loads occur at certain known times they can readily meet such conditions.

So far the fuels considered have been those between and including semi-anthracite and sub-bituminous.

The successful use of mechanical stokers for burning the finer or steam sizes of anthracite is a comparatively recent development, and the writer considers himself fortunate in having been closely associated with this development. These fuels and coke breeze are now burned successfully on a traveling-grate stoker with forced draft. This stoker is the development of the work and experiments of the late Eckley B. Coxe, a prominent anthracite-coal operator. Many boilers equipped with these stokers and burning No. 3 buckwheat coal or coke breeze are being operated at from 150 to 200 per cent of rating. Because of the cost of the equipment it is not usually advisable to install in small plants or small boilers where only moderate loads are required.

This type of stoker is not as elastic as the underfeed, but is more so than the natural-draft chain grate. It would probably not meet satisfactorily the conditions of violently fluctuating loads.

Some recent experiments on this stoker have indicated the possibility of burning as high as 60 lb. of soft coal per square foot of grate, and in the near future there will be more data available on the burning of Illinois coal and lignite on this grate.

In existing plants among the principal limiting conditions found are the setting heights of boilers, the capacity of the breechings and stacks, the overload requirements, the kind of coal, the class of labor and the cost of the installation, and the foregoing classification of plants is only an attempt to generalize.

THOMAS A. MARSH.[1] The two general classifications of fuel from the standpoint of adaptability to stokers are: (1) coking and non-coking; (2) clinkering or non-clinkering. Compared with these characteristics all other properties sink into insignificance, as every experienced fuel burner knows. The writer would therefore discuss the stokers suitable for each of these classifications.

Coking coal is coal whose tars fuse at a temperature below their distillation point, resulting in binding the fuel together in a caked mass. Obviously, such a fuel-bed condition must either not be allowed to occur or it must be broken up soon after occurring. Stokers suitable to such fuels are underfeeds, inclined stokers similar to Murphy stokers, Roneys, L-type chain grates, Type E stokers. Almost all such fuels are found east of Pittsburgh, although some coking fuels are found in a few western sections.

LOCATION OF NON-COKING COALS

Non-coking coals are those whose tars distill off at a temperature below their fusing point. Such coals are, therefore, obviously free burning. The chain grate is well suited to these coals. The performance of the Commonwealth Edison Co. of Chicago is well-known and striking evidence of this

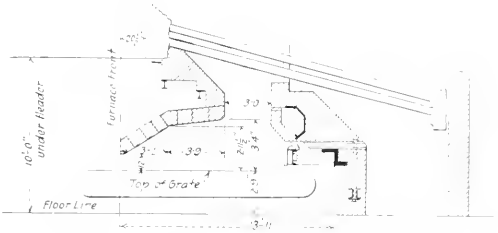

FIG. 12 CHAIN-GRATE SETTING, B. & W. TYPE BOILER

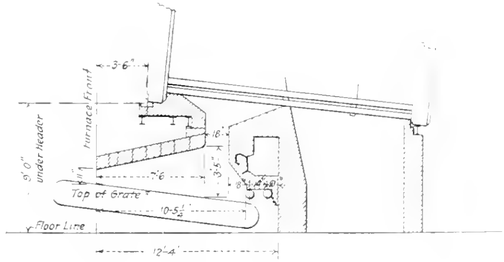

FIG. 13 INCLINED CHAIN-GRATE SETTING

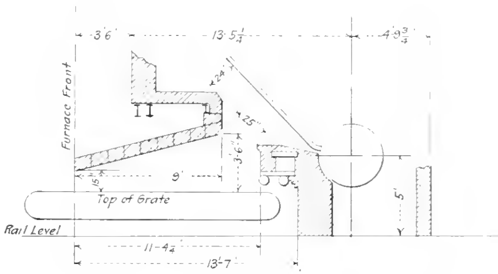

FIG. 14 CHAIN-GRATE SETTING—STIRLING BOILER

fact. Such fuels comprise most of the fuels of Ohio, Illinois, Indiana, Iowa and in general all coals west of Pittsburgh. Those types of stokers which do not agitate the fuel bed give best results when the coal is free burning. A characteristic of such fuels is the minimum of operating attention necessary and the uniformity of results obtainable with minimum attention. Bituminous coals above described are being burned to 14 per cent CO_2 with 3 to 5 per cent ashpit loss. Combustion rates of 30 to 50 per sq. ft. per hr.

[1] Engineer, Green Engineering Co., Chicago. Mem.Am.Soc.M.E.

Clinkering coals are those whose ash fuses at or below 2500 deg. fahr. Such fuels must be handled on stokers which clear themselves of ash continuously. If the coal in question is a coking coal, the fuel bed should be agitated. If, on the other hand, the coal is free burning, the fuel bed should not be agitated, as this simply aggravates the clinker trouble.

The work of the late J. P. Sparrow has been particularly helpful in aiding in the selection of suitable coals for certain stokers where a choice of coals is possible and a selection of suitable stokers for the available coal where a coal selection is not possible. Mr. Sparrow's tabulation of a variety of coals as presented before the National Electric Light Association in 1916 is given in Table 8.

Suitable stokers for coal that cokes and also clinkers are Green "L" type, Murphy, Model and Detroit.

Suitable stokers for free-burning clinkering coal include all chain grates and traveling-bar stokers. The argument is very strong, due to higher operating efficiencies, low labor cost and low maintenance cost against the reverse if agitating stokers are selected.

Suitable stokers for coking, non-clinkering coals are: Underfeeds, "L" type chain grates, Murphy, Model, Detroit and similar agitating grates. Such coals are New River, Pocahontas and the better-grade eastern fuels.

These are broad classifications. Local operating conditions may occasionally indicate exceptions to these selections. The

TABLE 8 COALS SUITABLE FOR VARIOUS TYPES OF STOKERS

Location of Mine.	Analysis: Moisture	Volatile Matter	Fixed Carbon	Ash	Sulphur	B T U	Fusion Temp.	Type of Stoker	Remarks.
Cambria Co, Pa	3.6	20.3	68.6	7.5	1.88	13710	2179		Very bad Clinkers.
Fulton County, Ill	15.0	33.1	36.8	15.1	2.82	9680	2184		Clinker Trouble at Dump Grate, side Wall protected by Steam Jets
Westmoreland Co. Pa	2.2	35.2	50.0	12.6	2.37	12419	2223		Bad Clinkers.
Raleigh Co, W Va	4.2	19.9	70.8	5.1	0.83	14019	2295		Some Trouble with Clinkering and bridging over Dump Grates
Borderland, W Va	7.6	35.9	49.8	6.7	1.15	12647	2297		Forms small Brittle Clinkers.
Raleigh Co, W Va	2.8	17.9	72.5	6.8	0.92	13889	2303		Trouble with Clinkers Bridging Dump Plates and on Side Walls
Caryville, Tenn	4.0	33.6	47.4	15.0	1.57	11605	2304		Hard Clinkers
Raleigh Co, W Va	4.4	17.5	70.9	7.2	0.85	13482	2306		Very large Clinkers on Side and Bridge Walls
Cambria Co. Pa	1.8	25.3	64.7	8.2	1.36	13795	2335		Some Trouble from Clinkers.
Cambria Co, Pa	2.8	19.5	69.8	8.1	1.92	13837	2361		Very Bad Clinkers.
Westmoreland Co, Pa	2.6	35.0	51.7	10.7	1.87	12713	2384		Bad Clinkers
Mercer Co. Pa:	5.4	34.0	47.5	13.1	3.40	12291	2390	Taylor	No serious Clinker Trouble.
Glen White, W Va	2.4	17.7	73.6	6.3	0.72	14112	2394		No Clinker Trouble.
Pocahontas	4.2	17.6	72.1	6.1	0.66	139[illegible]8	2405		No Clinker Trouble
Fayette & Raleigh Co's, W Va	1.4	22.2	71.6	4.7	1.11	14565	2408		Large Clinkers on Side and Bridge Walls
Somerset Co., Pa	1.0	17.7	70.5	10.8	2.14	13689	2414		Good Coking, Free Burning, Forms Large Vitreous Clinkers
Pittsburgh District	2.4	32.4	54.3	10.9	1.80	13006	2427		Very Little Trouble with Clinkers
Cambridge, Ohio	5.0	37.7	49.3	8.0	2.75	12521	2435		Forms Thin Brittle Clinkers
Somerset Co, Pa	0.6	17.8	71.6	10.0	1.89	13601	2468		Forms Large Clinkers
Cambria Co, Pa	2.2	25.4	63.2	9.2	2.67	13603	2534		Slight Clinker Trouble above 200% Rating
	1.5	22.4	69.5	6.6	1.87	14232	2554		No Clinker Trouble
Glen Richie, Clearfield Co, Pa	2.1	24.1	64.8	9.0	1.91	13480	2661		No Trouble.
Cambria Co, Pa	1.6	25.4	65.5	7.5	1.36	14022	2684		No Clinker Trouble
Washington Co, Allegheny Co, Pa	0.3	32.2	57.1	10.4	1.06	13282	2290	New Roney	Bad Clinkers.
Washington Co, Pa	3.7	27.7	56.2	12.4	1.45	12540	2363		" "
Rock Springs, Wyo	4.8	35.8	48.3	13.1	1.54	11085	2239		Very Thin Soft Clinker, gives serious Trouble
	2.6	23.4	66.4	7.6	1.75	13928	2379		
Barnsboro, Cambria Co, Pa	2.6	24.1	63.5	9.8	1.61	13414	2430	Roney	Clinkers part of the Time
	3.2	22.7	66.0	8.1	1.95	13658	2444		
Glen Richie, Clearfield Co, Pa	2.1	24.1	64.8	9.0	1.91	13480	2661		No Trouble.
Barnsboro,	2.6	23.4	66.4	7.6	1.75	13928	2379		
Cambria Co, Pa	2.6	24.1	63.5	9.8	1.61	13414	2430	Westinghouse	Clinkers part of the Time.
	3.2	22.7	66.0	8.1	1.95	13658	2444	Under Feed	
Westmoreland Co, Pa	2.2	35.2	50.0	12.6	2.37	12419	2223		Bad Clinkers
	2.6	35.0	51.7	10.7	1.87	2713	2384	Riley	" "
Glen Richie, Clearfield Co Pa	2.1	24.1	64.8	9.0	1.91	13480	2661		No Trouble
Washington Co, Pa	0.3	32.2	57.1	10.4	1.06	13282	2290		Bad Clinkers
Allegheny Co, Pa	4.0	32.3	52.3	11.4	1.40	12604	2366	New Murphy	Only a Little Trouble from Clinkers
West Virginia	1.4	8.5	74.6	5.5	0.84	14483	2339		Clinkering Fair - 69.4% Eff - Furnace Temp 2400° to 2450° Fahr
Fayette Co, W Va	1.2	17.6	75.2	6.0	0.64	14397	2471	Murphy	Very Little Clinker - 65.8% Eff - " " 2100° to 2400° "
Wood Co, W Va	1.4	33.3	58.2	7.1	0.55	13651	2800		Good, no Clinkers - 71.1% Eff - " " 2325° to 2450° "
Illinois	8.8	34.0	39.4	17.8	3.10	10231	2052		Lots of Clinker, but very Little Trouble
Madison Co, Ill	12.0	33.0	39.4	15.6	4.36	10145	2091		
Illinois	9.8	34.4	38.1	17.7	5.11	10193	2157		
Christian Co, Ill	13.6	30.8	37.8	17.8	5.04	9662	2179		Plenty of Clinkers, but no Trouble - 700 Hp. Maximum.
Sangamon Co, Ill	14.2	31.4	38.9	15.5	4.40	9718	2179		" " " " " " - 800 " "
Illinois	6.0	35.2	46.7	[illegible]	1.98	11659	2253		Lots of Clinkers but very Little Trouble.
Vigo Co, Ind	10.2	33.8	38.4	7.6	3.99	10291	2256	Chain Grate	Plenty of Clinkers, but no Trouble - 800 Hp Maximum
St Clair Co, Ill	10.8	33.4	37.9	17.9	5.04	9910	2291		Lots of Clinkers, but no Trouble
Saline Co., Ill.	6.8	31.8	50.6	10.8	3.36	12020	2297		Plenty of Clinkers, but no Trouble - 900 Hp Maximum.
	2.6	23.4	66.4	7.6	1.75	13928	2379		
Cambria Co, Pa.	2.6	24.1	63.5	9.8	.61	13414	2430		Clinkers part of Time
Barnsboro	3.2	22.7	66.0	8.1	1.95	13658	2444		
Carthage, N M	1.2	37.3	45.6	15.9	1.01	12135	2559		No Clinker Trouble.
	1.2	20.8	68.3	9.7	2.48	13803	2468		
Cambria Co, Pa	1.3	23.8	66.6	8.0	1.87	13989	2541		No Clinker Trouble
	1.4	22.5	67.3	8.8	2.05	13806	2570	Hand Fired	
Somerset Co, Pa	2.6	16.3	71.2	9.9	1.25	13428	2547		
	2.4	16.4	70.6	10.0	1.57	13269	2577		

The ash of most of the middle-west and western coals fuses from 2000 to 2400 deg. fahr. and some as low as 1800 deg. Clinker accumulations must be avoided. There are two methods of doing this. One is not to make the clinker, which necessitates that the ash be kept on the lower stratum of the fuel bed and out of the high temperature zone; the fuel bed must be undisturbed. The other method is to have a continuous discharge of the ash from the furnace.

The chain grate, which embodies both of these principles of keeping the ash in the low temperature stratum of the fuel bed and of discharging the ash continuously from the furnace, is suited to coals of the northern interior, eastern interior, Gulf, western interior, southern and Rocky Mountain fields.

one feature of being able to get steam quickly in case of a water-power shutdown would sometimes offset almost any difficulty with clinker and the resultant low operating efficiency.

We should not in our entire discussion of this problem lose sight of the commercial aspects of labor saving, ease of operation and maintenance of furnaces and continuity of service when stokers are using unsuitable fuels.

CARL SMERLING. The hand-operated stoker is now installed in all types of furnaces and almost every type of boiler from 40 to 600 hp. in one unit, and to the extent of 5000 hp. in one fireroom. This stoker could well be named

the Ford of stokers or more closely nicknamed the "Jitney."

I have no reason to believe that the hand stoker will ever be adopted or used extensively in any large power plant or central station, but believe that its place belongs in the smaller units of 500 hp. and below. These stokers are now in use under oil stills, oil-cracking furnaces for the production of gasoline, acid furnaces, in concentration furnaces, hot-mill and annealing furnaces.

The principal objects of this stoker are to obtain a more universal and complete combustion, increasing the efficiency of the boiler, and to reduce labor, thus eliminating carelessness on the part of the fireman, which is accomplished in doing away with the cleaning of fires by the old method, and by the coking method in which the coal is piled high in front of the fire doors.

Sifting out the ash from the clinkers finally deposits approximately 5 to 8 per cent of the total ash in clinkers at the bridge wall on the dump grate, where it is dropped at regular intervals as required. If red coke falls through the grate, it is an indication that the fireman must not pull the levers more but wait until the ashpit again looks a little dark. This pulling of levers as a rule requires one pull of each lever every half-hour, and on the average coal of 12 per cent ash the dump grate should be dropped once in 8 hr. After continuing this operation, it is possible to run water-tube boilers up to 225 per cent rating without difficulty, provided sufficient stack and correct flues are installed; at 175 per cent rating it is not unusual to obtain 72 per cent combined efficiency and a continuous high CO_2 of an average of 13 per cent.

One of the most interesting features of this "Jitney" stoker is the fact that the first cost of installation is very low compared with the saving over that of hand-fired flat or shaking grates.

ROBERT H. KUSS contributes the data given in Table 9 on the types of plants and qualities of coal for which stokers of different types are adapted.

TABLE 9 COALS AND PLANTS TO WHICH VARIOUS STOKERS ARE ADAPTED

Type of Stoker	Minimum size of unit	Minimum plant, hp	Maximum size of unit	Best coal characteristics	Unfit coal
Traveling grates	200 hp.	600	600 hp.	High volatile	Coking and low ash
Underfeed, Jones	150 hp.	300	300 hp.	Medium volatile	High ash, low-fusing ash
Combustion Engrg. Corp., Type E.	150 hp.	300	250 hp.	Medium volatile	High ash, low-fusing ash
Single incline	200 hp.	600	400 hp.	High fixed carbon	Low-fusing ash
Double incline	200 hp.	400	350 hp.	Medium volatile	Low-fusing ash
Inclined underfeed	500 hp.	200 0	Any larger size	High fixed carbon	Low-fusing ash

P. W. THOMAS. The stoker is restricted to a coal containing an ash which it will scavenge cleanly and without injury to its own metal. This brings a sharp division in the present types of stokers. Where the coal fluxes its ash at furnace temperature, a chain grate will invariably give the highest operating efficiency. Where the ash content is under 5 per cent or when the ash content will not flux at a temperature above 2600 deg. fahr., other types of stokers will give the same efficiency if properly handled.

The limiting factor in the use of the stoker in small plants is the cost of labor.

There is no *type* of fuel in the United States. Each field and each coal-producing district has absolutely individual fuel. The only comparison by analysis of the various fuels must be that analysis which shows, in addition to the usual proximate analysis, the quantitative analysis of the ash and its fluxing temperature. Given these figures, it is a matter of simple calculation to know which of the many stokers would perform so as to obtain the greatest percentage of heat to the boiler.

By the above let me explain that two bituminous coals showing the same proximate analysis may have entirely different ash contents, entirely different coking properties and attendantly different combustion rates. They both require the same quantity of air in the consumption of a pound of coal, but no device will cause one coal to unite with its given quantity of air in a shorter interval of time than its nature allows. The flexibility of a stoker, then, depends on how many pounds of coal can be supplied with the proper amount of air at one and the same time. Two methods are open: to increase the grate surface, or thicken the fire and apply the forced draft. In the latter case it is again necessary to figure the fluxing temperature of the ash in incandescent coke.

WALTER E. BRYAN. It has been common practice with Illinois fuel, where mechanical stokers are desired, to use chain grates. These give very satisfactory results, except that they cannot be forced to any great extent. Underfeed stokers should have a little larger size of coal, and also coal freer from impurities than that required for the chain grates. Stokers of the Westinghouse type have recently been used in this district on bituminous screenings with great success.

B. J. DENMAN. The chain-grate stoker is best adapted to coals containing 25 per cent or more of ash, due to the facility with which it disposes of the refuse. This is one of its chief advantages, and in addition to this it is one of the cheapest stokers available, and undoubtedly has the lowest cost of maintenance. From the operating standpoint, the chief objections to the chain-grate stoker are its lack of responsiveness and the fact that its point of best efficiency is rather sharply marked, dropping off somewhat rapidly at overloads and very rapidly at light loads. With proper care, good efficiencies can be maintained within a reasonable range of capacity, the low percentage of CO_2 which is obtained in most plants being unnecessary. The chain-grate stoker is practically smokeless. To secure the best results it should be set with flat coking and boiler arches of an inclination and length to best suit the fuel burned. This stoker is suitable for non-coking coals only. With coking coals it is impossible to get reasonable capacity, and the ash is practically pure coke. Chain grates which have been designed to burn coking coals have not been found to be successful.

The inclined overfeed type of stoker has the advantage of reasonably low cost but the disadvantage of high maintenance. Most stokers of this type require frequent poking of the fires, which produces considerable smoke. These stokers are not suitable for coals containing over 15 per cent of ash. They have a limited range of capacity, but are quite responsive to change in loads.

The inclined underfeed type of stoker has the greatest range

of capacity, the best efficiency of any stoker available, and the additional advantage that it is the most responsive to changes in load. Boilers can be raised from bank fire to steaming at the rate of 200 per cent in less than five minutes. This type of stoker has an unusually flat efficiency curve, with a high efficiency throughout the range, and with most arrangement of settings the highest efficiency is at light loads. This applies particularly to coal averaging about 11,000 B.t.u. and from 6 to 8 per cent ash. This enables a plant having evening peaks to eliminate the carrying of banked fires to meet the peak load, as it is possible to install sufficient stoker capacity to secure a boiler rating of 300 per cent.

The chief disadvantage of this type of stoker is its high first cost, but this is offset by the high capacities possible, which reduce the boiler-room investment. It is, of course, undesirable to operate the boilers at such high rating except for short periods, and for plants having no short peaks it would be uneconomical to put in sufficient stoker capacity to obtain these peaks. It has been my experience that considerably higher combined boiler and furnace efficiency can be obtained with this type of stoker than with any other type, and I have made extensive tests with chain-grate, inclined overfeed, and inclined underfeed stokers. This stoker is suitable for coals having as high as 20 per cent ash, but with coals running this high in ash, and with heating value as low as 10,000 B.t.u. per lb., it is necessary to arrange dumping sections of about twice the length normally provided, and to increase the height of the stoker sufficiently beyond the amount usually required, if very high rating is desired. We are carrying loads as high as 300 per cent rating with Illinois coal averaging about 10,500 B.t.u., with 15 per cent ash. The maintenance of this type of stoker is low as at present designed. This stoker is suitable for either coking or non-coking coals.

I do not believe the size of the plant determines whether or not a stoker should be used. This is more a question of labor conditions, load factor and funds available. We are at present operating a plant containing three 500-hp. boilers, hand-fired, while in an adjoining city of practically the same size we found it advantageous to install stokers. In that same city we are operating a gas plant containing two 200-hp. boilers, only one of which is in use at a time, which we have equipped with stokers.

A. H. Blackburn.[1] For the large electric-power plants with wide ranges of coal, and the larger manufacturing plants with boiler units from 500 to 2500 hp., the underfeed gravity and underfeed direct-push, self-cleaning stokers are the types of stokers best adapted, because they respond most quickly to the varying coals. They will show high efficiency for a range of from 80 to 200 per cent of rating. They will raise steam from no load to 200 per cent in a few minutes and are practically smokeless. They will successfully burn Pennsylvania, Maryland, Virginia, Ohio, Kentucky and Michigan coals.

The chain grates show best results when working at a steady load. They are adapted to free-burning coal high in volatile such as the coals mined in the Middle West; they are not so suitable for the coking coals having high fixed carbon.

The overfeed, inclined-grate and the side-feed stokers are adapted to boilers from 150 to 300 hp., and obtain their best economy when working from 80 to 100 per cent of rating and are not suited to heavy overloads.

The underfeed stokers and the combination of underfeed and overfeed stokers are suitable for boilers from 150 to 500 hp. and show excellent efficiencies at ratings from 80 to 150 per cent and can be worked up to loads of 200 per cent. The advantage of these stokers is the rapidity with which they will take care of sudden variations in load, the average good efficiencies obtained, and the comparatively low cost of repairs. They will successfully burn coals from Illinois, Kentucky, Ohio, Pennsylvania, Maryland, West Virginia, Iowa and Michigan. For internally fired Scotch marine boilers and internally fired vertical boilers of the Manning type the underfeed stoker has been successfully applied, showing results of 10 per cent saving over hand firing.

For the fair grades of lignite coals of the West, the underfeed stoker is being used with considerable success, especially when the fuel comes directly from the mine and before it dries out, by running light fires and rapid combustion.

As to the limiting factor in the use of mechanical stokers in small plants: Stokers can be applied with good results to boilers as low as 100 hp., especially when there is only one man employed to look after the boiler, engine and other apparatus about the plant, as hoppers can be put on that will hold an hour's supply of coal, or more; the automatic regulation will take care of the steam or combustion rate while the attendant is looking after other work.

Will Successfully Burn Green Lignite

Stokers have too often been applied under unsuitable conditions. Proper consideration has not been given to combustion space, the size of the unit and the particular design of the boiler to which the stoker has to be applied. The time has come when the first consideration must be given to proper design of combustion area to the particular quality of coal to be burned, and to the installation of boiler and stoker designs best suited to this condition.

8 What Experience Have You Had in the Use of Wood as Fuel? To What Extent Is Wood Available as a Fuel?

The coal shortage has occasioned the use of wood fuel in many unwonted places. Accounts of experience that will be helpful are solicited.

Robert H. Kuss. The writer's experience includes the burning of wood refuse coming from kiln-dried manufacturing operations of both hard and soft wood and "hog stuff" produced at logging mills in northern Minnesota. Kiln-dried wood refuse when burned alone constitutes no particularly difficult problem. If a sizable proportion is sawdust or planer shavings this material must be burned in a complete firebrick furnace, the fuel being introduced by gravity, and most of it being burned in suspension with very little air from the ashpit.

Where coal and wood refuse are burned together, difficulty is encountered if the major portion of the fuel is sawdust. Planer shavings in large quantities set up extremely difficult conditions. In any event, the combination of fuels must be

[1] Chief Engineer, Under Feed Stoker Co. of America, Chicago. Mem. Am.Soc.M.E.

burned in a complete firebrick furnace, so that the sawdust portion may be burned in suspension.

When "hog stuff" is produced from bark, edgings, etc. (as is the case in lumber-producing mills), it is best burned in a complete firebrick furnace where the fuel is introduced so as to form cone heaps over the grate surface, very little air being introduced by way of the ashpit, and the fire being most brisk at the grate surface around the edges of the cones.

Albert A. Cary. I have had to handle wood as a fuel under a wide variety of conditions which have called for different constructions in furnaces, as wood from a lumber camp, where undesirable tree trunks, boughs and branches were burned; in saw mills where the fuel was slabs, edgings and sawdust; in wood-pulp mills where the wood refuse was burned; in woodworking establishments where the fuel was the refuse from the saws, planers and other wood-working tools.

It must be remembered that fully one-half the weight of the wood is found in the volatile gases passing off during the process of combustion. With properly designed furnaces, the greater part of the air required for the combustion of these gases can be made to pass through the grates and fuel bed, where they become warmed to such an extent that they will not suppress the combustion of the gaseous portion of the fuel in the combustion chamber. An ample and well-designed combustion chamber is also essential to obtain efficient results.

Two objections commonly offered to the use of wood fuel are the production of objectionable smoke and danger from fire due to burning firebrands ejected from the chimney. With a properly designed and operated wood-burning furnace, however, the smoke nuisance can be so reduced as hardly to constitute a nuisance, and I have found no difficulty in stopping the trouble from sparks and hot cinders by using cinder screens enclosing the top of the chimney.

Heating Value of Wood Fuel

In the boiler-test code of the Society we have been instructed to regard 1 lb. of wood as equivalent to 0.4 lb. of coal; or, in other words, 2½ lb. of wood are equivalent to 1 lb. of coal.

The value of *dry* wood used as a fuel may be slightly greater or considerably less than this equivalent of bituminous coal, according to the design of furnace used and the manner in which the fire bed and its air supply are handled. The percentage of moisture carried materially affects the heating value of wood fuel, and therefore it is most desirable to have the wood as dry as possible.

Wet fuel, however, must often be used, and I have burned pulp-wood chips or shavings running as high as 30 to 40 per cent in moisture. Such very wet wood fuel must be burned in a reverberatory furnace with a heavy bed of burning fuel maintained, to dry the moist wood rapidly as it is fed continuously into the furnace.

Newly cut wood contains a large percentage of moisture, which varies in the different varieties of wood, but from one-third to one-half of this moisture will disappear if the wood is air-dried from six to twelve months.

Examples of Successful Wood-Burning Furnaces

In burning forest wood such as trunks, boughs and branches, I have found that much better results could be obtained with a wide furnace than with a long, narrow furnace in which wood is charged lengthwise through a front opening. With the long furnace it is difficult to maintain a good level fuel bed and have the grates evenly covered. I have obtained the best results for such fuel with a furnace about 5 ft. wide and 7 ft. deep. This had a charging door, running across the width of the furnace and about 12 in. high, which lifted vertically above the dead plate along the outer face of the front wall, being counterweighted and properly balanced, and the door was perforated with a number of ½-in. holes to admit and evenly distribute small streams of air over the fire bed.

The cut lumber was piled in front of the door so that it lay lengthwise, running from one side wall to the other. When the door was lifted the lumber, thus arranged, was pushed over the dead plate on to a grid of sloping grate bars dropping downward at an angle of about 30 deg. At the lower end of these sloping grates and about 18 in. from the bridge wall, I arranged another grid of sloping bars, dropping down from the bridge wall at an angle of 45 deg., thus forming a V-shaped grate surface having a long and short leg.

With this arrangement, the lumber was rolled or shoved down the bars from the dead plate in such a manner as to maintain a fairly thick and more or less compact fire bed over the lowest position formed by these sloping grates and very little difficulty was found in keeping the upper end of the grates (nearest to the door) covered with fuel. The charging door was kept open for the shortest possible time.

I designed and installed some very successful furnaces, built on the same general lines, for a large manufacturer of wooden cars, near Buffalo. The grates (under water-tube boilers) were placed a short distance above the floor level, thus obtaining a very high combustion chamber. An ashpit was excavated about 24 in. below the floor level with a trench along the outer face of the boiler fronts through which air entered. This trench was covered with removable plates in front of each of the large lifting, charging doors to permit easy cleaning of the ashpits.

The refuse from the woodworking shops was delivered to the boiler room through chutes and consisted of large and small pieces, chips, shavings and sawdust. The fireman piled the refuse in front of the upward-sliding doors, which were balanced in order to operate easily. When the doors were opened the fuel was shoved in quickly upon the large flat grate surface and the doors immediately closed. Two boilers, of about 200 hp. each, were operated in this manner most successfully.

In another woodworking shop in the West, manufacturing furniture, I supervised the installation of another form of wood-burning furnace placed under water-tube boilers.

Here the boilers were set very high above the grate surface and the wood refuse was continuously spouted down tube-like pipes, shooting into the furnace directly through the boiler fronts and landing upon the fuel bed below. A supplementary fire of coal was maintained upon the grates, and thus the plant obtained an ample supply of steam.

I do not know who was the designer of this system, but I protested against its installation on account of danger from fire running back along the wood-conveying spouts. About two years afterwards this plant burned and there was some question raised as to whether or not the cause was due to this system of feeding wood refuse to the furnace.

I have designed and supervised the installation of several different forms of extension furnaces for burning wood refuse, which have given satisfaction. Some of these have their fuel charged through top openings in the covering arch, above the

grate bar. The principal defect in this type of furnace is the pyramiding of the fuel on the grates directly below the stoke holes. This can be overcome to a large extent by building up a grate construction under the stoke holes, shaped like a pyramid. This insured a good penetration of air throughout the entire fuel bed and did away largely with the poking necessary to free up the other form of fuel bed.

Grateless Furnace for Wood Burning

One of the most successful forms of wood-burning furnaces for woodworking shops that I have installed is a grateless furnace similar in its general form to the well-known beehive type of coke oven. It is circular in shape, with a semi-spherical, dome-like cover over the top. I owe my first conception of this type of furnace to my friend, the late F. W. Edwards of the Standard Oil Company, who was deeply interested in the study of furnace equipments.

In this furnace the refuse wood is first run through a disintegrator, consisting of a disk having heavy knives inserted near the circumference of one of its faces. This disk is revolved at a high rate of speed inside of a casing, the larger pieces of wood refuse being fed into the disk chamber.

Thus the size of the wood is reduced until it is small enough to be carried by an air blast through conducting tubes. The end of these conveying tubes terminate in a centrifugal separator head, where the greater part of the air used for flotation is discharged. The wood refuse is then dropped through a tube from the bottom of the separator, accompanied by air under sufficient pressure to project the fuel into the furnace.

The wood passes into the furnace in a tangential direction, which causes it to travel around the circular face of the round furnace, and with the very high temperature maintained the wood ignites and burns very rapidly, somewhat after the manner in which pulverized coal is burned.

An opening, running in a normal or radial direction out of one side of the circular furnace, carries the burning gases directly into the firebox chambers of adjoining boiler settings.

A slowly burning fire bed of coal is maintained upon the grate bars of the boiler furnace and the combustible gases burn rapidly above this coal fire bed, without smoke production, and by this means the most efficient results are obtained from the wood refuse.

In case the supply of wood refuse gives out a damper is closed between the wood furnace and the boiler furnace and the boilers are operated in the regular manner with coal.

I have designed several variations in the construction of this type of furnace and in one case I fed wet spent licorice root down through the top of the furnace while operating the furnace proper in the way described above, with wood refuse from a large neighboring box shop.

A. G. Christie. At a recent meeting of the Baltimore Section of the Society, Mr. Henry Adams stated that he had burned wood on several occasions in furnaces designed to use soft coal and had obtained satisfactory results. However, only about 60 per cent of the rated boiler capacity could be obtained under average conditions. Another local member stated that he had found it advisable to lower the bridge walls when using wood in furnaces designed for coal.

9 What Coal Economies Can Be Effected in Residence Heating?

He who could make one ton of coal do the work of two during the past winter, not only conserved the coal for his neighbor and saved his own money but was comfortable when he might have otherwise been cold. How can it be done?

Frank T. Chapman.[1] According to good authority approximately 120,000,000 tons (2000 lb.) of coal is the present rate of use per year for domestic purposes in the United States. No accurate record exists to indicate what proportion of this coal is used for residence-heating purposes, but probably at least two-thirds, or 80,000,000 tons, of this amount is used for what might be broadly stated as residence heating.

The possible saving in coal used for residence heating may be divided into five principal items as follows:

1 Elimination of Heating for Unnecessary Rooms and Buildings:

a Shutting heat off from rooms not actually needed

b Closing of large residences where heating requirement is unreasonable for number of occupants or the rearrangement of heating equipment in order to heat only the portion of house actually needed for occupancy. (This item should represent a saving of at least 10 per cent.)

2 Lower Temperature Maintained in Homes:

a A 5 deg. lower average than past practice would save about 10 per cent of the fuel requirement.

3 Observance of Practical Methods of Reducing Preventable Heat Losses:

a Insulation of cellar piping, heater or other sources of heat loss

b Prevention of undue leakage at windows and doors.

4 Economical Operation of Heating Apparatus:

a The keeping of gas passages of heaters clean. (By far the most vital factor and the most important to emphasize.)

b Proper draft regulation

c Sifting ashes where they contain fuel value

d The study and application of available war coal-saving rules. (This item No. 4 should represent a possible saving of 20 per cent.)

5 The Use Where Available of Substitutes for Coal as Fuel, such as natural gas, kerosene oil, fuel oil, wood, peat.

A summary of these possible savings totals a proportion of about 50 per cent of the coal now used for residence heating. For practical calculation let us assume that one-half this proportion, or 25 per cent of the saving, can actually be effected, provided proper means are used to inspire, educate and require the public to take a more personal interest in conserving coal. Based upon 80,000,000 tons, 25 per cent would mean a

[1] Eastern Manager, American Radiator Company, New York. Mem. Am.Soc.M.E.

saving of 20,000,000 tons in residence-heating work, to which could undoubtedly be added a goodly percentage of coal now used for domestic cooking and hot-water service, by increased economy in its use and by a more extensive substitution of other fuels for cooking.

The practical possible saving on all domestic uses of coal would, therefore, appear to lie somewhere between 20 and 30 million tons. It is important to note that in this 25 per cent saving, only 10 per cent is figured as secured from "economy of operation," the remainder being mainly by elimination and lower maintained temperatures.

Having visualized the first two phases of the subject question, we come to the third phase, viz., the method of procedure that will bring about the greatest conservation. This phase is only indirectly covered by the original subject but is the vital factor which governs the proportion of the possible economies that can be effected.

An active educational program with punch and compulsion in it, as well as an appeal to patriotism, is required, and such a program must necessarily be based upon a plan of regulation and limitation of coal supply calculated upon quantities requiring economy. Only by such means can the average householder be aroused and impressed with the fact that if he does not study and apply the conservation rules, his negligence will react upon the comfort of his own family. He will run short of coal, while his neighbor who has observed the rules will have sufficient for his needs.

Information accumulated leads to the statement that a sufficiently consistent plan of apportioning coal for residence heating, cooking and hot-water service by regulation and limitation, can be secured to make the enforcement practical.

SAVING COAL IN HOT-AIR FURNACES

C. R. MUELLER.[1] In a residence of six rooms an estimated saving of 30 per cent of the coal was made last winter without any radical changes in the heating system. The installation consisted of an ordinary hot-air furnace using recirculated air. The means by which this saving was effected may be applied to practically all types of hot-air furnaces, to obtain as good and even better results.

One way of saving coal was to employ the alternate method of firing for the various poor grades of bituminous coal available. Instead of being spread over the whole surface, fresh charges of coal were thrown on one side of the fire only. The red coals left exposed on the other side ignited the gases distilled from the green coal, thereby saving the heat which ordinarily would have been wasted up the stack, in the form of unburned gas. Smoking was reduced and the usual explosion, which occurred just after firing, was prevented.

The fuel saving was further increased by lowering the room temperature below that required for comfort in ordinary residences. In residences where the humidity averages 20 per cent or less, during the heating season it is not comfortable unless the room temperature is at least 74 deg. By maintaining a relative humidity of 40 per cent a temperature of 68 deg. was found comfortable. In order to obtain this high humidity it was necessary to substitute for the regular water container pans with twice the evaporating surface, and set them close to the firepot. The pans were kept full by means of a float valve connected to the city water service. Since the amount of water evaporated was comparatively small, the coal consumed in this way was neglected in the following example.

[1] Detroit, Mich.

The calculation of the saving which resulted by operating at the lower temperature is based on the fact that the heat loss of a house is directly proportional to the difference in temperature between the inside and outside air. For this city (Detroit) the average outdoor temperature during the heating season is 37 deg. The difference between the inside and outside temperatures is 31 deg. for a house at 68 deg., and 37 deg. for one at 74 deg. The saving, then, by the comfortable house with 40 per cent humidity over the comfortable house with 20 per cent humidity is (37 deg.—31 deg.)/37 deg. or 19 per cent.

In addition to this economy there is, due to the increased humidity, a diminished susceptibility to colds and other pleural ailments.

Recirculating the air in a residence instead of drawing fresh air from outdoors results in a saving of coal, since less heat is expended in warming the inside air through the smaller temperature range. In regard to the healthfulness of recirculation, it can be no more objected to than in the case of steam-heated dwellings, which have no particular fresh-air inlet. Moreover, the air which leaks out of the cracks around the doors and windows is generally sufficient to supply many times more than the amount required for breathing.

The sluggish circulation encountered in the large majority of houses due to the poorly designed air ducts, results in a high stack temperature with its consequent waste of heat. A vigorous flow of air around the firepot and gas passages is necessary to take away this heat and carry it to the rooms above. Good combustion being maintained, the greatest saving of heat occurs when the stack temperature is reduced to the minimum required for draft. The writer made his largest saving during the past winter by using a 12-in. electric desk fan in the recirculating duct leading to the furnace. The fan was operated about fourteen hours daily, forcing twice as much air through the furnace as would have flowed naturally.

Several tests were made under various conditions, in all of which the superiority of forced circulation was obvious. In two consecutive 24-hr. tests, run to determine the economy of forced circulation, the results in Table 10 were obtained.

TABLE 10 TESTS OF HOT-AIR FURNACES

Kind of Circulation		Test No. 1	Test No. 2
		Natural	Forced
Duration, hours		24	24[1]
Average temperatures, deg. fahr.	difference, inside and outside	47	60
	stack	309	205
Total lb. coal fired		106.5	78

[1] The fan was run only 17 hr. of the 24 hr. of the test.

Reducing the coal consumption for the conditions of the first test to those of the second based on the ratio of temperature difference, we have $106.5 \times (60/47) = 136$ lb. The coal saving was then $136 - 78 = 58$ lb., which, at $\frac{1}{2}$ cent per lb., amounts to 29 cents. The cost of fan current at about $\frac{1}{4}$ cent per hour, or 4 cents for the test, makes the net daily saving 25 cents. The saving of coal expressed as a percentage was $100\,(136-78)/136 = 42.6$ per cent.

The few published results available on the performances of hot-air furnaces with forced circulation seem to agree to the extent that the efficiency is increased from 5 to 50 per cent by the use of a fan.

The means of saving coal in hot-air furnaces may be summarized thus:

a Alternate method of firing

b Maintenance of a room temperature of 68 deg. with humidity of 40 per cent

c Recirculation of air

d Reduction of stack temperature by forced circulation.

PHILIP J. SAVAGE.[1] Probably the best method of recommending possible economies in residence heating is to summarize briefly some observations and experiences extending over a period of six years and made in connection with the operation of a warm-air generator of well-known make, installed in a ten-room solid brick residence with average general exposure. Anthracite fuel was used exclusively.

Coal in each of the following forms has been given a full heating season's trial: egg size alone, egg and stove size mixed in equal portions, and stove size alone. Experience indicated that the stove size or smaller coal produces a more compact fire bed, and has the advantage of uniformity of burning rate causing less loss in the ashes. There was no appreciable loss of unburned coal through the grates with the stove size and, in a furnace of proper size, it produces flexibility and burning speed sufficient for severe weather. Incidentally, the cost per ton is lower for the smaller size.

The proper method of operating the grate shakers or revolvers should be carefully studied and the furnace maker's instructions closely followed. Great economies are possible here, in the lack of waste in the ashes. The variation in practice with identical apparatus is remarkable.

The necessity for a check damper in the smoke pipe, for purposes of economy, is obvious. The smoke pipe and its connection to the chimney should be free of air leaks, as the draft-checking effect may necessitate opening, more or less, the damper in the direct draft, which in most furnaces is designed to cause the hot products of combustion to bypass this damper section and flow through heat-absorbing chambers before admission, indirectly, to the smoke pipe. In the residence referred to, the damper in the direct-draft path is left in the closed position at all times of normal operation, except when the fire is being shaken down, and when coal is being added.

The prevention of air leakage at fireplace or grate openings by means of dampers or folding screens, at night and at other times when the ventilating effect is not necessary, is also valuable as a heat saver. Means should be improvised to prevent the all-night loss of heat through the open windows of bedrooms whose doors are left open, for various reasons, to the rest of the house. Stairways can often be more or less completely blocked by the use of a suitable folding screen, for example. In the residence in question, the morning temperature of the downstairs living rooms has been raised from around 60 deg., to 68 or 70 deg. by means of a screen placed nightly on a stairway, which effectively prevents the convection losses.

Relatively large areas of window and door exposure should be checked up very closely, as heat losses of great magnitude are occasioned by this means. The installation of weather strips on one door, and of storm windows on four large windows with severe exposure, in the residence referred to, effected very marked improvement.

The question of humidity does not seem to receive enough attention. The water pan in most of the hot-air installations, when present at all, is placed in the cold-air intake where the moisture absorption is almost negligible; and in installations of the hot-water or steam systems provision is seldom made for humidifying. At a nominal cost an efficient and automatic humidifying system can be installed in a hot-air furnace, with water pan in the dome above the firepot, where the moisture absorption is naturally greatest. Water pans, with some sort of simple wick arrangement to assist evaporation, placed beside the hot-air registers or over steam or hot-water radiators are appreciably helpful. In the installation under observation, a water pan in the air dome of the hot-air furnace and three pans, each with wick arrangement, placed beside floor registers, have increased the relative humidity during normal winter weather from an average of under 30 per cent to an average of about 45 per cent. An evaporation of over five gallons per day was secured.

By means of the changes above enumerated, in equipment and method of operation, the coal consumption in the residence referred to has been reduced from an established average of 16 tons per winter of average severity to 12 tons. The expense involved for the double windows, weather strips on a door, a new indoor air feed to the furnace and the humidifying apparatus was $50, and it has been an exceedingly profitable investment, aside from the added comfort obtained.

[1] The Detroit Edison Company, Detroit, Mich.

ROBERT H. KUSS. The writer has found success, when using bituminous coal of the non-coking variety (Illinois or Indiana, prepared sizes) by employing the following methods:

1 Attempt to operate throughout the heating season with the same height of refuse and live-coal level, this being two or three inches above the level of the bottom of the charging-door opening in the usual equipment.

2 Prepare for a new firing by crowding the live coal to the place nearest the firepot-chamber gas outlet. If the gases rise vertically over the entire firepot area, there is no choice in the matter.

3 Charge the green coal into the depression which should extend down to the refuse, thus permitting no contact with live fuel except on the surface nearest the placement of the live coal.

4 Regulate adjustments in draft for the period of a day's run by means of the check damper; regulate the maximum and minimum heat delivery (depending upon the severity of the season) by means of the chimney damper. In other words, the check damper is the daily, and the chimney damper the seasonal, draft appliance.

5 Admit very little air over the fire.

6 As the demands for greater or less heat delivery occur, vary the thickness of the refuse from 3 in. for greatest requirements to only a small live-coal area about 6 in. deep for mildest weather.

7 To facilitate refuse removal from the place of greatest accumulation, disconnect the bars of the other grate sections from the shaking lever.

8 Shake grates very moderately.

The results have been found to be, when compared with usual practice:

a Decidedly less combustible in the refuse

b Decidedly less clinkering

c Decidedly less soot formation

d More uniform heat delivery

e Substantial economy increases in mild weather.

DONALD B. PRENTICE.[1] The annual domestic coal consumption of the United States is estimated to be 1.1 tons per capita

[1] Assistant Professor of Mechanical Engineering, Lafayette College, Easton, Pa. Jun.Am.Soc.M.E.

of total population, and to be 1.4 tons per capita of those living in buildings heated by coal. These figures place the annual consumption for heating, excluding exhaust-steam installations, at 110,000,000 tons, including all grades of coal. If the average efficiency secured in boilers, furnaces and stoves can be raised from 45 to 55 per cent, for example, the same heating results will be produced with 90,000,000 tons. This reduction of 20,000,000 tons would decrease shipments by nearly 500,000 carloads, with an additional saving of fuel on the railroads. Under the present circumstances, of course, these 20,000,000 tons would be shipped as usual and diverted to industries where the need is severe, making an important contribution to relieve the industrial shortage.

Many residences are equipped with hot-water heating plants. A disadvantage of this system is the cooling of the large body of water during the night, and the consequent losses due to forced combustion in the morning, when an effort is made to raise the water temperature rapidly. The greatest cooling effect is felt in bedrooms, especially in children's rooms where windows are often open for twelve hours or more. All hot-water radiator valves when closed permit enough circulation to prevent freezing, which is necessary, but this circulation, unfortunately, is enough to reduce the temperature of the water in the entire system. The writer has found that closing bedroom radiator valves and then carefully wrapping the radiators with blankets will keep the temperature of the water in the system at least 60 deg. higher than it will be if the radiators are exposed to window drafts. If the water is at 140 deg. instead of at 80 deg. in the morning, fuel is saved and the living rooms are more comfortable.

On new installations with sectional boilers it is possible to have two distinct water systems, one for the living-room floor and one for other floors. This arrangement keeps the living-room circuit warm over night. It involves, however, considerably more piping and therefore adds to the cost.

The coefficient of heat loss from glass is four times that for the ordinary residence wall. If shades are drawn completely down after dark at all windows on the first floor and at all windows except those in bedrooms on other floors, and left down until morning, very valuable dead-air spaces are added to the glass areas, reducing the heat loss perhaps 50 per cent. This procedure also checks window leakage to some extent. Although living-room shades are usually drawn, the number of unshaded windows in most houses is surprising. Window shades are important factors in residence heating in another respect, the shutting out of sunlight. Part of the heating requirements of a residence can be met for many hours on sunny days by allowing the interior furnishings to absorb the radiant heat of the sun to the greatest extent possible.

A means of saving fuel in the furnace itself, which is not mentioned as often as it should be, is the use of small sizes of coal. It is quite practicable to burn anthracite as fine as No. 1 buckwheat on the ordinary shaking and dumping grate by carrying the fire on a bed of ashes, provided there is sufficient draft, which is usually true. This small coal, although higher in ash, can deliver as many heat units per pound as the larger sizes for three reasons: (1) For the same weight the coal has greater surface on which carbon oxidation can take place, which insures complete combustion; (2) the air passes through the fuel bed in fine streams and against enough resistance to keep the excess oxygen in the flue gas at a moderate amount; (3) the fire tends to spread over the whole grate quickly and without manipulation, which eliminates dead spots and prevents air leaks. These statements are not merely expressions of opinion, but conclusions from numerous tests.

Is it too much to expect of householders and amateur firemen that in the winter of 1918-19, by the use of small coal, by anticipating heating requirements and managing their fires accordingly, by eliminating or decreasing heat losses wherever possible, they will save the equivalent of at least one-fifth of the anticipated industrial shortage of 50,000,000 tons?

L. W. Eggleston.[1] The average rate of combustion in house-heating boilers is about 30 per cent of the rated capacity of the boiler. Most boilers develop their highest efficiency at their rated capacity, but to secure the most economical results the boiler should have its greatest efficiency at from 40 to 60 per cent of its load. All boilers designed for ascending gas

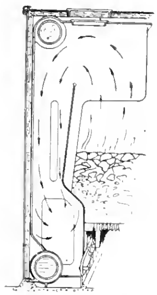

Fig. 15 Principle of Construction of Revertible-Flue House-Heating Boiler

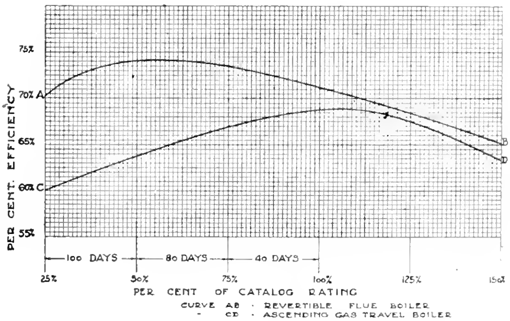

Fig. 16 Comparative Efficiencies of Revertible-Flue and Ascending-Gas-Travel Boilers

travel are most efficient at high rates of combustion; under low rates of combustion there is not sufficient volume of gases to fill all of the flue space. The gases pass to the chimney by the shortest route without giving up all of their available energy.

The most modern boiler construction is designed with a revertible flue travel, forcing the gases from their natural course. This feature properly applied to a boiler leaves no short cut for the gases to escape to the chimney. The floating effect of the gases while trying to resist the power of the chimney on their downward travel causes them to press against the heating surfaces of the boiler and give up their available heat under

[1] Manager, Sales Engineering Dept., American Radiator Co., Chicago, Ill.

all rates of combustion. This principle of construction is shown in Fig. 15.

Fig. 16 shows two efficiency curves. The lower curve shows the efficiency of a boiler with ascending gas travel. Its highest efficiency is at catalog rating. The upper curve indicates the efficiency of the revertible flue boiler, its greatest efficiency occurring at 50 per cent of catalog rating.

An important step in connection with a steam boiler is to free the system from oil and grease. Oily substances on the surface of the water in the boiler offer resistance to the generation of steam, producing an unsteady water line in the boiler and resulting in a wet-steam supply to the heating system. It has been frequently demonstrated that a greasy condition in a boiler has increased the fuel consumption more than 25 per cent and, unless the boiler is thoroughly cleaned after the plant is installed, the grease and oil will remain in the system indefinitely.

The most economical control for house-heating boilers is effected by allowing the greatest possible amount of the draft tension on the boiler at all times. The fire should be regulated by the draft door located in the ashpit. This door should be adjusted so that the maximum results can be obtained with the smallest possible amount of opening. With this control, excess air is prevented and good results are obtained at all rates of combustion. A great many operators imagine that by closing the choke damper in the smoke hood they prevent the heat from escaping up the chimney. This practice, however, decomposes the fuel without giving off its available heat.

It is very important that the boiler should be made airtight so that the air for combustion enters the draft-inlet door. Thermostatic control, properly connected to the draft dampers, effects a great saving in fuel and gives a more uniform heat.

It has been demonstrated by actual practice that this method of operation, compared with the average manner of operation, will result in a great saving of fuel.

P. J. DOUGHERTY.[1] At least 5 tons of coal per year are wasted in the average 10-room residence due to excess air leakage through loose fitting jambs, windows and doors. Assuming a clearance of $\frac{1}{16}$ in. around the windows and doors, the total area of such openings is equal to that of a 24-in. pipe. Allowing one-half of this area for air infiltration, at least 40,000 cu. ft. of cold air per hour enters the building, while 9000 cu. ft. per hour is ample for a family of five. In zero weather it requires about 5 lb. of extra coal per hour to heat this large amount of excess air.

The heat loss through an $8\frac{1}{2}$-in. brick wall and plaster is 1.8 times as much as through a 13-in. brick wall furred and plastered; or twice as much as through a $17\frac{1}{2}$-in. brick wall furred and plastered. In frame construction the heat loss through a wall consisting of clapboard, studded and plastered, is 1.4 times that through clapboard, paper, studding and plaster; or 1.9 times that through clapboard, paper, sheathing, studding and plaster. It is quite evident that a judicious use of building paper and interlocking metal weather strips are gilt-edge investments in reducing coal bills.

The next important leak to be stopped is the excessive escape up the chimney of unconsumed gases such as carbon monoxide, hydrogen, hydrocarbons and carbon. The fuel bed itself acts principally as a gas producer. About one-half of the heat energy of the fuel passes into the combustion space in the form of combustible gases. Unless the combustion conditions within the heater are right, these unconsumed gases carry nearly half the heat value of the coal up the chimney as a dead loss, irrespective of how low the smoke-pipe temperature may be. A high combustion temperature, not less than 1000 deg. fahr., is absolutely essential to produce economic combustion. Invariably a low combustion temperature accompanies a weak draft.

A weak draft, improper firing or faulty heater design are the usual causes of high coal bills because of unfavorable combustion conditions within the heater. The strength of a natural draft depends primarily upon the average temperature of the gases within the chimney, which should range from 300 deg. to 500 deg. fahr., depending upon the height of the chimney. Because of excessive leakage of cold air into the average chimney, and the maximum chilling effect due to the usual 4-in. chimney walls, it is no uncommon condition to have the flue gases chilled from 800 deg. to 200 deg. fahr. in passing from the bottom to the top of the chimney. This condition gives an average stack temperature of 500 deg. fahr., the requirement for the average low outside chimney 35 ft. or less in height. A properly designed heater will therefore permit the gases to escape to the stack at from 400 to 800 deg. fahr. in order to maintain the required temperature in the chimney.

Leaky chimneys are the bane of a heating engineer's existence. A heater cannot deliver heat to the system unless the draft is strong enough to first generate the heat from the fuel. A weak draft changes a heater from a heat producer to a gas producer. The combustible gases escaping up the chimney unburnt are the same gases that are purchased from the gas companies for cooking and lighting. A large saving in fuel and loss by fire could readily be accomplished if the Board of Underwriters as well as city ordinances and architects should demand a smoke test to prove a chimney tight before accepting it, as is the case in testing all plumbing and electrical installations before acceptance.

A strong draft properly controlled is the best fuel economizer on the market. In the average residence the available draft at the smoke damper should be about 0.2 in. of water. A sensitive draft gage of the Ellison type with a 15 to 1 ratio should be part of the equipment of every heater. No house owner can intelligently regulate the draft without a sensitive draft gage.

A strong draft not only saves coal by producing a high combustion temperature to burn the combustion gases, but it materially increases the effectiveness of the heating surface of the heater. The heating surface of the combustion chamber will absorb $2\frac{1}{3}$ times as much heat when the combustion temperature is 1350 deg. fahr. as when at 950 deg., the steam or water against the heating surface being at 212 deg. High combustion temperature is far more important than low stack temperature in burning fuel economically. It is far more economical to permit 20 per cent of the fuel energy to pass into the chimney as high stack temperature in order to produce the necessary draft, than to suffer the loss of 40 per cent of the fuel energy in the form of unconsumed gases due to a low stack temperature.

Excess air passing through the heater is a frequent cause of high coal bills. A thin fire on the grates, 12 in. or less, or a strong draft improperly controlled are the principal causes of heat loss through excess air as indicated by a low percentage of CO_2 (from 5 to 10 per cent) in the flue gases.

A deep bed of fire and ash on the grates at all times, from 16 to 20 in., will materially reduce the heat loss due to excess air. Excess air produces such a chilling and deceiving effect that more actual heat units escape from a heater whose flue gases show a temperature of only 300 deg. fahr. and 5 per cent CO_2, than escape from a heater whose flue gases show a

[1] International Heater Co., Utica, N. Y.

temperature of 800 deg. fahr. and 15 per cent CO_2. The former condition represents 19.6 per cent of the heat of the fuel, while the latter with its high stack temperature and low excess air represents only 18.5 per cent of the heat units passing up the stack as sensible heat.

B. J. Denman. The greatest saving in districts using bituminous coal for residence heating is to be obtained by encouraging the use of coke. In most residence heaters, the volatile matter is distilled off without being consumed, due to the general practice of filling up the furnace in endeavoring to cut down the frequency of firing. This can be avoided by advocating frequent and light firing of coal, or by the use of anthracite coal or coke. The use of thermostats for residence heating is very desirable, and would result in a material saving of fuel in the average house.

Most people do not appreciate the saving which can be effected by having a door or heavy curtain at the top of the stairway, so that the upstairs can be cut off. This makes it possible to heat only as much of the upstairs as is necessary, and prevents disagreeable drafts coming down, if the upstairs is not heated. It also prevents the chilling of the entire house, due to bedroom windows being raised during the night. An enormous saving could be effected if every one would cut off as many sleeping rooms as possible.

C. E. Van Bergen. Fuel may be saved in residence heating by using the smaller sizes of anthracite coal such as pea and No. 1 buckwheat. These can be used by careful handling of grates, taking care at all times to keep some ashes on or over the grates, to prevent the small coal falling through grates.

Do not shake or dump the grates roughly and if coal begins to run through grates, stop it by pushing down enough coal with poker to plug the hole.

Walter E. Bryan. Waste in residence heating is due, to a great extent, to ignorance of proper methods of handling heating apparatus. I have found that when it is not necessary to push the fire hard, the most economical results are obtained by keeping the ashpit door and firing door (including the slide) tightly closed and opening the damper in the smokepipe, which allows air from the outside to enter. The keeping of the fire door tightly closed may result in a little smoking immediately after firing, but it also results in a more even temperature and prevents cold air from being drawn in over the fire.

10 What Coal Economies Can Be Effected in the Small Steam Plants?

Plants which are not sufficiently important departments of their industries to warrant expert supervision and are too small to support real engineers waste a lot of coal and steam in the aggregate. What are the principal sources and methods of waste and how can they be avoided and corrected?

E. H. Kearney.[1] We would be lacking in the gift of foresight if we allowed ourselves to be lulled into the belief that at the present time, by virtue of existing conditions, a form of fuel conservation hysteria were sweeping over the country and that at the termination of a few months or a few years a return would be had to normal conditions—and to normal conditions is meant a relapse to pre-war price, production and consumption. In all probability, not in our day and generation will we again see the time when the commodities which enter into power-plant operation can be secured with the same facility which obtained previous to the present tightening-up-all-round period.

This is a thought which should occupy our minds to the exclusion of lesser things in dealing with present and future power plant conditions—we as engineers are the nation's fuel conservators.

In order to bring about the best possible efficiency in the plant, the operating engineer should, figuratively speaking, "camp" in the boiler room. Not a single detail of its operating conditions should escape his personal attention—methods of firing, condition of fires, leaks in settings, adjustment of draft, temperature of feed water and condition of feed pumps are but a few of the many things which should engross his attention. In short, the engineer does well who keeps constantly in mind the truth of the old adage, "If you want a good job done, take pains to do it yourself."

For several years preceding the war period there was a growing tendency upon the part of owners and engineers of medium-sized plants to install apparatus in the boiler room by which a closer check could be had upon fuel consumed, water evaporated, quality and temperature of gases, etc. Larger plants were equipped with these aids to economy as a matter of course, and the beneficial results which attended the operation of these more modern systems had set a worthy example for less pretentious plants to follow.

If increasing scarcity and cost of fuel had been the only factors to be dealt with, it is easily seen that firms dealing in scientific power-plant apparatus would have been swamped with orders. Had prices and delivery remained a fixed quantity, there would have been a scramble on the part of engineers of smaller plants to obtain apparatus which during the 24-hour period would enact the part of watch dogs of the coal pile. But while war conditions brought about a scarcity and soaring price of fuel, they also affected the apparatus manufacturer in like degree with the result that the modest plant owner found himself between two fires; either to install checking apparatus at a tremendously increased cost, provided he could secure it at all, or to continue under the old order of things by obtaining the best results possible with what he had in hand. Right here is presented a problem for the plant owner who is interested not only in the matter of his own fuel costs, but in the larger scheme of national fuel saving as well.

There is no question but that many plants which are now being operated without adequate provision for bookkeeping and cost checking could make a decided improvement in the appearance of the monthly balance sheet without the expenditure of extravagant sums. It should be the ambition of every power-plant owner and engineer to ascertain beyond reasonable doubt, through the medium of practical expert advice if necessary, whether or not his plant is being operated under conditions which square with good practice.

Reduced to its lowest terms the whole fuel problem as far as we engineers are concerned is just this: *Voluntary* fuel saving there *should be;* if not, *compulsory* conservation there *must be.* We as engineers must accept as a duty our share in the great task which now confronts the nation.

[1] Supt. of Bldgs., John Hancock Mut. Life Ins. Co., Boston, Mass.

D. C. Faber.[1] The possibility of improvement in boiler-room equipment and firing methods in small steam plants was very forcibly impressed upon engineers connected with the fuel-conservation work done in Iowa under the direction of the Fuel Administration last winter. In connection with this work, combustion conditions were investigated in about one thousand small steam plants, for the purpose of determining what could be done to improve boiler-room efficiency. While it is not possible to enumerate here the conditions found, there are a number of faults which are common to most plants of this type. In many of these plants the firemen have other duties which take them away from the boiler room for a great part of the time, so that firing instead of being a principal duty becomes merely an incidental one. Under such conditions the firemen usually do about all that is expected of them, which is to shovel enough coal from the pile into the furnace to keep up steam, regardless of how or when this is done, so that carrying too thick a fire, firing too large quantities at one time, and failure to regulate fire with damper in uptake are common faults. Air leaks in boiler settings, bare steam pipes and failure to remove soot and scale at frequent intervals account for a large percentage of the fuel losses in such plants.

Many of these faults can be done away with only through education of owners and operators. Right now, on account of the general interest in fuel economy, is the time to start such educational work. Supervision under direction of the Fuel Administration could well be a part of such educational work. Results can be secured now in the small steam plants which would be impossible under other circumstances.

Geo. H. Diman. One of the best ways to save coal is to save the heat units. This can be done in many ways. First, be careful not to have the rooms in the manufacturing plants overheated. Do not allow steam on in rooms with windows open. This summer, see that all the window frames are properly pointed so as to admit no cold air. If operating dyehouses, utilize all the available heat units in the dyehouse and finishing departments.

Let me illustrate what I mean. In one of our large mills, some years ago, the dyeing and finishing departments got behind with their work. In order to get the goods into the market we stopped the mill, running nothing but the dyeing and finishing departments. When the mill was running full we used about 6000 hp. and burned 1000 tons of coal per week. This power was generated by two pairs of cross-compound engines, sacrificing on the vacuum, and keeping the discharge water in the condensers at 110 deg. All this water was stored in the finishing department in tanks for washing the goods. A simple engine of 2400 hp. furnished exhaust steam for use in dyeing.

When we ran two weeks with only the dyehouse and finishing room we used direct steam, and ran only one engine. It took 275 hp. to turn the shafting of the dyehouse, and we burned 775 tons of coal per week.

It will be seen that in the first case, where the heat units were utilized as far as possible, we got 6000 hp.: while in the other case, where direct steam was used, we got only 275 hp. and burned three-quarters as much coal as before.

B. J. Denman. It is our belief that even in large plants, insufficient attention is paid to intelligent operation of the various boiler and engine units. Efficiency curves of boilers, engines and turbines should be made, and the units operated at their most efficient point. Great savings are possible in many plants if this is done.

One point frequently overlooked is the temperature of the hotwell in condensing units. The amount of circulating water pumped should be varied with the temperature of the circulating water, and the temperature of the hotwell kept as near that corresponding to the vacuum as possible, to reduce the heat loss to the circulating water.

A. G. Christie. This question was discussed informally at one of the meetings of the Baltimore Section last winter. It was pointed out that inefficiency in small plants was generally due to the following causes:

a Practically all horizontal return tubular boilers in the Baltimore district have been set too close to the grates owing to the fact that a local concern cast boiler fronts from a pattern which allowed only about 20 in. between boiler and grate surface. This had been increased in several cases to 6 ft. with decidedly satisfactory results.

b Air infiltration through cracks in the setting.

c Failure to keep the heating surfaces clean.

d Improper firing methods.

It was pointed out that economies could be secured by:

a Offering a bonus for coal saved.

b Keeping careful records of coal used and posting these.

c Providing a sufficiently large combustion space over the grates.

d Insisting on clean tubes.

e Using prepared mixtures to make the setting airtight. Several are on the market. The settings must be inspected periodically to see that they are kept tight.

f Elimination of steam leaks through joints, faulty traps, etc.

Carl J. Fletcher. The question as to coal economies that can be effected in small steam plants in the aggregate is one of the most important questions asked. The fuel cost in these plants is too small to permit the proper expert supervision and the possibility of saving much greater than in the larger plants. After an examination of a great many small plants, I have two suggestions to offer which would result in a very great saving:

Most plants clean the inside of their boilers fairly well; but it is my observation that when soot is removed by hand blowing (done at night when the pressure is low), it is one of the most neglected jobs around the boiler room. Automatic soot blowers should be installed and should be used several times a day.

One other possible saving is in the use of the damper on the individual boilers. Plenty of advice has been given regarding this feature, but I find in most plants that the dampers are inconveniently placed, and often not in real operating condition. As the first step, the plant management should insist that dampers are in good condition, equipped with levers which are within easy reach of the firemen. The damper should be easily controlled by means of a proper handle, placed where the fireman would not have to walk behind boilers to reach it.

P. W. Thomas. Economies approaching 50 per cent of the requirements in small steam plants of, say, 200 to 500 hp. can often be effected by simply putting the plants in shape. We have a record of one plant using 22 tons daily which now uses 11 tons, and the owners bought no fuel-saving equipment

[1] Consulting Engineer, U. S. Fuel Administration, Des Moines, Iowa.

except firebrick, baffle brick, asbestos and fireclay. The 11 tons were saved by the proper education of the men in the boiler room.

Walter E. Bryan. Probably the greatest loss in such plants is due to dirty boilers, improper firing and handling of dampers. If this fact, together with the remedy, could be placed in the hands of the managers of industries who are operating small plants, considerable saving would result.

C. E. Van Bergen. As long as the war lasts, no plant using coal for generating steam or for heating purposes can be considered too small to require the careful attention of some one within the organization. Fuel must be saved, no matter how small the quantity, and this is just the point which must be emphasized: "Every plant must save some coal." And along with this is another thought that, unless each one of us saves, we may experience a worse coal shortage next winter. And each of us should preach coal saving on all occasions.

11 What Experiences Have You Had with the Storage of Coal?

H. H. Stoek.[1] It is practicable, advisable and advantageous to store bituminous coal not only during war times, but also under normal conditions either at the mines, near the point where it is to be used: or at some intermediate point. It is well to store coal as near the point of consumption as possible to avoid rehandling and for the following reasons:

a To insure the fuel consumer of a supply of coal at all times

b To take advantage of lower freight rates, or of lower prices of the coal at certain seasons of the year

c To permit the railroads to utilize their cars and equipment to the best advantage

d To permit the mines to be operated more steadily.

Kinds and Sizes of Coal that Can be Stored

Although it is undoubtedly true that some coals may be stored with greater safety than others, the danger from spontaneous combustion is due more to improper piling of coal than it is to the kind of coal stored.

Most varieties of bituminous coal can be stored in the air if of proper size and if free from fine coal and dust. The coal must be so handled that dust and small coal are not produced in excessive amounts during the storing, because spontaneous combustion is due mainly to the oxidation of the coal surface.

All varieties of bituminous coal can be stored under water, which excludes the air and prevents spontaneous combustion.

The danger of spontaneous combustion in storing the coal is very greatly reduced if not entirely eliminated by storing only lump coal from which the dust and fine coal have been removed. Of two coals the least friable should be chosen for storage purposes, because less dust and fine coal will be produced in its handling.

Fine coal or slack has sometimes been successfully stored:

a By preventing air currents through the pile by means of a closely sealed wall built around the pile

b By closely packing the fine coal. Such a coal pile must be closely watched for heating. Piles of slack must be very closely watched for heating and means provided for promptly moving the pile if heating develops. The only absolutely safe way to store slack or fine coal is under water

c Many varieties of mine-run coal can not be stored safely because of fine coal and dust mixed with the lumps

d Coal exposed to the air for some time may become "seasoned" and thus may be less liable to spontaneous combustion, due to the oxidation of the surface of the lumps of coal, but opinions are by no means unanimous upon this point

e It is believed by many that damp coal stored on a damp base is peculiarly liable to spontaneous combustion, but the evidence on this point is by no means conclusive. It is safer not to dampen coal as or after it is placed in storage.

Effect of Sulphur on Spontaneous Combustion

It has been shown by experimentation that the sulphur contained in coal in the form of pyrites is not the chief source of spontaneous combustion, as was formerly supposed, but the oxidation of the sulphur in the coal may assist in breaking up the lumps of coal and thus increase the amount of fine coal, which is particularly liable to rapid oxidation. Even this latter opinion is not unanimously endorsed. In spite of experimental data showing that sulphur is not the determining element in spontaneous combustion, the opinion is very widespread that, if possible, it is well to choose a coal with low sulphur content for storage purposes.

Method of Piling Coal

To prevent spontaneous combustion, coal should be so piled that air can circulate through it freely and thus carry off the heat due to oxidation of the carbon, or else it should be so closely piled that air cannot enter the pile and oxidize the fine coal.

Stratification or segregation of fine and lump coal should be avoided since an open stratum or a chimney of coarse lumps of coal gives a passage for air to enter and come in contact with fine coal and thus to oxidize it and start combustion.

If space permits, low piles are preferable, as the coal is thus more exposed to the air and better cooled than in high piles, and in case of heating it can be more readily and quickly moved. A disadvantage in high piles is the greater difficulty of moving the coal quickly, if necessary. The idea that a high pile causes heating at the bottom is erroneous, since as many fires take place near the top as near the bottom and near the outside as near the interior of the pile. If possible, the coal pile should be divided by alleyways so as to facilitate rapid loading out of the coal in case of necessity, so that an entire coal pile may not be endangered by a local fire.

Much of the attempted ventilation of coal piles in the United States has been inadequately done by the use of only an occasional ventilation pipe which has been not much more than a place in which to insert a thermometer for reading temperatures. The practice of placing ventilating pipes close together has been used in Canada and is reported to have been effective.

Water is an effective agent in quenching fire in a coal pile if it can be applied in sufficient quantities, but a small amount is ineffective. Unless there is an ample supply of water to thoroughly quench the fire and cool the pile, it is very dangerous to add any water to a coal pile.

[1] Professor of Mining Engineering, University of Illinois, Urbana, Ill., Chairman of Fuel Conservation Committee, Fuel Administration of Illinois.

Coal of different varieties should not be mixed in storage if this can be helped, for one coal that has a greater susceptibility to spontaneous combustion than the other may jeopardize the safety of other coals that are not so liable to spontaneous combustion.

Effect of Storage on Value of Coal

The heating value of a coal as expressed in B.t.u. is decreased very little by storage, but the opinion is very widespread that storage coal burns less freely when fired in a furnace. Experiments indicate that much of this can be overcome by keeping a thinner bed on the grate than is kept with fresh coal and by regulating the draft.

The coking properties of most coals seem to be decreased as a result of storage.

The value of coal for making illuminating gas is not decreased as a result of storage.

The deterioration of coal stored under water is negligible, and such coal absorbs very little extra moisture. If only part of a coal pile is submerged, the part exposed to the air is still liable to spontaneous combustion.

Additional Precautions

The best preventive of loss in coal storage is to inspect the pile regularly and if heating occurs up to 150 deg. fahr. to keep very close watch on the pile; and if the heating increases to 175 or 180 deg., to remove the coal as promptly as possible from the spot affected, and thoroughly cool it before piling it again.

Storage appliances and arrangements should be so designed as to make it possible to load out the coal quickly if necessary, and the coal should not be stored in large piles unless provision is made for loading it out quickly.

Pieces of wood, greasy waste, or other easily combustible material mixed in a coal pile may form a starting point for a fire, and every effort should be made to keep such material from the coal as it is being put in storage.

It is very important that coal in storage should be kept from such external sources of heating as steam pipes, because the susceptibility of coal to spontaneous combustion increases rapidly with an increase in temperature.

T. N. Wynne.[1] The Indianapolis Light and Heat Company has been storing Indiana coal since 1888. Before 1912 all coal stored was on the ground in open air, with no particular attention paid to sizes, quality, or the method of storing. In 1912 this company investigated the question of storing coal under water to prevent spontaneous combustion and loss of heating value. No. 4 vein Indiana coal contains approximately 2 per cent of sulphur and No. 5 vein from 3½ to 6 per cent, and our experience has been that No. 5 will invariably fire if exposed to the air, while No. 4 will not. While we feel it safe to store No. 4 coal on the ground, it is so difficult to obtain that we feel it necessary to provide storage that will be safe for No. 5. We burn No. 4 on Roney stokers and No. 5 on Green chain grates.

An average of 741 tests shows the freshly mined No. 4 vein coal to contain about 35 per cent of volatile combustible matter. From tests of various samples taken from No. 4 coal stored for three years in open air at our Kentucky Avenue Station the volatile content was found to average 28.34 per cent, indicating a loss of 20 per cent. This coal during its period of storage did not show any signs of heating.

At the same station we have had stored for about eight months 2000 tons of No. 4 vein Indiana mine-run coal. This coal has never shown a tendency to fire, although in places it is 35 ft. deep.

The history of coal storage by our company has been a series of fires and losses. In 1912 we constructed at our Mill Street Station a concrete pit 300 ft. long, 100 ft. wide and 20 ft. deep, designed to contain 13,000 tons of coal submerged. A standard-gage track crosses this pit at ground level from one end to the other on concrete piers. The cars are run upon this track and dumped. After the coal has reached a certain height it must be handled to both sides of the track by means of a Brown hoist. The topography of the ground prevents the elevation of track to facilitate dumping, a condition very desirable if possible. The pit when filled is not disturbed except in case of shortage in daily delivery. Mine-run coal only is stored because screenings under water become a mud-like mass, almost impossible to handle or burn.

Capillary attraction will take care of coal piled above the water level of the pit as much as 8 or 10 ft., thus permitting of additional capacity of about 40 to 50 per cent.

Whenever coal is taken from the pit to be used on the stokers it is loaded into railroad cars and the water allowed to drain off for about six hours before the coal is put into the bunkers; or, when coal is to be taken from the pit the water may be lowered until sufficient coal has been uncovered and drained to meet the requirements.

The result of underwater storage fully met our expectations in that it prevented fires and preserved the heating value of the coal. We have never been troubled with excessive moisture when burning pit coal if mine run is used. Screenings which have been stored under water burn with difficulty.

A loss of heating value is very evident in the case of coal stored in air. In fact, when burning air-stored coal it is necessary to have additional boiler capacity to carry the same load.

Results of 181 tests of No. 4 vein coal which has been submerged for one year as compared with those of the 741 tests of freshly mined coal previously referred to, show a reduction of 1.7 per cent in available B.t.u. in the case of the submerged coal. This loss is so small that it might very well exist between two lots of freshly mined coal.

Recently we constructed a reinforced-concrete coal pit at our Kentucky Avenue Station, 145 ft. long, 65 ft. wide and 32 ft. deep, built on the same general lines as that at the Mill Street Station and holding 8000 tons.

The Indianapolis Light and Heat Company burns 500 tons of coal per day, and as the two pits have a total capacity of 20,000 tons of coal submerged and 10,000 tons above the water line, this means a sixty days' supply on hand if both pits are filled. The total cost of the two pits was \$60,000 or \$2 per ton of storage.

Albert A. Cary. Another phase of the coal-wasting proposition is that of spontaneous combustion.

With the clean coal formerly received by a certain large power plant, running low in percentage of non-combustible matter, trouble from spontaneous combustion was almost unknown even after the coal had been stored for six or seven years in dense piles.

With the coal now received they find that they cannot store it for two weeks without spontaneous firing; in fact, they have such fires burning in their coal bins almost continuously, with

[1] Indianapolis Light & Heat Co., Indianapolis, Ind.

the result that when this supply is drawn upon for use they have coke to burn instead of coal.

With the valuable heat-producing volatile matter thus distilled out of our eastern bituminous coal, the loss in steam-making capacity is from 10 to 15 per cent.

Should coals from the Central West be used (which coals contain a considerably higher percentage of volatile matter), the amount of such loss is materially increased.

Loss from spontaneous combustion simply means that a correspondingly *greater amount of coal* must be carried over our transportation systems from the mines to make up for the deficiency thus created.

The spontaneous combustion of coal is occasioned by the combination of some of its constituents (including impurities) with atmospheric oxygen, which reactions raise the temperature of the surrounding coal to its ignition point.

Whether this firing is due to the presence of that easily decomposed form of iron pyrites known as marcasite or to the presence of other impurities, it is difficult to say, but we have the strongest evidence—at the large power station referred to—that with the clean coal formerly received, no loss due to spontaneous combustion occurred, but with the dirty coal that is now being received, such firing is almost continuously occurring. Generally speaking, the coals running the highest in non-combustible matter give the greatest trouble due to spontaneous combustion.

As regards the statement that coal containing 40 per cent of refuse is valueless as a fuel, I would say that there is no doubt coal with such a high percentage of refuse will be found to be a very undesirable fuel, but whether it can be burned to produce useful results depends largely upon the rate of combustion, the facilities available to give the fuel bed the requisite air supply, and the skill of the fireman.

It is desirable to know just what is meant by the term "refuse." The word is commonly used to denote the total matter rejected from the furnace, which includes the combustible matter contained in the so-called ash. If it is intended to mean pure ash, or wholly incombustible matter, it is doubtful whether a steam boiler could be operated with such fuel. On the other hand, if it is intended to define the pure ash with accompanying combustible matter, such as is commonly rejected from boiler furnaces, I know that the remaining 60 per cent of fuel has been used successfully for purposes of steam generation.

In the office building in which my office is located they received the so-called steam sizes of anthracite coal last winter and managed to carry their load and maintain the regular steam pressure, burning this coal when taking 42 per cent of refuse out of the ashpit and furnace.

This plant is equipped with five 400-hp. boilers and the ratio of heating to grate surface is 49 to 1. The furnaces are hand-fired, and when burning this dirty coal they maintained a blast pressure of 1¼ in. water pressure under the grates and developed from 70 to 75 per cent of the boilers' rating, as shown by the steam-flow meter.

Much credit is due to the chief engineer of this plant, whose instructions to the firemen made it possible to obtain such remarkable results under adverse conditions.

P. W. Thomas. Our personal experiences with storage coal may be of great interest. All of our coal is of a nature that heats very quickly. Where we are unable to procure underwater storage, we adopt the following plan:

The storage place is first absolutely cleaned of all rubbish in the way of deadwood and vegetation. We then cover the entire area with coal to the depth of about one foot. After this coal has been exposed to the air for one or two days, we place another layer above it. We continue this to a depth of 8 to 10 ft., being careful to store only coal from one given mine. We have carried raw screenings over a period of a year without smolder, where under ordinary circumstances they would have fired in from one to three weeks. A scientific explanation would be rather difficult, but in all likelihood would center around the undoubted fact that each layer so put down has time to lose the majority of its occluded gases and becomes more or less inert. The pyrite also has time to become partially or wholly oxidized.

I note that in Question No. 1 there is a statement regarding the amount of refuse which renders a fuel valueless. I might make the absolute statement that it is not the amount of refuse, but its character. I have successfully burned fuel running 45 per cent ash, but this ash was inert and absorbed no heat from the coal to exceed 3 or 4 per cent. On the other hand, a fuel containing 31 per cent ash, which ash was 90 per cent metallic, failed to carry boiler ratings, although its heating value was over 10,000 B.t.u. per lb. This was due to the fact that approximately 11 per cent of the initial heat in the coal was absorbed by the ash, whereupon it became impossible to maintain a combustion rate that would give sufficient heat to the boiler.

Walter E. Bryan. Where coal is not too small in size and contains few impurities, it can be stored either under roof or in the open for long periods with little danger from combustion and, I believe, little deterioration. We have found it necessary in storing screenings, of rather poor quality, under roof, to allow them to stand not longer than three to four weeks in warm weather. In the open it is almost impossible to store such screenings during the summer months without firing, and with the comparatively poor coal supplied last year it was impossible to store the coal for any great length of time, even in the winter months, without its catching on fire. In my opinion, the question of ventilating storage piles is of questionable value, the important points being not to store too fine coal or dirty coal, and not to store it in large piles.

In case the coal actually does fire, I know of no effective way to put the fire out; it is our practice to pick up the coal as rapidly as possible and use it. I realize, however, that there are several methods of chemically treating the coal after it has fired which are supposed to put the fire out. In the case of coal stored in buildings, care should be taken after emptying a bin that all pockets are brushed out before the new coal is put in.

B. J. Denman. Up to a few years ago I was in charge of plants burning Pennsylvania and West Virginia coking coals which required storage of approximately 100,000 tons. Mine-run coal was stored in continuous piles as high as could be handled by locomotive cranes. No attempt was made to ventilate the piles, and no fires ever occurred. There was no loss in heating value of coal which had been in storage as much as three years.

I am at present storing eastern Kentucky "Elkhorn" gas coal for nine gas plants. Most of this is under cover, but some is unprotected. This coal is stored in piles as high as 25 ft., and no precautions are taken, but no fires have resulted. Most of this coal is ¾-in. lump, but some of it is screenings. Some of the lump coal has been in storage for five years or more.

For electric plants, I am at present storing each winter in various localities from 3000 to 20,000 tons of Illinois and Iowa coal. It is our experience that washed central Illinois coal screenings can be put in stock during the summer and used the following winter with very little danger of firing. Springfield, Ill., district $1\frac{1}{4}$-in. screenings cannot be put in stock in summer without great danger of firing. If this coal is put in stock during the winter time, when the coal is very cold or mixed with snow, it will ordinarily carry through the following summer. Fulton County, Ill., screenings will ordinarily fire before fall if put in stock during the summer months, although we have one plant in northern Iowa where we put about 3000 tons of this coal in stock each year and have very little trouble; in a number of plants in the central part of the state, however, trouble invariably results. This may be due to some climatic condition, but we have not been able to account for it.

We have had very satisfactory results in storing southern Illinois screenings and experience very little trouble. The lump coal from any of the Illinois districts can be carried through the summer without trouble.

Iowa screenings cannot be stored at all during the summer time, and frequently the coal fires in transit. I have had no experience in storing Iowa lump, but am of the opinion that it would disintegrate and fire.

I have had little faith in the usual schemes for ventilating coal piles, and have observed several experiments which have not been satisfactory. It is our practice not to store the coal over 12 ft. high, and if it begins to heat, to move it as quickly as possible.

A. G. Christie. I have found it impossible to store certain grades of western lignite if wet even in as shallow piles as 6 ft. without having spontaneous combustion. Alberta bituminous coal could be stored in piles 12 ft. deep if kept dry. Wet weather may start combustion. We have had no difficulty storing semi-bituminous coal in piles of 12 ft. deep in Baltimore, but care is taken to keep it dry.

Carl Smerling. It is comparatively safe to store bituminous coal containing up to $1\frac{1}{2}$ per cent sulphur in piles not exceeding a depth of 7 to 8 ft. and not be troubled with spontaneous combustion. The same kind of coal can be stored at any depth if supplied with sufficient air pipes penetrating the storage at proper intervals, although we find that in 50 per cent of the cases where bituminous coal is stored, especially through the Middle West, hundreds of tons of coal are lying in the open for years 20 to 30 ft. in depth and containing from 2 to $2\frac{1}{2}$ per cent sulphur. It must be noted, nevertheless, that in all cases spontaneous-combustion fires are found at the bottom of the pile or at the floor level, and it therefore seems advantageous to have from a foot to eighteen inches of water at the bottom of the pile to insure safety.

C. E. Van Bergen. We do not recall any interesting experiences in connection with coal storage, having never had any large quantities to deal with, nor have we had any fires in storage piles. We do not store until fall, and about 1000 tons well spread in piles not over 15 ft. high is the most we ever have on hand.

W. L. Abbott. We have stored hundreds of thousands of tons of bituminous coal every year at a cost not to exceed 10 cents per ton into and out of storage. We have had no trouble whatever in many years with spontaneous combustion in the coal piles. It has been our experience that we can prevent spontaneous combustion by storing grades of coal that do not contain the small sizes, using preferably a 3-in. by 6-in. egg or lump size of coal which has gone over a $1\frac{1}{2}$-in. screen.

12 (a) To What Extent and Where Will the Gas Producer Be Used to Produce Economies?

Robert H. Fernald.[1] There seem to be three obvious fields for producer gas development:

1 For extensive power production at the mines
2 As a substitute for natural gas for general heating purposes
3 In conjunction with by-product coke ovens.

1 In the field of power production through the internal-combustion engine the application of the gas producer seems limited to plants of relatively small capacity. This is due to the fact that the practical size limit for gas engines seems to be not over 5000 hp., and very few engines of this size are built. The gas-engine-gas-producer combination can hardly be considered for central station service. For large power installations the natural development is the by-product producer-gas plant located at the mines in conjunction with steam boilers and steam turbines. The low efficiencies due to the two-step conversion—first, gas generation from the coal and, second, burning of the gas under steam boilers—may be counterbalanced by the development of highly efficient boilers equipped for gas burning, and by the return from the valuable by-products secured from the coal. Should the development of the gas turbine result in commercial units that compare favorably with the present large steam turbine units, additional marked economies may of course be looked for.

2 The depletion of the supply of natural gas in many regions is leading to the gradual substitution of producer gas in place of natural gas,—using producers of either the by-product or non-by-product type.

3 This field embraces two divisions; (*a*) one in which there is an unlimited demand for the coke from the ovens as well as for the gas and by-products; (*b*) one in which there is no market for the coke but a ready market for the gas and by-products.

a This type of plant is composed essentially of two distinct installations, a by-product coke plant and a by-product producer gas plant. The entire gas output of the coke plant may thus be made available for the market, as the lower heat value producer gas may be used for heating the coke ovens. One of the advantages of this system lies in the fact that coke breeze and low-grade fuels may be used in the producers. In a large European plant of this type the coke oven gas is the main product and the coke, which finds a ready market, is regarded as one of the by-products. The by-products from the producer-gas plant, sulphate of ammonia and pitch, practically pay the cost of operation of this portion of the installation.

[1] Professor of Dynamical Engineering, University of Pennsylvania, Philadelphia. Mem.Am.Soc.M.E.

b In case there is a demand for the by-product coke oven gas but no convenient market for the coke, the natural step involves placing gas producers in close contact with the by-product coke plant, feeding the coke directly into these producers. Such portion of the producer gas as is not used for heating the coke can be mixed with the by-product coke oven gas for general distribution.

Developments along the three lines indicated seem to offer attractive possibilities, and their adoption on an extensive scale would lead to economy in fuel consumption.

12 (b) To What Extent Is Natural Gas Being Used as a Fuel for Power Purposes?

SAMUEL S. WYER.[1] The natural gas industry is in a transition stage, changing from the large-volume, low-price-per-unit basis, to the relatively small-volume and larger-price-per-unit basis. The reasons why natural gas cannot and ought not to have an extensive use for steam-boiler work in the future may be enumerated as follows:

a The number of domestic consumers, now over 2,363,000, is increasing much faster than the number of producing wells

b The initial production and the routine available production coming in are much lower than for wells that came in five years ago. This is due to the general depletion of existing fields, and the extensive underground drainage from past production

c New fields are not being discovered fast enough to replace the rapidly declining present supplies

d The general shortage of coal for domestic heating in the past and the inevitable continuance of this condition for some time in the future, at least during the period of the war, has placed enormous additional demands for domestic heating on the natural-gas resources where natural gas is now and will be used in lieu of solid fuels for heating homes.

Natural gas is preëminently a domestic fuel. Its high heating value, practically twice that of any manufactured gas available, its purity, and ease in handling make it the premier fuel for home use. While low-grade solid fuels can be efficiently used under steam boilers with proper stoking equipment, they cannot be satisfactorily or efficiently used for house heating. For this reason it is a matter of conservation to use the fuel for domestic service that in the long run will yield the greatest good to the greatest number.

The tests recently made in the Home Economics Department of the Ohio State University on cooking various meals with natural gas, soft coal, coal oil, gasoline and electricity, show conclusively that natural gas is by far the cheapest fuel for the domestic consumer's use for cooking. Thus, in cooking a dinner for six people, the total fuel costs, with natural gas at 40 cents per 1000 cu. ft., soft coal at $6.50 per ton, coal oil at 15 cents per gallon, gasoline at 27 cents per gallon, and electricity at 3 cents per kw-hr., were substantially as follows:

Natural gas	0.88 cents	Electricity	5.0 cents
Soft coal	2.5 cents	Coal oil	5.4 cents
Gasoline	4.6 cents		

The rendering of domestic natural-gas service is a public-utility business. Practically all of the states where natural gas is now produced and sold have public-utility commissions with broad powers in matters of rate regulation and quality of service. The general tendency, and the one that is in accordance with sound public policy, is to give the domestic consumer first preference and curtail the consumption of natural gas for industrial purposes. For the reasons given in the preceding paragraphs, it may be reasonably expected that this tendency will become more marked in the future and public-utility regulations regarding the use of this best of all of nature's fuels for domestic service will become more exacting and ultimately will result in the very great curtailment of the use of natural gas for steam-boiler work and for other industrial purposes.

12 (c) What Is the Relative Economy of the Locomotive of 1900 and Today?

JOHN E. MUHLFELD. The general development of the steam locomotives in use in the United States since 1900 can be best shown by the data in Table 11, which are approximately correct.

SUMMARY OF ECONOMIC FEATURES

Prior to 1900 considerable development work had been done on two-, three- and four-cylinder types of compound locomotives by Mallet, Webb, Pitkin, Mellin, Vauclain and others. Pitkin's two-cylinder system was applied to a Michigan Central 10-wheel locomotive in 1889, and Vauclain's four-cylinder system was first introduced on a Baltimore and Ohio 8-wheel locomotive—No. 848—in October of the same year. These and other developments caused the adoption of both the two- and four-cylinder systems in new locomotives, the maximum application being reached during 1904, when approximately 1,000 two-cylinder, and 2,000 four-cylinder compound locomotives were in existence.

Previous to 1900 Schmidt, Pielock and others had done considerable experimenting with superheated steam, the former having succeeded in 1894 in producing a boiler and motor in which superheated steam of relatively low pressure was used at about 700 deg. fahr.

The failure of the compound locomotive to produce the economy predicted—due largely to the factors of indifferent design, lack of proper maintenance and operation, cheap fuel and road failures—resulted in the general return to the single-expansion cylinder locomotive, and this, with the demand for greater steaming capacity per sq. ft. of boiler heating surface, naturally brought about consideration of the use of superheated steam. The results of further experiments by Vauclain,

[1] Consulting Engineer, Columbus, O. Mem.Am.Soc.M.E.

Vaughn, Horsey, Cole, Emerson, Jacobs and others, along the lines of high and low degrees of superheat, in combination with either high or low steam pressures, by means of smoke-box, fire tube, or a combination of both types of superheaters.

TABLE 11 STEAM LOCOMOTIVES IN THE UNITED STATES SINCE 1900

Year	Item	Single-expansion cylinder	Two-cylinder compound	Four-cylinder compound	Mallet articulated compound	Total locomotives
1900	Number	36,600	1,000	900	..	38,500
	Average tractive power, lb	19,000	28,000	29,000	.	..
	Average wt. on drivers, lb.	85,000	125,000	130,000	..	..
1905	Number[1]	48,949	900	1,800	1	51,650
	Average tractive power, lb.	23,000	31,000	32,000	75,000	..
	Average wt. on drivers, lb.	100,000	140,000	145,000	335,000	..
1910	Number[2]	56,425	875	1,500	200	59,000
	Average tractive power, lb.	27,000	31,500	40,000	72,000	..
	Average wt. on drivers, lb.	120,000	142,000	175,000	320,000	.
1915	Number[3]	62,000	650	1,300	800	64,750
	Average tractive power, lb.	30,500	32,000	33,000	79,000	.
	Average wt. on drivers, lb.	135,000	145,000	148,000	350,000	

[1] Includes 1 superheater locomotive.
[2] Includes 300 superheater and 3000 oil-burning locomotives.
[3] Includes 14,000 superheater aod 4250 oil-burning locomotives.

resulted in the fire-tube type being now practically a standard part of all new equipment, and it is further being rapidly applied to existing saturated-steam locomotives in the United States.

While the Cole and Vauclain balanced compound types of locomotives as brought out since 1900—along the lines of the French De Glehn system—have not made much progress, the Mallet Articulated Compound system, introduced on the Baltimore and Ohio in 1904, is now in use on over fifty railways in the United States, and aggregates more than 1,500 locomotives. This latter type of locomotive not only permits extreme concentration of great power over a flexible wheel base within axle-load limits, but also reduces the stresses by greater distribution and lightness of parts, and through the combination of high-pressure superheating, compounding, simpling and reduction of unbalanced pressure gives the maximum direct and reserve tractive power for from 25 to 35 per cent less fuel and water consumption per ton-mile than a superheated single-expansion locomotive.

Comparison of Steam and Electric Equipment for Railways

With regard to the present status of the relative economy of steam and electric locomotives in the United States, as compared with the results obtained in 1900, general conditions have very substantially changed and the predominating factors today are manual labor and fuel for operation. While the inauguration of the use of fuel oil on almost 4500 steam locomotives has somewhat improved the firing and steam-generation conditions, the increasing cost and demand for oil for more essential purposes and the reducing supply will soon make its use for locomotive fuel prohibitive. However, the use of oil as a locomotive fuel has long since demonstrated that the mechanical feeding and burning of fuel in suspension, whether gaseous, liquid or solid, for the production of steam in a self-contained motive-power unit, is the most logical, successful, effective and economical method for generating power and moving long-haul heavy-tonnage traffic on railways.

Even where hydroelectric power is available the self-contained steam-power-plant locomotive will show a much lower cost for fixed charge, maintenance and operation than the electric unit, as the transmission and conversion of electric current into drawbar hauling capacity is a very wasteful and expensive process in the present state of the electrical art. In fact, the principal economies brought about in the electrical field during the past quarter century have been in the production and use of steam for the generation of current and not in the electrical apparatus.

As applied to a long-haul railway, the metering and conveying of extremely high-voltage current from various power-plant sources into transmission mains, through switching sub-stations, transforming and converting, conveying to contact lines and converting into great hauling capacity at the drawbar results in enormous line and bonding dead losses, which will bring the cost of even hydroelectric current per drawbar horsepower hour to from 6 to 7 mills. This cost, which, in combination with copper limitations, fixed train speeds up and down grades, general tie-up of operation in case of failure, and like factors, will hardly admit of comparison with steam-locomotive boilers operating at equivalent to 700 per cent of the rated capacity of stationary boilers, with a 75 per cent combined furnace, boiler and superheater efficiency, and furnishing a boiler horsepower for each $1\frac{1}{2}$ sq. ft. of evaporating surface and producing a drawbar horsepower-hour for $2\frac{1}{4}$ lb. of coal.

Improvements to be Expected in Steam Locomotives

Nevertheless, the steam locomotive is still in its infancy so far as economy per ton-mile is concerned. The atomization and burning of liquid or solid fuels in suspension will enable the elimination of grates and other metal work from the combustion zone and permit of higher furnace temperatures and more complete and effective combustion, which, in combination with higher steam pressures; compounding; higher superheating of both high- and low-pressure steam; utilization of waste gases and steam for feedwater heating and purification; better boiler-water circulation; reduced cylinder clearances and back pressure; improved steam distribution; lower factor of adhesion; higher percentage of propelling to total weight; less radiation; elimination of unbalanced pressures and weights; application of safety and labor-saving devices, and the greater refinement and perfection of general and detailed design, equipment and control throughout, will yet enable it to produce a drawbar horsepower-hour for one pound of coal.

Steam-Electric Locomotives

Furthermore, it is not inconsistent to now predict that a self-contained steam-electric articulated compound locomotive, combining the advantages of both steam and electric motive power, will shortly find a useful field in services where maximum power and efficiency at high speeds; greater utilization of existing waste heat; high starting and low speed torque and rapid acceleration are required and where an exclusive electrification system would not be permissible from the standpoint of first cost or justified on account of the combined expense for operation and maintenance.

12 (d) What Is the Proportion of Coke Made in By-Product Ovens in the United States?

C. E. Lesher.[1] The proportion of coke (excluding gas-house coke), made in by-product ovens in the United States has increased from 17.1 per cent in 1910 to 40 per cent in 1917. The figures, by years, are as follows:

Year	1910	1911	1912	1913	1914	1915	1916	1917
Per cent	17.1	22.1	25.3	27.5	32.5	33.8	35.0	40.0 (Est.)

The development of the by-product coke industry in the United States up to the close of 1914 was largely the result of the recognition by iron and steel companies of the economies possible by the recovery of by-products and of the flexibility of operation, as well as the assurance of a regular and continual supply of suitable blast-furnace fuel.

Beginning in 1915, and most strikingly so today, the necessity for benzol and toluol for explosives and chemical manufacture has given this industry marked impetus. So urgent are the demands for explosives that the Federal Government is expected to finance the erection of additional by-product ovens this year.

These new by-product plants will continue to be operated after the demand for coke—now abnormal—decreases, with the result that the percentage of by-product coke to the total output in the United States will continue steadily to increase.

W. H. Blauvelt.[1] Preliminary Government estimates place the total coke production for 1917 at 56,600,000 tons, the largest tonnage in the history of the industry. Of this production, 34,000,000 tons, or 60 per cent, was beehive coke, and 22,600,000 tons, or 40 per cent, was by-product coke.

The by-product plants now under construction in the United States will have a capacity of 13,800,000 tons. Not all of these plants now building will be put in operation this year, but the majority of them will, so it seems safe to prophesy that at some time the latter part of this year the production of by-product coke will pass the beehive production. The total capacity of the by-product ovens in the United States now in operation or under construction will be about 40,600,000 tons per annum. This is more than 5,000,000 tons above the maximum production of the beehive industry in 1916, when all of the conditions were favorable to bringing out the greatest possible production from the beehive plants.

12 (e) What Are New and Important Developments in Methods of Burning Coal?

W. W. Jourdin.[2] Aside from cost, the advantages of fuel oil in steam-boiler practice over rough-crushed coal are so manifest that a particularly strong inducement exists at this time of increasing power costs to apply the economic test to coal in this form.

The superior thermal efficiency of gaseous fuels is unquestionable, but commercial success in the manufacture of gas for firing under boilers has not been realized. Coal, when ground so fine that 95 per cent will pass 100 mesh, can be conveyed through pipes over considerable distances as readily, almost, as oil, and combustion will occur in a manner quite analogous to that of gas, provided air be supplied in proper proportion and in intimate contact with the particles of the coal.

That desirable characteristic of oil—easy and complete control of the heating medium to meet variations in steam demand—is inherent to coal in this finely divided state. Better economy is attainable than with coal as commonly fired, since excess air may be kept within narrow limits, and, furthermore, the boiler room is free from heavy storage and handling equipment.

This feature of quick response to variable load conditions cannot be fully appreciated by one whose experience has been confined to stoker equipment. In the plant with which the writer is connected, the excess air is usually maintained within 10 or 12 per cent of theoretical requirements, and with a 50 per cent variation either way from normal load the automatic regulating system will respond so quickly that the extreme variation in steam pressure will be not more than 2 lb. per sq. in., equivalent to 1 per cent of normal. When properly adjusted the damper regulator opens the dampers in time to prevent smoking, in the case of an increase in the rate of firing, or a "clear stack" with a sharp reduction of load.

Steam is the best atomizing agent for oil, but compressed air appears to be most satisfactory for use with powdered coal. All air required for combustion may be compressed by turbo-blowers to a comparatively low pressure, heated by the waste gases, then released in a mixing chamber or burner designed to distribute the charge evenly in the furnace.

The methods used to atomize pulverized coal fall short of requirements since the evaporative efficiency is generally lower, often up to 10 per cent, than obtained with gas or oil. With well-designed apparatus, however, nearly constant oxygen-carbon ratio should obtain over a wide range, and evaporative efficiency need not be less than is developed in the best oil-burning practice.

The grinding and drying equipment should be placed between the boiler plant and coal in storage. The quantity of waste gases to be diverted to the drying plant will depend upon their temperature and the moisture content of the coal. The best performance known to the writer is 4 to 5 lb. of water evaporated per pound of coal used in the dryer; in certain plants the ratio is nearer unity. Therefore, with coals running high in moisture a material saving will be possible by the use of waste gases in the dryer.

A large pulverized-coal plant is being installed in Seattle, where oil is cheap compared to places more remote from the oil fields. If we cannot afford to burn oil, let us weigh carefully the possibility of utilizing this fine substitute.

[1] U. S. Geological Survey, Washington. Published by permission of the Director.

[2] Chief Engineer, Power Plant, Inspiration Consolidated Copper Co., Miami, Ariz. Mem.Am.Soc.M.E.

[1] Consulting Engineer, Semet-Solvay Company, Syracuse, N. Y.

12 (f) What Economies Have Resulted from Recent Practice in Making Brick Settings Leakless?

Albert A. Cary. The remarkably low flue-gas temperatures frequently reported from boiler tests are generally due to air leakage through boiler settings or at flue connections. A number of boiler tests which I have made were conducted in such a manner as to determine these losses and I will therefore give the results of three or four of these tests from which can be appreciated the gain in efficiency that would result if the air leakage were suppressed.

1 Two horizontal tubular boilers of the same size and located in the same plant, with settings supposed to be identical, gave the following results by taking samples of gas simultaneously from the rear end of the furnace chamber and just inside the flue outlet:

	Boiler *A*	Boiler *B*
Excess of air found in the furnace..	70 per cent	49 per cent
Excess of air found at the flue outlet.	103 per cent	71 per cent

These results clearly show how worthless the gas analysis taken at the flue outlet really is, as an indication of the conditions of combustion in the furnace.

Turning now to temperature readings taken just inside of the flue outlet, a nitrogen-filled thermometer, with proper corrections applied, showed that the temperatures of gases escaping from the boiler settings were as follows:

Boiler *A*	Boiler *B*
543 deg. fahr.	482 deg. fahr.

By making corrections for the chilling effect of the infiltrating air, we find that had there been no air leakage through the boiler settings, the temperature of these escaping gases would have shown, with Boiler *A*, 607 deg. fahr., and with Boiler *B*, 562 deg. fahr.

The actual loss in efficiency due to air leakage in these two boilers was as follows: Boiler *A*, 1.73 per cent; Boiler *B*, 2.13 per cent.

The losses occurring in these cases principally were due to the chilling effect of the cold entering air alone, as it was found that practically all of the air leakage occurred beyond the furnace and combustion chambers. A correction of the gas analysis taken at the flue outlet, making allowance for the increased air supply, shows practically the same results as were obtained in the samples of gas taken from the combustion chamber.

2 I will next refer to two interesting tests made with a water-tube boiler having its heating surface widely distributed, and requiring a setting about double the size of a normal setting. It was equipped with stationary grates and hand-fired. One test was conducted at the rated capacity of the boiler, while the second was a forcing test.

During the non-forcing test, I found that the average excess air in the *furnace* was 45.05 per cent, while the excess air found in the escaping gases, just inside of the flue outlet, was 95.79 per cent. There was an unusually high loss in the combined efficiency of the boiler and furnace operation due to air leakage through the masonry; namely, 4.63 per cent.

The average combustion, during this test, was 20.87 lb. of dry coal per sq. ft. of grate.

During a subsequent forcing test, when 40.15 lb. of dry coal was burned per sq. ft. of grate under forced blast, the entire chamber enclosing the boiler was under pressure so that the furnace gases actually blew out through cracks in the masonry and thus we had a case of gas leakage outward.

There is no necessity for employing extraordinary means to obtain tight boiler settings. Long experience has taught me that the material we have been employing for years, if properly selected and properly erected in place, will produce a setting that for all practical purposes is tight and can easily be made to remain tight for years.

It is the duty of every engineer who is called upon to install boiler settings to study the stresses and strains that occur in boiler masonry the same as he is supposed to do in other designing work and he must also study the widely varying qualities of the various materials used so as to make and secure a proper selection. Extreme expansion and contraction are constantly occurring in nearly every part of a boiler setting and they must be properly provided for. The interior of a furnace wall may be subjected to a temperature of 2000 deg. and running upwards to nearly 3000 deg. fahr., while its exterior is sometimes subjected to a freezing temperature.

What can we expect but disintegration, cracking or distortion, if provision is not made to meet these conditions? With bridge walls or arches heated to very high temperatures and expanding against the side walls, how can we expect such walls to withstand such pressures without cracking unless provision is made to relieve or prevent such thrusts by proper arrangement of supporting beams, buck stays, pockets in masonry, or other means properly applied?

The average mason knows little or nothing about laying up firebrick work and bonding it properly into the red-brick exterior, and yet this most important matter is often left to such men. I always make it a practice to specify exactly how this work should be done.

The market is filled with most undesirable material for boiler setting and if proper refractory material, red brick, mortar, fireclay or high temperature cement is not distinctly specified, the poor client simply buys his trouble and adds to his maintenance account, when he has such unsuitable material dumped into his boiler setting.

Proper provisions must be made for relining furnace interiors without damaging other parts of the setting. Provision must be made for supporting the boiler securely and for taking care of the expansion and contraction of the boiler itself and the greatest care must be exercised to provide ample foundations which will not settle.

12 (h) Is Automatic Air Supply Correctly Proportioned to Coal Supply Possible?

M. C. M. Hatch. Theoretically, such control of the supply of air necessary for combustion would seem to be desirable. There is a certain amount of excess air which, for a given furnace design, method of firing and nature of fuel, will give

the best results, and this excess, expressed as *percentage*, will be constant throughout the entire range of fuel rates, from lowest to highest.

Accurate control of the air for any method of burning coal on grates, either by hand or by stoker firing, is more or less difficult and may be, and probably is, impossible under many conditions. The comparative sluggishness of furnace action with coal thus fired to respond to rapid variation in load on the boiler and the fact that grates will clinker or ash over, changing the air-inlet area under the fire, account in large measure for the difficulties encountered, and these faults would seem to be inherent in grate firing.

Coal burned in pulverized form offers a chance for development work along the line of positive air control. There is no change of air-inlet area to the furnace caused, automatically, by slagging or ash deposits. The excess air necessary can be readily determined and is materially less, on account of intimate mixture, than in other methods of burning coal, hence, for a given fuel rate, the total amount of air to be controlled is reduced. The flexibility of the furnace, by which is meant its ability to respond almost instantaneously to varying demands upon the boiler, is very pronounced, and this again simplifies the problem.

Pulverized coal, fed by carefully-designed screws which give practically constant delivery per unit revolution for all feeds, affords ideal conditions for standardization work in furnace operation. It is entirely possible, although there has as yet been no attempt made to place such an arrangement on a commercial basis, that the position of the main boiler damper and of the dampers in the induced-air pipes may be synchronized with the feed-screw revolutions in such a way as to insure constant air-excess percentage at all furnace outputs.

12 (l) Miscellaneous—School Heating, Insulation, Smoke Prevention

J. H. Brady[1] contributes a report made by him to the Board of Directors of the School District of Kansas City, Mo. This report is given in great detail and is extremely valuable. It contains a tabulated statement for 1916-17, showing the cost per cubic foot for heating the buildings of the school district.

There are 88 public buildings having a total cubic contents of 32,300,000 cu. ft. and an average per building of 367,000 cu. ft. More than half the buildings contain over 250,000 cu. ft. of space and several are much larger. The cost of fuel for all the buildings averaged 3.1 mills per cu. ft. The figures given in the report include the fuel furnished the custodians of the buildings for their residences, except in the case of seven buildings. In what follows is a brief summary of the conclusions:

Grouping the buildings according to the type of heating plant used gives the following results:

Group No. 1, steam hot blast, using fuel oil, average cost 3.5 mills per cu. ft.

Group No. 2, direct radiation, using fuel oil, average cost 3.6 mills per cu. ft.

Group No. 3, steam hot blast, using coal for fuel, average cost 2.8 mills per cu. ft.

Group No. 4, direct radiation, using coal, average cost 2.9 mills per cu. ft.

Group No. 5, frame and brick buildings heated by stoves, average cost 4.1 mills per cu. ft.

Group No. 6, schools heated by hot-air furnaces, using coal, average cost 3.6 mills per cu. ft.

Contrasting two of the buildings, the writer states:

"Central High School shows a cost of 2.7 mills per cu. ft. while Northeast shows a cost of 2.5 mills per cu. ft. The cubic contents of Northeast High is greater than Central High, and the difference in the cost per cu. ft. for heating the two buildings is, in my opinion, due to the fact that Central High has metal frames and sash while Northeast has wooden frames and sash, and the leakage of air or wind around metal sash is greater than with wooden sash. Both these buildings use coal for fuel. As a rule the high cost of heating certain buildings is caused by metal frames and sash, while in other buildings it is due to poor construction, taking into account their age, etc."

Another point is the fact that where mechanical ventilation, or what is known as hot blast fan system, using coal for fuel, is installed, the cost for heating per cu. ft., is less on an average than the others, being 2.8 mills.

The fact that the figures for schools equipped with mechanical ventilation run less than for those not so equipped may be attributed to automatic temperature control. The highest cost per cu. ft. is shown where stoves are used for heating, being 4.1 mills.

[1] Chief Engineer and Supt. of Buildings, The School District of Kansas City, Mo. Mem. Am.Soc.M.E.

G. D. Bagley.[1] The insulation of heated surfaces to conserve radiation and convection losses often does not receive the attention which it deserves. Such insulation is necessary regardless of the purpose of the installation or the method of heating. Coverings of the proper thickness and material applied to power plants, chemical plants, heating systems, etc., result in a large saving in coal and a high rate of return on the investment.

The losses from such surfaces range from 2 to 10 B.t.u. per sq. ft. per hour per deg. fahr. temperature difference, at the temperatures at which steam is used and amount to 300 tons of coal per year for every 1000 sq. ft. of exposed surface at 100 lb. steam pressure.

The Mellon Institute of Industrial Research has been engaged for some time in making a study of heat insulating materials for the Magnesia Association of America, and in order to check up the results of the laboratory work under practical conditions a set of tests was made on a boiler before and after covering with magnesia.

The tests were made at a mine at Bruceton, Pa., in conjunction with the Bureau of Smoke Regulation of the City of Pittsburgh. The two boilers used in the tests were of the locomotive type, 60 and 80 hp., fire tubes and single pass. They were installed on concrete piers without coverings. The total uncovered surface was 675 sq. ft. and the average pressure 80 lb. per sq. in.

Each test covered a period of 24 hours. The firing was under the supervision of the Bureau of Smoke Regulation in order to have it as consistent and regular as possible. The coking method was used, firing the coal in the front of the furnace, leaving the fire door open for a short time after each firing, and breaking the coal back as it coked. This method of

[1] Mellon Institute, Pittsburgh, Pa.

procedure resulted in nearly smokeless combustion of the fuel.

During the first test, 10,784 lb. of coal were used and 58,000 lb. of water were evaporated. This corresponds to a rate of 6.35 lb. of water from and at 212 deg. fahr. per lb. of coal as fired.

After the first test was completed, the boiler was covered with 1½ in. of magnesia blocks, and plastered with magnesia cement and a coat of hard-finish cement for protection, making a total thickness of about 2 in. The boiler test was then repeated, taking great care to hold the load at the same values as during the first test, and to keep all other conditions the same.

In the second test, 59,500 lb. of water were evaporated and 9296 lb. of coal consumed, giving a rate of 7.55 lb. of water from and at 212 deg. fahr. per lb. of coal as fired and a saving of 1488 lb. of coal per day.

If calculated for an equal water evaporation, the saving would be 1700 lb. of coal. It seemed much easier to hold a nearly uniform pressure after the boilers were covered and this probably accounts for the excess of the measured saving over that calculated, as the coal was burned more uniformly and the boiler efficiency was higher.

The saving in coal as shown by this test amounted to about 15 per cent of the coal originally burned. The per cent saving will vary with the amount of exposed surfaces in proportion to the capacity of the boilers. The losses shown by the test are those due to heat loss from the boiler alone and do not take into account the losses from the pipe lines which cause condensation and wet steam in addition to wasting coal.

The tests show that the losses from uninsulated surfaces are large enough to amount to a very considerable factor in the total coal consumption of the country, and to warrant every one who is interested in the conservation of fuel in seeing that all surfaces, however small, are properly insulated.

Victor J. Azbe. In regard to smoke prevention, if we would base our studies upon furnace volume, gas velocity, composition of volatile matter, and take into consideration eddies and whirls, dead space, etc., we soon would have information enough collected to design furnaces for any type boiler and any fuel so smoke would not be produced. That most furnaces are built upon unscientific principles can be shown by a study of gas flow with a fairly accurate anemometer in a cold boiler when the damper is open.

PROGRESS REPORT OF COMMITTEE ON LIMITS AND TOLERANCES IN SCREW THREAD FITS

To the Council of The American Society of Mechanical Engineers:

The Committee on Limits and Tolerances in Screw Thread Fits was assigned by the Council of The American Society of Mechanical Engineers the task "to prescribe the permissible tolerances in the commercial manufacture of taps, dies, bolts, nuts, and screws, including the method of measuring of the same."

During the years following the appointment of this committee, many meetings have been held, and work has been done through sub-committees, involving a great amount of investigation and study.

Methods of Investigation

Careful study has been given to data already published and assistance has been secured from the U. S. Bureau of Standards, The Franklin Institute, the Navy Department, and from other sources.

A request sent to many tap makers for confidential information showing the limits allowed for their commercial work, led to a response by a number of leading manufacturers, giving such information. This was tabulated and compared. Later, some of the tap makers assisted by having over 4000 taps of commercial sizes from $\frac{1}{4}$ in. to 2 in., secured from a number of different makers, measured for errors in lead, in order to obtain the average variation of commercial taps which are in use today.

Early in the investigation, a meeting of screw manufacturers and users was called at the headquarters of The American Society of Mechanical Engineers in New York, at which about forty representatives were present, and the matter of tolerances and limits in screws was thoroughly discussed in the light of a tentative report which this committee had prepared. This meeting resulted in the appointment of a sub-committee, consisting of Messrs. E. H. Ehrman of the Chicago Screw Company, E. A. Darling of the Draper Company, and C. B. Young, engineer of tests of the Pennsylvania Railroad Company, to coöperate with the general committee by obtaining data from the screw manufacturers.

Through this committee, and the officers of the A.S.M.E., over 5000 screws were obtained from the regular commercial stock of many different manufacturers, these representing work of various grades and sizes, and with cut and rolled threads. These screws were measured and the results tabulated.

Sample screws and nuts were prepared having varying degrees of error in diameter and lead, and from these it was determined what would be the maximum error allowable, and charts were made to show the relation of taps and screws measured to these allowable limits.

Sample gages were also made to a closer limit than those now proposed by the committee, in order to learn how close it was practicable to make commercial work. These gages were distributed without stating what the allowance was in order that the users might not be prejudiced by thinking the limits were closer than they could work to.

Comparisons have also been made with the allowances and tolerances recommended by the British Engineering Standards Committee.

The recommendations of the report are the outcome of all this study and investigation.

While separate diagrams have not been provided for manufacturers' standards and users' or consumers' standards, it is expected that manufacturers will aim to work within the zones established by the diagrams so as to produce work that will come within these limits; and that gages will be so made as to insure this result.

Allowances to be provided for are wear of tools and unavoidable imperfection of workmanship.

Gaging Systems

The gaging tools required *for the threaded hole* are:

- *a* Threaded "go" plug of a length equal to the longest engagement of work
- *b* Threaded "not go" plug, made short and with clearance for full and root diameters;

and *for bolt or screw:*

- *a* Threaded "go" ring of a length equal to the longest engagement of work
- *b* Threaded "not go" ring made short and with clearance for full and root diameters.

The study given to gaging systems has led to the conclusion that no one system is best adapted to all needs; and that for a variety of work made in moderate quantities a gage for measuring errors of diameter and lead combined in the same instrument may give the best results, while for manufacturing in large quantities a fixed gage for one size only and having separate means for measuring errors in diameter and lead may be best.

There is also the need in many cases of master gages, inspection gages and workman's gages, each so made as to suit the particular needs.

A number of designs of gages for these various purposes have been submitted to 40 prominent manufacturers and users, and following their recommendations selections have been made which are illustrated and described in this report.[1]

The illustrations, Figs. 9 to 17, give general suggestions only of what it is recommended to use as it would require too voluminous a report to fully cover the ground.

Tables for Limits and Tolerances

It is believed that eventually three grades should be established, to cover not only general work, such as is here provided, but also that of more restricted and more liberal tolerances. This report deals with limits and tolerances for general work only.

Tables covering medium-grade work for general use have been prepared for diameters from $\frac{1}{4}$ in. to 2 in. but the formulæ can be used for sizes beyond this range. They can also be used for different numbers of threads for a given diameter within ordinary range, provided the thread is of the U. S. S. form.

The variations which affect the fit between screw and nut

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[1] Reference can also be made to Report No. 38 on British Standards for Limit Gages for Screw Threads.

are those of diameter, lead, including length of engaged thread, and angle of thread, besides others of a minor character, such as the crookedness of tap, the condition of its cutting edge, the kind of metal being tapped, etc. The first three of these variations have been definitely taken into consideration in the tables included in this report, and it is believed that the allowance is sufficient to provide also for the other variations mentioned, unless they are extreme.

The effect of errors of lead on the quality of fit is proportional to the length of fit; but the effect of this is modified by the error in pitch diameter. Thus, if a tap, for example, is materially oversize, it can have a greater error of lead than would be the case if it were nearer to the standard size, and

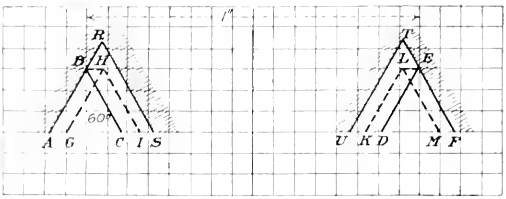


FIG. 1 EFFECT OF VARIATION IN LEAD

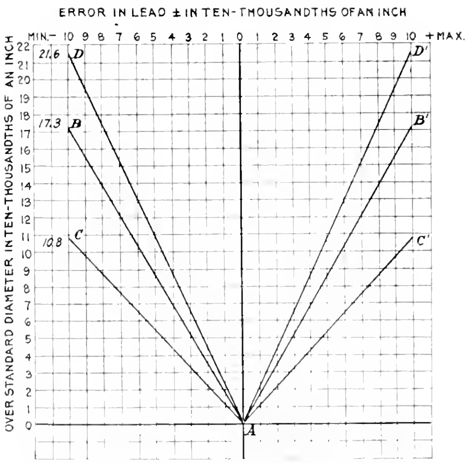


FIG. 2 EFFECT OF VARIATION IN LENGTH OF FIT BETWEEN SCREW AND NUT

still give satisfactory results in use, because the error in lead counteracts the increased diameter of the tapped hole to an extent dependent on the length of fit in the tapped hole.

The available variations, when the length of fit is not in excess of one diameter, are shown by the triangular zones of Tables 1 to 18. They are such that any screw having a diameter and error of lead which would come within such zones would enter any tapped hole which would also pass like inspection in the zone established for holes; and the extremes which would pass inspection as to looseness would not be so loose but that they would be considered mechanically satisfactory for general work.

The zones in Tables 1 to 18, as has been stated, are based on the engagement between screw and tapped hole with a length of fit equal to one diameter. If the length of fit is greater than one diameter there is a possibility of interference in *extreme cases* such as where a screw having the longest allowable lead is screwed into a hole of a depth greater than one diameter of screw, which has been tapped with a tap having the shortest allowable lead.

Under these conditions, however, unless the length considerably exceeds $1\frac{1}{2}$ diameters of the screw, the flow or distortion of metal when forced by the wrench will allow the parts to be screwed together. Actual tests made under the direction of the committee show this to be so. After the first engagement, where the fit might seem unduly tight it would be materially easier,—in fact, for many uses it would be better than a shaky fit even if within the prescribed limits.

For this reason it is believed that taps, nuts and screws passing inspection within these limits, even where it is not known what length of thread may be required in actual use, can be used with the expectation that the work will be interchangeable even when the length of engagement is greater than one diameter, although theoretically there might be the interference in lead above pointed out. The keeping within the prescribed limits would be a radical improvement over the variations of taps and screws in general use today, because of a common standard serving as a "bull's-eye" at which all would aim.

If in any case it should be important to entirely avoid interference in lead, the narrower zones shown by the triangles for the larger-sized screws having a length equal to the length of fit between screw and nut to be used, will show the limiting zone. This method can be used in any case where greater accuracy is desired, and is further explained in the last three paragraphs under the heading How to Use the Tables. The plan here submitted is based on having the maximum screws basic in pitch, outside and root diameters.

Generally stated, all tapped holes should be above basic standard and all screws, below; the more above or below in pitch diameter the greater the allowance possible in error of lead, while still maintaining a satisfactory fit.

In Tables 1 to 18 the figures for taps are held to a limit slightly above the largest allowable screws to provide for wear of the tap, the greatest allowance being made at perfect lead where a reduction in diameter due to wear would be most objectionable. In applying the tables and diagrams to the use of fixed gages, a rectangle representing a given maximum and minimum in pitch diameter and a given error in lead within the triangular zone can be established. Work failing to pass inspection with such gages can be then measured for diameter and lead, and if coming within the triangular zone even though outside the limits of the gages need not be thrown out but can be accepted for use.

CHARTS AND TABLES FOR LIMITS AND TOLERANCES SHOWN IN TABLES 1 TO 18, INCLUSIVE

When a screw or nut has an error in lead, the amount of that error varies directly as the length of thread on screw or depth of threaded hole, i.e., the longer the screw or the deeper the hole, the greater the total error in lead; and where a definite quality of fit between a screw and nut is desired, less error in lead per inch can be allowed for a long thread than for a short one.

In these tables and charts, therefore, the length of thread is made the governing feature and any chart applies equally well to a screw or nut of any diameter or pitch, for the length of thread specified.

The limits for the lengths of threads as adopted and shown

by the charts are 0 for the minimum limit and once the nominal diameter of U. S. S. thread for the maximum limit. In this way each chart is especially applicable to a definite size and becomes a standard for that size between the lengths of thread specified.

Another factor in the fit between a screw and nut is the pitch diameter measured on the "V" of the thread. For a 60-deg. thread of a *given length* the error in pitch diameter bears a definite relation to the error in lead.

This is illustrated in Fig. 1 where *ABC* and *DEF* represent two threads 1 in. apart on a standard thread gage. Let *GHI* and *KLM* represent two actual spaces cut by a tap of the same pitch diameter with an error in lead equal to *BH* and *LE*. Then the stock *ABHG* and *LMEF* would interfere with the entrance of the threaded gage. But if the tap was increased in radius by the amount *RH*, its lead remaining the same, then it would cut the spaces *ARS* and *UTF* and the thread gage would enter full length and bear along the surfaces *AB* and *FE*.

From this it follows that to obtain a fit for a definite length of thread the pitch diameter can be made to compensate for any error in lead within reasonable limits.

This relation between the pitch diameter and lead, when *plotted* on the chart, becomes a straight line.

In Fig. 2 a tap or screw with perfect lead and pitch diameter would fall at the intersection of the two zero lines at *A* and, we will assume, would cut a perfect thread for a threaded hole 1 in. deep, i.e., a hole in which a standard threaded plug gage would fit.

Another tap having an error in lead of 0.0010 in. per inch

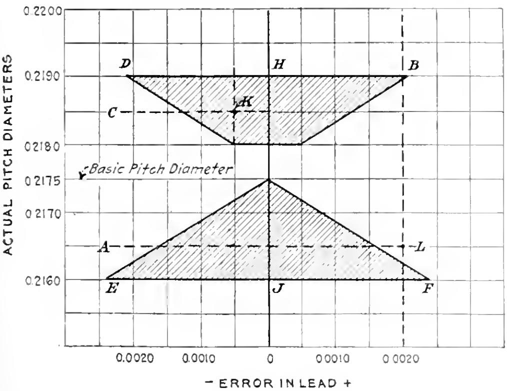


Fig. 3 Diagram Illustrating Method of Using Charts Shown in Tables 1 to 18

but having an increased pitch diameter of 0.00173 in. would fall at *B'* and for a hole 1 in. deep would be the equivalent of the first tap. If two nuts 1 in. thick were tapped one with each of these taps, a standard threaded plug gage when clear through the nut would fit with equal shake in both nuts.

The line *AB'* passing through zero represents *all* oversize threads 1 in. long with a long or plus lead that are equivalent to a standard or perfect thread. The line *AB* similarly represents *all* oversize threads 1 in. long with a short or minus lead.[1]

The lines *AC* and *AC'* represent taps equivalent to standard for threads 5/8 in. long and *AD* and *AD'* for threads 1.25 in. long, the amounts over standard for *CC'* and *DD'* being respectively 5/8 and $1\frac{1}{4}$ times *B* (17.3) for a lead error of 0.001 in.

The oblique lines on the charts, Tables 1 to 18, are similar lines for the maximum length of thread specified in the table

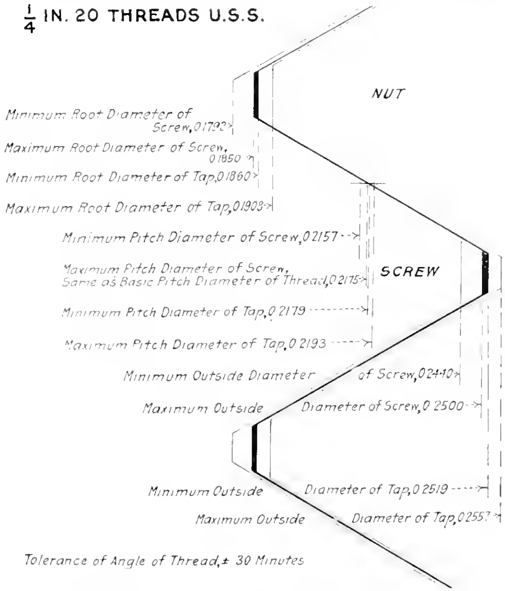


Fig. 4 Relation of Screw and Nut, Showing Maximum and Minimum Allowances

alongside of each chart. For screws these lines pass through zero and represent equivalents of perfect screws. For taps and nuts these lines pass through a point slightly above the zero point in order to keep all taps and nuts slightly over standard.

In Fig. 3, the points *HJ* where the upper and lower lines intersect the perfect lead line, represent the extreme limits for the pitch diameters of a nut and screw with perfect lead, and the distance between these two points represents the maximum diametrical shake between any nut and screw falling within the shaded areas or zones of the chart, while the average shake would be about one-half of this maximum shake.

It is assumed that a tap makes a hole the exact counterpart of itself, therefore taps and nuts are referred to as having identically the same pitch diameter and lead.

How to Use the Tables

For a Tap:

a Find the actual pitch diameter of the tap with a "V"-thread micrometer. Look in left-hand column at the bottom of the table for taps for the required size (Tables 1 to 18) for this diameter. If the diameter is less than the first figure or greater than the last figure of the column, the tap is not within the limits required.

b When the diameter is found in the table, read to the right in the next column the amount it is *over basic* pitch diameter. Read again to the right in the third column the allowable "errors in lead" for this pitch diameter.

[1] The shorter the length of thread the more nearly horizontal this line becomes, and for a zero length of thread it becomes horizontal, coinciding with the horizontal zero line *OA*. Similarly the greater the length of thread the more nearly vertical this line becomes.

$\frac{1}{4}$ (0250) INCH 20 THREADS U.S.S.
BASIC PITCH DIAMETER 0 2175
Outside and Root Measurements

	FOR A TAP OR NUT FLAT ON BOTTOM OF THREAD SAME AS 18 PITCH TOOL= [illegible]		U S S BASIC SIZES	FOR A SCREW OR BOLT FLAT AT ROOT OF THREAD SAME AS 22 PITCH TOOL=0 0057	
	MIN	MAX		MAX	MIN
OUTSIDE DIAMETER	0 2519	0 2557	0 2500	0 2500	0 2440
ROOT "	0 1867	0 1877	0 1850	0 1850	0 1792

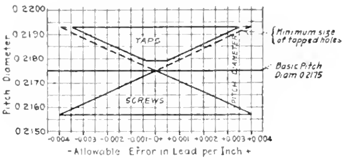
LIMITS ON PITCH DIAMETER AT PERFECT LEAD

TAP	TAPPED HOLE	CLEARANCE		SCREW OR BOLT
		TAP	HOLE	
MAX 0 2193	MAX 0 2193	0 0035	0 0035	0 2157 MIN
MIN 0 2179	MIN 0 2175	0 0004	0 0000	0 2175 MAX

Tolerance for Thread Angle ± 30 Minutes

CHART AND TABLE FOR TAPS, NUTS, SCREWS ETC. WITH LENGTH OF THREAD ENGAGEMENT 0 TO $\frac{1}{4}$ INCH (ONCE THE DIAM.)

NOTE In Practice these can be recommended for length of thread engagement to one and one half diam's ($\frac{3}{8}$") because of the partial rectifying of errors in lead by "flow of metal" see Pars 24 and 25



ALLOWABLE ERROR IN LEAD PER INCH
FOR ACTUAL PITCH DIAMETER

FOR A TAP OR TAPPED HOLE
READ FROM LEFT TO RIGHT

ACTUAL PITCH DIAM	AMOUNT OVER BASIC	ALLOWABLE ERROR IN LEAD PER INCH	
		TAP	TAPPED HOLE
0 2179	0 0004	± 0 0005	± 0 0009
0 2180	0 0005	± 0 0007	± 0 0011
0 2185	0 0010	± 0 0018	± 0 0022
0 2190	0 0015	± 0 0029	± 0 0033
0 2193	0 0018	± 0 0035	± 0 0040

FOR A SCREW OR BOLT
READ FROM RIGHT TO LEFT

ALLOWABLE ERROR IN LEAD PER INCH	AMOUNT UNDER BASIC	ACTUAL PITCH DIAM
0 0000	0 0000	0 2175
±0 0012	0 0005	0 2170
±0 0022	0 0010	0 2165
±0 0033	0 0015	0 2160
±0 0040	0 0018	0 2157

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TABLE 1

$\frac{5}{16}$ (0.3125) INCH 18 THREADS U.S.S.
BASIC PITCH DIAMETER 0.2764
Outside and Root Measurements

	FOR A TAP OR NUT FLAT ON BOTTOM OF THREAD SAME AS 16 PITCH TOOL=0 0078		U S S BASIC SIZES	FOR A SCREW OR BOLT FLAT AT ROOT OF THREAD SAME AS 20 PITCH TOOL=0 0062	
	MIN	MAX		MAX	MIN
OUTSIDE DIAMETER	0 3144	0 3186	0 3125	0 3125	0 3069
ROOT "	0 2414	0 2464	0 2403	0 2403	0 2342

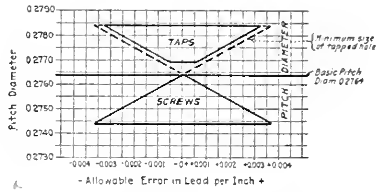
LIMITS ON PITCH DIAMETER AT PERFECT LEAD

TAP	TAPPED HOLE	CLEARANCE		SCREW OR BOLT
		TAP	HOLE	
MAX 0 2784	MAX 0 2784	0 0040	0 0040	0 2744 MIN
MIN 0 2769	MIN 0 2764	0 0005	0 0000	0 2764 MAX

Tolerance for Thread Angle ± 30 Minutes

CHART AND TABLE FOR TAPS, NUTS, SCREWS ETC. WITH LENGTH OF THREAD ENGAGEMENT, 0 TO $\frac{5}{16}$ INCH (ONCE THE DIAM.)

NOTE In practice these can be recommended for length of thread engagement to one and one half diam's ($\frac{15}{32}$") because of the partial rectifying of errors in lead by "flow of metal" see Pars 24 and 25



ALLOWABLE ERROR IN LEAD PER INCH
FOR ACTUAL PITCH DIAMETER

FOR A TAP OR TAPPED HOLE
READ FROM LEFT TO RIGHT

ACTUAL PITCH DIAM	AMOUNT OVER BASIC	ALLOWABLE ERROR IN LEAD PER INCH	
		TAP	TAPPED HOLE
0 2769	0 0005	± 0 0006	± 0 0010
0 2770	0.0006	± 0 0008	± 0 0011
0 2775	0 0011	± 0 0016	± 0 0021
0 2780	0 0016	± 0 0025	± 0 0030
0 2784	0 0020	± 0 0033	± 0 0037

FOR A SCREW OR BOLT
READ FROM RIGHT TO LEFT

ALLOWABLE ERROR IN LEAD PER INCH	AMOUNT UNDER BASIC	ACTUAL PITCH DIAM
± 0 0000	0 0000	0 2764
± 0 0008	0 0004	0 2760
± 0 0017	0 0009	0 2755
± 0 0027	0 0014	0 2750
± 0 0037	0 0019	0 2744

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TABLE 2

$\frac{3}{8}$ (0.375) INCH 16 THREADS U.S.S
BASIC PITCH DIAMETER 0 3344
Outside and Root Measurements

	FOR A TAP OR NUT FLAT ON BOTTOM OF THREAD SAME AS 14 PITCH TOOL=0 0089		U S S BASIC SIZES	FOR A SCREW OR BOLT FLAT AT ROOT OF THREAD SAME AS 18 PITCH TOOL=0 0069	
	MIN	MAX		MAX	MIN
OUTSIDE DIAMETER	0 3770	0 3815	0 3750	0 3750	0 3677
ROOT "	0 2949	0 3001	0 2936	0 2936	0 2871

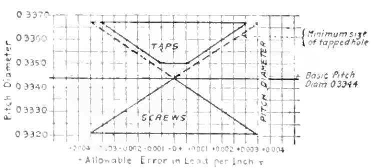
LIMITS ON PITCH DIAMETER AT PERFECT LEAD

TAP	TAPPED HOLE	CLEARANCE		SCREW OR BOLT
		TAP	HOLE	
MAX 0 3367	MAX 0 3367	0 0046	0 0046	0 3321 MIN
MIN 0 3347	MIN 0 3344	0 0003	0 0003	0 3344 MAX

Tolerance for Thread Angle ± 30 Minutes

CHART AND TABLE FOR TAPS, NUTS, SCREWS ETC. WITH LENGTH OF THREAD ENGAGEMENT, 0 TO $\frac{3}{8}$ INCH (ONCE THE DIAM.)

NOTE: In practice these can be recommended for length of thread engagement to one and one half diam's ($\frac{9}{16}$") because of the partial rectifying of errors in lead by "flow of metal" see Pars 24 and 25



ALLOWABLE ERROR IN LEAD PER INCH
FOR ACTUAL PITCH DIAMETER

FOR A TAP OR TAPPED HOLE
READ FROM LEFT TO RIGHT

ACTUAL PITCH DIAM	AMOUNT OVER BASIC	ALLOWABLE ERROR IN LEAD PER INCH	
		TAP	TAPPED HOLE
0 3350	0 0006	± 0 0005	± 0 0009
0 3355	0 0011	± 0 0013	[illegible]
0 3360	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	± 0 0028	± 0 0032
[illegible]	[illegible]	[illegible]	± 0 0035

FOR A SCREW OR BOLT
READ FROM RIGHT TO LEFT

ALLOWABLE ERROR IN LEAD PER INCH	AMOUNT UNDER BASIC	ACTUAL PITCH DIAM
± 0 0000	0 0000	0 3344
± 0 000[illegible]	0 0004	0 3340
± 0 0014	0 0009	0 3335
± 0 00[illegible]	0 0014	0 3330
± 0 0024	0 0019	0 3325
± 0 003[illegible]	[illegible]23	0 3321

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TABLE 3

$\frac{7}{16}$ (0.4375) INCH 14 THREADS U.S.S.
BASIC PITCH DIAMETER 0.3911
Outside and Root Measurements

	FOR A TAP OR NUT FLAT ON BOTTOM OF THREAD SAME AS 13 PITCH TOOL=0 0096		U S S BASIC SIZES	FOR A SCREW OR BOLT FLAT AT ROOT OF THREAD SAME AS 16 PITCH TOOL=0 0078	
	MIN	MAX.		MAX.	MIN
OUTSIDE DIAMETER	0 4396	0 4444	0 4375	0 4375	0 4292
ROOT "	0 3461	0 3516	0 3447	0 3447	0 3378

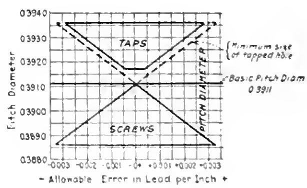
LIMITS ON PITCH DIAMETER AT PERFECT LEAD

TAP	TAPPED HOLE	CLEARANCE		SCREW OR BOLT
		TAP	HOLE	
MAX 0 3936	MAX 0 3936	0 0050	0.0050	0 3886 MIN
MIN 0.3917	MIN 0.3911	0 0006	0 0000	0 3911 MAX

Tolerance for Thread Angle ± 30 Minutes

CHART AND TABLE FOR TAPS, NUTS, SCREWS ETC. WITH LENGTH OF THREAD ENGAGEMENT, 0 TO $\frac{7}{16}$ INCH (ONCE THE DIAM.)

NOTE: In practice these can be recommended for length of thread engagement to one and one half diam's ($\frac{21}{32}$") because of the partial rectifying of errors in lead by "flow of metal" see Pars 24 and 25



ALLOWABLE ERROR IN LEAD PER INCH
FOR ACTUAL PITCH DIAMETER

FOR A TAP OR TAPPED HOLE
READ FROM LEFT TO RIGHT

ACTUAL PITCH DIAM	AMOUNT OVER BASIC	ALLOWABLE ERROR IN LEAD PER INCH	
		TAP	TAPPED HOLE
0 3917	0 0006	±0 0004	±0 0008
0 3920	0 0009	±0 0008	±0 0012
0 3925	0 0014	±0 0015	±0 0019
0 3930	0 0019	±0 0021	±0 0025
0 3935	0 0024	±0 00[illegible]	±0 0032
0 3936	0 0025	±0 00[illegible]3	±0 0033

FOR A SCREW OR BOLT
READ FROM RIGHT TO LEFT

ALLOWABLE ERROR IN LEAD PER INCH	AMOUNT UNDER BASIC	ACTUAL PITCH DIAM
±0 0000	0 0000	0 3911
±0 0008	0 0006	0 3905
±0 0015	0 0011	0 3900
±0 0021	0 0016	0.3895
±0 0028	0.0021	0 3890
±0 0033	0 0025	0 3886

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TABLE 4

$\frac{1}{2}$ (0.500) INCH 13 THREADS U.S.S.
BASIC PITCH DIAMETER 0.4501

Outside and Root Measurements

	FOR A TAP OR NUT FLAT ON BOTTOM OF THREAD SAME AS 12 PITCH TOOL = 0.0104		U S S BASIC SIZES	FOR A SCREW OR BOLT FLAT AT ROOT OF THREAD SAME AS 14 PITCH TOOL = 0.0089	
	MIN	MAX		MAX	MIN
OUTSIDE DIAMETER	0.5021	0.5073	0.5000	0.5000	0.4911
ROOT "	0.4016	0.4074	0.4001	0.4001	0.3928

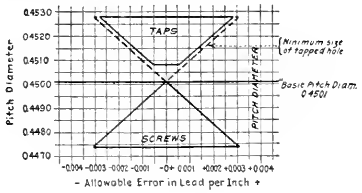
LIMITS ON PITCH DIAMETER AT PERFECT LEAD

TAP	TAPPED HOLE	CLEARANCE TAP	CLEARANCE HOLE	SCREW OR BOLT
MAX 0.4528	MAX 0.4528	0.0054	0.0054	0.4474 MIN
MIN 0.4508	MIN 0.4501	0.0007	0.0000	0.4501 MAX

Tolerance for Thread Angle ± 30 Minutes

CHART AND TABLE FOR TAPS, NUTS, SCREWS ETC. WITH LENGTH OF THREAD ENGAGEMENT, 0 TO $\frac{1}{2}$ INCH (ONCE THE DIAM.)

NOTE In practice these can be recommended for length of thread engagement to one and one half diam's ($\frac{3}{4}$") because of the partial rectifying of errors in lead by "flow of metal" see Pars 24 and 25.



ALLOWABLE ERROR IN LEAD PER INCH FOR ACTUAL PITCH DIAMETER

FOR A TAP OR TAPPED HOLE — READ FROM LEFT TO RIGHT

ACTUAL PITCH DIAM	AMOUNT OVER BASIC	ALLOWABLE ERROR IN LEAD PER INCH: TAP	ALLOWABLE ERROR IN LEAD PER INCH: TAPPED HOLE
0.4508	0.0007	±0.0006	±0.0008
0.4510	0.0009	±0.0009	±0.0010
0.4515	0.0014	±0.0013	±0.0016
0.4520	0.0019	±0.0020	±0.0022
0.4526	0.0024	±0.0025	±0.0028
0.4528	0.0027	±0.0028	±0.0031

FOR A SCREW OR BOLT — READ FROM RIGHT TO LEFT

ALLOWABLE ERROR IN LEAD PER INCH	AMOUNT UNDER BASIC	ACTUAL PITCH DIAM
±0.0000	0.0000	0.4501
±0.0007	0.0006	0.4495
±0.0019	0.0011	0.4490
±0.0018	0.0016	0.4485
±0.0024	0.0021	0.4480
±0.0030	0.0026	0.4475
±0.0031	0.0027	0.4474

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TABLE 5

$\frac{9}{16}$ (0.5625) INCH 12 THREADS U.S.S.
BASIC PITCH DIAMETER 0.5084

Outside and Root Measurements

	FOR A TAP OR NUT FLAT ON BOTTOM OF THREAD SAME AS 11 PITCH TOOL = 0.0114		U S S BASIC SIZES	FOR A SCREW OR BOLT FLAT AT ROOT OF THREAD SAME AS 13 PITCH TOOL = 0.0096	
	MIN	MAX		MAX	MIN
OUTSIDE DIAMETER	0.5646	0.5701	0.5625	0.5625	0.5530
ROOT "	0.4559	0.4618	0.4542	0.4542	0.4466

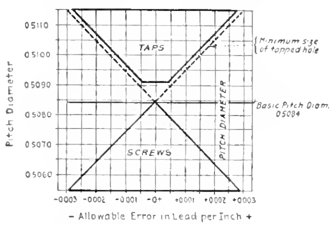
LIMITS ON PITCH DIAMETER AT PERFECT LEAD

TAP	TAPPED HOLE	CLEARANCE TAP	CLEARANCE HOLE	SCREW OR BOLT
MAX 0.5112	MAX 0.5112	0.0056	0.0056	0.5056 MIN
MIN 0.5091	MIN 0.50'4	0.0007	0.0000	0.5084 MAX

Tolerance for Thread Angle ± 30 Minutes

CHART AND TABLE FOR TAPS, NUTS, SCREWS ETC WITH LENGTH OF THREAD ENGAGEMENT, 0 TO $\frac{9}{16}$ INCH (ONCE THE DIAM.)

NOTE In practice these can be recommended for length of thread engagement to one and one half diam's ($\frac{27}{32}$") because of the partial rectifying of errors in lead by "flow of metal" see Pars 24 and 25



ALLOWABLE ERROR IN LEAD PER INCH FOR ACTUAL PITCH DIAMETER

FOR A TAP OR TAPPED HOLE — READ FROM LEFT TO RIGHT

ACTUAL PITCH DIAM	AMOUNT OVER BASIC	ALLOWABLE ERROR IN LEAD PER INCH: TAP	ALLOWABLE ERROR IN LEAD PER INCH: TAPPED HOLES
0.5091	0.0007	±0.0005	±0.0007
0.5095	0.0011	±0.0009	±0.0011
0.5100	0.0016	±0.0014	±0.0016
0.5105	0.0021	±0.0019	±0.0022
0.5110	0.0026	±0.0025	±0.0027
0.5113	0.0033	±0.0027	±0.0029

FOR A SCREW OR BOLT — READ FROM RIGHT TO LEFT

ALLOWABLE ERROR IN LEAD PER INCH	AMOUNT UNDER BASIC	ACTUAL PITCH DIAM
±0.0000	0.0000	0.5084
±0.0004	0.0004	0.5080
±0.0010	0.0009	0.5075
±0.0016	0.0014	0.5070
±0.0020	0.0019	0.5065
±0.0025	0.0024	0.5060
±0.0029	0.0029	0.5055

TABLE 6

$\frac{5}{8}$ (0.625) INCH 11 THREADS U.S.S.
BASIC PITCH DIAMETER 0.5660

Outside and Root Measurements

	FOR A TAP OR NUT FLAT ON BOTTOM OF THREAD SAME AS 10 PITCH TOOL = 0.0125		U S S BASIC SIZES	FOR A SCREW OR BOLT FLAT AT ROOT OF THREAD SAME AS 12 PITCH TOOL = 0.0104	
	MIN	MAX		MAX	MIN
OUTSIDE DIAMETER	0.6272	0.6330	0.6250	0.6250	0.6147
ROOT "	0.5087	0.5148	0.5069	0.5069	0.4990

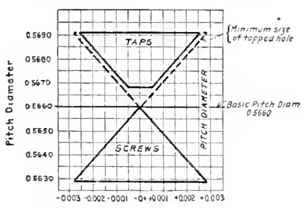
LIMITS ON PITCH DIAMETER AT PERFECT LEAD.

TAP	TAPPED HOLE	CLEARANCE TAP	CLEARANCE HOLE	SCREW OR BOLT
MAX 0.5691	MAX 0.5691	0.0062	0.0062	0.5629 MIN
MIN 0.5668	MIN 0.5660	0.0008	0.0000	0.5660 MAX

Tolerance for Thread Angle ± 15 Minutes

CHART AND TABLE FOR TAPS, NUTS, SCREWS ETC. WITH LENGTH OF THREAD ENGAGEMENT, 0 TO $\frac{5}{8}$ INCH (ONCE THE DIAM.)

NOTE: In practice these can be recommended for length of thread engagement to one and one half diam's ($\frac{15}{16}$") because of the partial rectifying of errors in lead by "flow of metal" see Pars 24 and 25.



ALLOWABLE ERROR IN LEAD PER INCH FOR ACTUAL PITCH DIAMETER

FOR A TAP OR TAPPED HOLE — READ FROM LEFT TO RIGHT

ACTUAL PITCH DIAM.	AMOUNT OVER BASIC	ALLOWABLE ERROR IN LEAD PER INCH: TAP	ALLOWABLE ERROR IN LEAD PER INCH: TAPPED HOLE
0.5668	0.0008	±0.0006	±0.0008
0.5670	0.0010	±0.0008	±0.0009
0.5675	0.0015	±0.0012	±0.0014
0.5680	0.0020	±0.0016	±0.0018
0.5685	0.0025	±0.0021	±0.0023
0.5690	0.0030	±0.0025	±0.0027
0.5691	0.0031	±0.0026	±0.0028

FOR A SCREW OR BOLT — READ FROM RIGHT TO LEFT

ALLOWABLE ERROR IN LEAD PER INCH	AMOUNT UNDER BASIC	ACTUAL PITCH DIAM
0.0000	0.0000	0.5660
±0.0005	0.0005	0.5655
±0.0009	0.0010	0.5650
±0.0014	0.0015	0.5645
±0.0018	0.0020	0.5640
±0.0023	0.0025	0.5635
±0.0027	0.0030	0.5630
±0.0028	0.0031	0.5629

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TABLE 7

$\frac{3}{4}$ (0.750) INCH 10 THREADS U.S.S.
BASIC PITCH DIAMETER 0.6851

Outside and Root Measurements

	FOR A TAP OR NUT FLAT ON BOTTOM OF THREAD SAME AS 9 PITCH TOOL = 0.0139		U S S BASIC SIZES	FOR A SCREW OR BOLT FLAT AT ROOT OF THREAD SAME AS 11 PITCH TOOL = 0.0114	
	MIN	MAX		MAX	MIN
OUTSIDE DIAMETER	0.7522	0.7585	0.7500	0.7500	0.7387
ROOT "	0.6221	0.6284	0.6201	0.6201	0.6118

LIMITS ON PITCH DIAMETER AT PERFECT LEAD

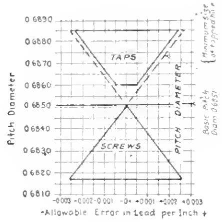
TAP	TAPPED HOLE	CLEARANCE TAP	CLEARANCE HOLE	SCREW OR BOLT
MAX 0.6885	MAX 0.6885	0.0068	0.0068	0.6817 MIN
MIN 0.6860	MIN 0.6851	0.0009	0.0000	0.6851 MAX

Tolerance for Thread Angle ± 15 Minutes

CHART AND TABLE FOR TAPS, NUTS, SCREWS ETC. WITH LENGTH OF THREAD ENGAGEMENT, 0 TO $\frac{3}{4}$ INCH (ONCE THE DIAM.)

NOTE In practice these can be recommended for length of thread engagement to one and one half diam's ($1\frac{1}{8}$") because of the partial rectifying of errors in lead by "flow of metal" see Pars 24 and 25

ALLOWABLE ERROR IN LEAD PER INCH FOR ACTUAL PITCH DIAMETER



FOR A TAP OR TAPPED HOLE — READ FROM LEFT TO RIGHT

ACTUAL PITCH DIAM	AMOUNT OVER BASIC	ALLOWABLE ERROR IN LEAD PER INCH: TAP	ALLOWABLE ERROR IN LEAD PER INCH: TAPPED HOLE
0.6860	0.0009	±0.0005	±0.0007
0.6865	0.0014	±0.0009	±0.0011
0.6870	0.0019	±0.0012	±0.0015
0.6875	0.0024	±0.0016	±0.0018
0.6880	0.0029	±0.0020	±0.0022
0.6885	0.0034	±0.0024	±0.0026

FOR A SCREW OR BOLT — READ FROM RIGHT TO LEFT

ALLOWABLE ERROR IN LEAD PER INCH	AMOUNT UNDER BASIC	ACTUAL PITCH DIAM
0.0000	0.0000	0.6851
±0.0005	0.0006	0.6845
±0.0009	0.0011	0.6840
±0.0012	0.0016	0.6835
±0.0016	0.0021	0.6830
±0.0020	0.0026	0.6825
±0.0024	0.0031	0.6820
±0.0026	0.0034	0.6817

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TABLE 8

$\frac{7}{8}$ (0.875) INCH 9 THREADS U.S.S.

BASIC PITCH DIAMETER 0.8029

Outside and Root Measurements

	FOR A TAP OR NUT FLAT ON BOTTOM OF THREAD SAME AS 8 PITCH TOOL=0.0156		USS BASIC SIZES	FOR A SCREW OR BOLT FLAT AT ROOT OF THREAD SAME AS 10 PITCH TOOL=0.0125	
	MIN	MAX		MAX	MIN
OUTSIDE DIAMETER	0.8773	0.8840	0.8750	0.8750	0.8625
ROOT "	0.7329	0.7395	0.7307	0.7307	0.7219

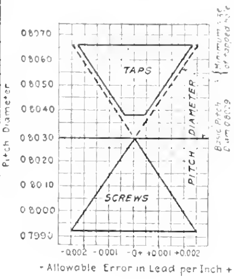
LIMITS ON PITCH DIAMETER AT PERFECT LEAD

TAP	TAPPED HOLE	CLEARANCE TAP	CLEARANCE HOLE	SCREW OR BOLT
MAX 0.8066	MAX 0.8066	0.0054	0.0054	0.8012 MIN
MIN 0.8038	MIN 0.8029	0.0009	0.0000	0.8029 MAX

Tolerance for Thread Angle ± 15 Minutes

CHART AND TABLE FOR TAPS, NUTS, SCREWS ETC. WITH LENGTH OF THREAD ENGAGEMENT, 0 TO $\frac{7}{8}$ INCH (ONCE THE DIAM.)

NOTE In practice these can be recommended for length of thread engagement to one and one half diam's ($1\frac{5}{16}$) because of the partial rectifying of errors in lead by "flow of metal" see Pars 24 and 25



ALLOWABLE ERROR IN LEAD PER INCH FOR ACTUAL PITCH DIAMETER

FOR A TAP OR TAPPED HOLE READ FROM LEFT TO RIGHT

ACTUAL PITCH DIAM	AMOUNT OVER BASIC	ALLOWABLE ERROR IN LEAD PER INCH TAP	ALLOWABLE ERROR IN LEAD PER INCH TAPPED HOLE
0.8039	0.0009	±0.0004	±0.0006
0.8040	0.0011	±0.0005	±0.0008
0.8045	0.0016	±0.0009	±0.0011
0.8050	0.0021	±0.0012	±0.0015
0.8055	0.0026	±0.0016	±0.0018
0.8060	0.0031	±0.0019	±0.0021
0.8065	0.0036	±0.0022	±0.0024
0.8066	0.0037	±0.0023	±0.0025

FOR A SCREW OR BOLT READ FROM RIGHT TO LEFT

ALLOWABLE ERROR IN LEAD PER INCH	AMOUNT UNDER BASIC	ACTUAL PITCH DIAM
±0.0000	0.0000	0.8029
±0.0003	0.0004	0.8025
±0.0006	0.0009	0.8020
±0.0010	0.0014	0.8015
±0.0013	0.0019	0.8010
±0.0016	0.0024	0.8005
±0.0020	0.0029	0.8000
±0.0023	0.0034	0.7995
±0.0025	0.0037	0.7992

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TABLE 9

1 INCH 8 THREADS U.S.S.

BASIC PITCH DIAMETER 0.9188

Outside and Root Measurements

	FOR A TAP OR NUT FLAT ON BOTTOM OF THREAD SAME AS 7 PITCH TOOL=0.0179		USS BASIC SIZES	FOR A SCREW OR BOLT FLAT AT ROOT OF THREAD SAME AS 9 PITCH TOOL=0.0139	
	MIN	MAX		MAX	MIN
OUTSIDE DIAMETER	1.0023	1.0092	1.0000	1.0000	0.9961
ROOT "	0.8401	0.8469	0.8376	0.8376	0.8283

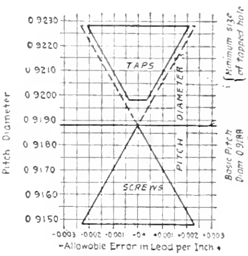
LIMITS ON PITCH DIAMETER AT PERFECT LEAD

TAP	TAPPED HOLE	CLEARANCE TAP	CLEARANCE HOLE	SCREW OR BOLT
MAX 0.9228	MAX 0.9228	0.0080	0.0080	0.9148 MIN
MIN 0.9198	MIN 0.9188	0.0010	0.0000	0.9188 MAX

Tolerance for Thread Angle ± 15 Minutes

CHART AND TABLE FOR TAPS, NUTS, SCREWS ETC. WITH LENGTH OF THREAD ENGAGEMENT, 0 TO 1 INCH (ONCE THE DIAM.)

NOTE: In practice these can be recommended for length of thread engagement to one and one half diam's ($1\frac{1}{2}$) because of the partial rectifying of errors in lead by "flow of metal" see Pars 24 and 25.



ALLOWABLE ERROR IN LEAD PER INCH FOR ACTUAL PITCH DIAMETER

FOR A TAP OR TAPPED HOLE READ FROM LEFT TO RIGHT

ACTUAL PITCH DIAM	AMOUNT OVER BASIC	ALLOWABLE ERROR IN LEAD PER INCH TAP	ALLOWABLE ERROR IN LEAD PER INCH TAPPED HOLE
0.9198	0.0010	±0.0004	±0.0006
0.9200	0.0012	±0.0005	±0.0007
0.9205	0.0017	±0.0008	±0.0010
0.9210	0.0022	±0.0011	±0.0013
0.9215	0.0027	±0.0014	±0.0016
0.9220	0.0032	±0.0017	±0.0019
0.9225	0.0037	±0.0019	±0.0022
0.9228	0.0040	±0.0021	±0.0023

FOR A SCREW OR BOLT READ FROM RIGHT TO LEFT

ALLOWABLE ERROR IN LEAD PER INCH	AMOUNT UNDER BASIC	ACTUAL PITCH DIAM
0.0000	0.0000	0.9188
±0.0002	0.0003	0.9185
±0.0005	0.0008	0.9180
±0.0008	0.0013	0.9175
±0.0010	0.0018	0.9170
±0.0013	0.0023	0.9165
±0.0016	0.0028	0.9160
±0.0019	0.0033	0.9155
±0.0022	0.0038	0.9150
±0.0023	0.0040	0.9148

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TABLE 10

$1\frac{1}{8}$ (1.125) INCH 7 THREADS U.S.S.

BASIC PITCH DIAMETER 1.0322

Outside and Root Measurements

	FOR A TAP OR NUT FLAT ON BOTTOM OF THREAD SAME AS 6 PITCH TOOL=0.0208		USS BASIC SIZES	FOR A SCREW OR BOLT FLAT AT ROOT OF THREAD SAME AS 8 PITCH TOOL=0.0156	
	MIN	MAX		MAX	MIN
OUTSIDE DIAMETER	1.1274	1.1347	1.1250	1.1250	1.1093
ROOT "	0.9422	0.9494	0.9394	0.9394	0.9294

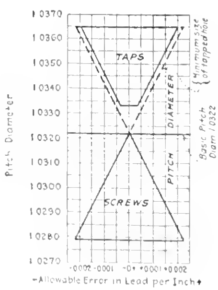
LIMITS ON PITCH DIAMETER AT PERFECT LEAD

TAP	TAPPED HOLE	CLEARANCE TAP	CLEARANCE HOLE	SCREW OR BOLT
MAX 1.0365	MAX 1.0365	0.0086	0.0086	1.0279 MIN
MIN 1.0333	MIN 1.0322	0.0011	0.0000	1.0322 MAX

Tolerance for Thread Angle ± 15 Minutes

CHART AND TABLE FOR TAPS, NUTS, SCREWS ETC. WITH LENGTH OF THREAD ENGAGEMENT, 0 TO $1\frac{1}{8}$ INCH (ONCE THE DIAM.)

NOTE In practice these can be recommended for length of thread engagement to one and one half diam's ($1\frac{11}{16}$) because of the partial rectifying of errors in lead by "flow of metal" see Pars 24 and 25



ALLOWABLE ERROR IN LEAD PER INCH FOR ACTUAL PITCH DIAMETER

FOR A TAP OR TAPPED HOLE READ FROM LEFT TO RIGHT

ACTUAL PITCH DIAM	AMOUNT OVER BASIC	ALLOWABLE ERROR IN LEAD PER INCH TAP	ALLOWABLE ERROR IN LEAD PER INCH TAPPED HOLE
1.0333	0.0011	±0.0004	±0.0006
1.0336	0.0013	±0.0005	±0.0007
1.0340	0.0018	±0.0007	±0.0009
1.0345	0.0023	±0.0010	±0.0012
1.0350	0.0028	±0.0012	±0.0014
1.0355	0.0033	±0.0015	± 0017
1.0360	0.0038	±0.0018	±0.0020
1.0365	0.0043	±0.0020	±0.0022

FOR A SCREW OR BOLT READ FROM RIGHT TO LEFT

ALLOWABLE ERROR IN LEAD PER INCH	AMOUNT UNDER BASIC	ACTUAL PITCH DIAM
±0.0000	0.0000	1.0322
±0.0004	0.0007	1.0315
±0.0006	0.0012	1.0310
±0.0009	0.0017	1.0305
±0.0011	0.0022	1.0300
±0.0014	0.0027	1.0295
±0.0016	0.0032	1.0290
±0.0019	0.0037	1.0285
±0.0021	0.0042	1.0280
±0.0022	0.0043	1.0279

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TABLE 11

$1\frac{1}{4}$ (1.250) INCH 7 THREADS U.S.S.

BASIC PITCH DIAMETER 1.1572

Outside and Root Measurements

	FOR A TAP OR NUT FLAT ON BOTTOM OF THREAD SAME AS 6 PITCH TOOL=0.0208		USS BASIC SIZES	FOR A SCREW OR BOLT FLAT AT ROOT OF THREAD SAME AS 8 PITCH TOOL=0.0156	
	MIN	MAX		MAX.	MIN.
OUTSIDE DIAMETER	1.2524	1.2605	1.2500	1.2500	1.2343
ROOT "	1.0673	1.0744	1.0644	1.0644	1.0544

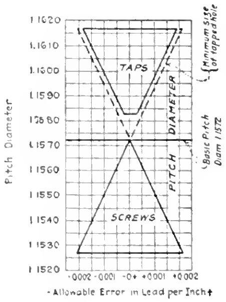
LIMITS ON PITCH DIAMETER AT PERFECT LEAD

TAP	TAPPED HOLE	CLEARANCE TAP	CLEARANCE HOLE	SCREW OR BOLT
MAX 1.1617	MAX 1.1617	0.0090	0.0090	1.1527 MIN.
MIN 1.1583	MIN. 1.1572	0.0011	0.0000	1.1572 MAX

Tolerance for Thread Angle ± 15 Minutes

CHART AND TABLE FOR TAPS, NUTS, SCREWS ETC. WITH LENGTH OF THREAD ENGAGEMENT, 0 TO $1\frac{1}{4}$ INCH (ONCE THE DIAM.)

NOTE: In practice these can be recommended for length of thread engagement to one and one half diam's ($1\frac{7}{8}$) because of the partial rectifying of errors in lead by "flow of metal" see Pars 24 and 25



ALLOWABLE ERROR IN LEAD PER INCH FOR ACTUAL PITCH DIAMETER

FOR A TAP OR TAPPED HOLE READ FROM LEFT TO RIGHT

ACTUAL PITCH DIAM	AMOUNT OVER BASIC	ALLOWABLE ERROR IN LEAD PER INCH TAP	ALLOWABLE ERROR IN LEAD PER INCH TAPPED HOLE
1.1583	0.0011	±0.0003	±0.0005
1.1585	0.0013	±0.0004	±0.0006
1.1590	0.0018	±0.0006	±0.0008
1.1595	0.0023	±0.0009	±0.0011
1.1600	0.0028	±0.0011	±0.0013
1.1605	0.0033	±0.0013	±0.0015
1.1610	0.0038	±0.0016	±0.0018
1.1615	0.0043	±0.0018	±0.0020
1.1617	0.0045	±0.0019	±0.0021

FOR A SCREW OR BOLT READ FROM RIGHT TO LEFT

ALLOWABLE ERROR IN LEAD PER INCH	AMOUNT UNDER BASIC	ACTUAL PITCH DIAM
±0.0000	0.0000	1.1572
±0.0003	0.0007	1.1565
±0.0006	0.0012	1.1560
±0.0008	0.0017	1.1555
±0.0010	0.0022	1.1550
±0.0013	0.0027	1.1545
±0.0015	0.0032	1.1640
±0.0017	0.0037	1.1535
±0.0020	0.0042	1.1530
±0.0021	0.0045	1.1527

TABLE 12

$1\frac{3}{8}$ (1.375) INCH 6 THREADS U.S.S.

BASIC PITCH DIAMETER 1.2668

Outside and Root Measurements

	FOR A TAP OR NUT FLAT ON BOTTOM OF THREAD SAME AS $5\frac{1}{2}$ PITCH TOOL = 0.0227		U.S.S. BASIC SIZES	FOR A SCREW OR BOLT FLAT AT ROOT OF THREAD SAME AS 7 PITCH TOOL = 0.0179	
	MIN	MAX		MAX	MIN
OUTSIDE DIAMETER	1.3777	1.3865	1.3750	1.3750	1.3568
ROOT "	1.1618	1.1695	1.1585	1.1585	1.1475

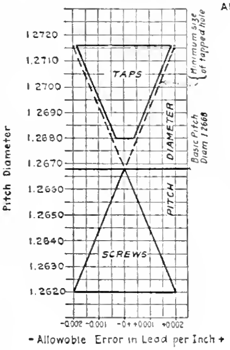
LIMITS ON PITCH DIAMETER AT PERFECT LEAD

TAP	TAPPED HOLE	CLEARANCE		SCREW OR BOLT
		TAP	HOLE	
MAX 1.2716	MAX 1.2716	0.0096	0.0096	1.2620 MIN
MIN 1.2680	MIN 1.2688	0.0012	0.0000	1.2668 MAX

Tolerance for Thread Angle ± 15 Minutes

CHART AND TABLE FOR TAPS, NUTS, SCREWS ETC. WITH LENGTH OF THREAD ENGAGEMENT 0 TO $1\frac{3}{8}$ INCH (ONCE THE DIAM.)

NOTE: In Practice these can be recommended for length of thread engagement to one and one half diam's ($2\frac{1}{16}$") because of the partial rectifying of errors in lead by "flow of metal" see Pars 24 and 25.



ALLOWABLE ERRORS IN LEAD PER INCH FOR ACTUAL PITCH DIAMETER

FOR A TAP OR A TAPPED HOLE — READ FROM LEFT TO RIGHT

ACTUAL PITCH DIAM.	AMOUNT OVER BASIC	ALLOWABLE ERROR IN LEAD PER INCH	
		TAP	TAPPED HOLE
1.2680	0.0012	±0.0004	±0.0005
1.2685	0.0017	±0.0006	±0.0007
1.2690	0.0022	±0.0008	±0.0009
1.2695	0.0027	±0.0010	±0.0011
1.2700	0.0032	±0.0012	±0.0014
1.2705	0.0037	±0.0014	±0.0016
1.2710	0.0042	±0.0016	±0.0018
1.2715	0.0047	±0.0018	±0.0020
1.2716	0.0048	±0.0019	±0.0020

FOR A SCREW OR BOLT — READ FROM RIGHT TO LEFT

ALLOWABLE ERROR IN LEAD PER INCH	AMOUNT UNDER BASIC	ACTUAL PITCH DIAM.
±0.0000	0.0000	1.2668
±0.0003	0.0008	1.2660
±0.0005	0.0013	1.2655
±0.0007	0.0018	1.2650
±0.0010	0.0023	1.2645
±0.0012	0.0028	1.2640
±0.0014	0.0033	1.2635
±0.0016	0.0038	1.2630
±0.0018	0.0043	1.2625
±0.0020	0.0048	1.2620

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TABLE 13

$1\frac{1}{2}$ (1.500) INCH 6 THREADS U.S.S.

BASIC PITCH DIAMETER 1.3918

Outside and Root Measurements

	FOR A TAP OR NUT FLAT ON BOTTOM OF THREAD SAME AS $5\frac{1}{2}$ PITCH TOOL = 0.0227		U.S.S. BASIC SIZES	FOR A SCREW OR BOLT FLAT AT ROOT OF THREAD SAME AS 7 PITCH TOOL = 0.0179	
	MIN	MAX		MAX	MIN
OUTSIDE DIAMETER	1.5024	1.5115	1.5000	1.5000	1.4818
ROOT "	1.2868	1.2944	1.2835	1.2835	1.2726

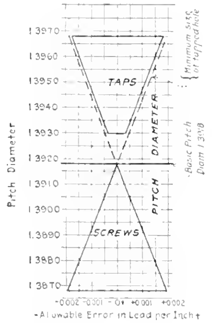
LIMITS ON PITCH DIAMETER AT PERFECT LEAD.

TAP	TAPPED HOLE	CLEARANCE		SCREW OR BOLT
		TAP	HOLE	
MAX 1.3968	MAX 1.3968	0.0100	0.0100	1.3868 MIN
MIN 1.3931	MIN 1.3918	0.0013	0.0000	1.3918 MAX

Tolerance for Thread Angle ± 15 Minutes

CHART AND TABLE FOR TAPS, NUTS, SCREWS ETC. WITH LENGTH OF THREAD ENGAGEMENT, 0 TO $1\frac{1}{2}$ INCH (ONCE THE DIAM.)

NOTE: In practice these can be recommended for length of thread engagement to one and one half diam's ($2\frac{1}{4}$") because of the partial rectifying of errors in lead by "flow of metal" see Pars 24 and 25



ALLOWABLE ERROR IN LEAD PER INCH FOR ACTUAL PITCH DIAMETER

FOR A TAP OR TAPPED HOLE — READ FROM LEFT TO RIGHT

ACTUAL PITCH DIAM	AMOUNT OVER BASIC	ALLOWABLE ERROR IN LEAD PER INCH	
		TAP	TAPPED HOLE
1.3930	0.0012	±0.0004	±0.0005
1.3940	0.0022	±0.0008	±0.0009
1.3950	0.0032	±0.0011	±0.0012
1.3960	0.0040	±0.0015	±0.0016
1.3968	0.0050	±0.0018	±0.0019

FOR A SCREW OR BOLT — READ FROM RIGHT TO LEFT

ALLOWABLE ERROR IN LEAD PER INCH	AMOUNT UNDER BASIC	ACTUAL PITCH DIAM
±0.0000	0.0000	1.3918
±0.0003	0.0008	1.3910
±0.0007	0.0018	1.3900
±0.0011	0.0028	1.3890
±0.0014	0.0038	1.3880
±0.0018	0.0048	1.3870
±0.0019	0.0050	1.3868

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TABLE 14

$1\frac{5}{8}$ (1.625) INCH $5\frac{1}{2}$ PITCH U.S.S.

BASIC PITCH DIAMETER 1.5069

Outside and Root Measurements

	FOR A TAP OR NUT FLAT ON BOTTOM OF THREAD SAME AS 5 PITCH TOOL = 0.0250		U.S.S. BASIC SIZES	FOR A SCREW OR BOLT FLAT AT ROOT OF THREAD SAME AS 6 PITCH TOOL = 0.0208	
	MIN.	MAX.		MAX	MIN
OUTSIDE DIAMETER	1.6275	1.6375	1.6250	1.6250	1.6053
ROOT "	1.3924	1.4003	1.3888	1.3888	1.3773

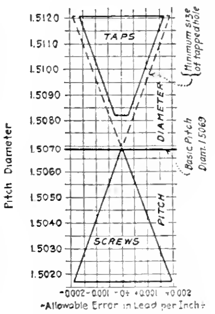
LIMITS ON PITCH DIAMETER AT PERFECT LEAD

TAP	TAPPED HOLE	CLEARANCE		SCREW OR BOLT
		TAP	HOLE	
MAX 1.5121	MAX 1.5121	0.0104	0.0104	1.5017 MIN
MIN 1.5082	MIN. 1.5069	0.0013	0.0000	1.5069 MAX

Tolerance for Thread Angle ± 15 Minutes

CHART AND TABLE FOR TAPS, NUTS, SCREWS ETC. WITH LENGTH OF THREAD ENGAGEMENT, 0 TO $1\frac{5}{8}$ INCH (ONCE THE DIAM.)

NOTE: In practice these can be recommended for length of thread engagement to one and one half diam's ($2\frac{7}{16}$") because of the partial rectifying of errors in lead by "flow of metal" see Pars 24 and 25.



ALLOWABLE ERROR IN LEAD PER INCH FOR ACTUAL PITCH DIAMETER

FOR A TAP OR TAPPED HOLE — READ FROM LEFT TO RIGHT

ACTUAL PITCH DIAM.	AMOUNT OVER BASIC	ALLOWABLE ERROR IN LEAD PER INCH	
		TAP	TAPPED HOLE
1.5082	0.0013	±0.0003	±0.0005
1.5090	0.0021	±0.0006	±0.0008
1.5100	0.0031	±0.0009	±0.0011
1.5110	0.0041	±0.0013	±0.0015
1.5120	0.0051	±0.0016	±0.0019
1.5121	0.0052	±0.0017	±0.0019

FOR A SCREW OR BOLT — READ FROM RIGHT TO LEFT

ALLOWABLE ERROR IN LEAD PER INCH	AMOUNT UNDER BASIC	ACTUAL PITCH DIAM.
±0.0000	0.0000	1.5069
±0.0004	0.0009	1.5060
±0.0007	0.0019	1.5050
±0.0011	0.0029	1.5040
±0.0014	0.0039	1.5030
±0.0018	0.0049	1.5020
±0.0019	0.0052	1.5017

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TABLE 15

$1\frac{3}{4}$ (1.750) INCH 5 THREADS U.S.S.

BASIC PITCH DIAMETER 1.6201

Outside and Root Measurements

	FOR A TAP OR NUT FLAT ON BOTTOM OF THREAD SAME AS $4\frac{1}{2}$ PITCH TOOL = 0.0278		U.S.S. BASIC SIZES	FOR A SCREW OR BOLT FLAT AT ROOT OF THREAD SAME AS $5\frac{1}{2}$ PITCH TOOL = 0.0227	
	MIN	MAX		MAX	MIN
OUTSIDE DIAMETER	1.7525	1.7630	1.7500	1.7500	1.7284
ROOT "	1.4942	1.5024	1.4902	1.4902	1.4780

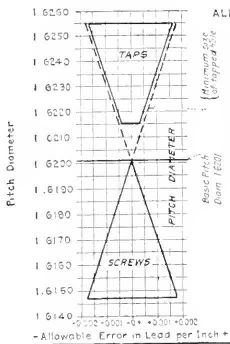
LIMITS ON PITCH DIAMETER AT PERFECT LEAD

TAP	TAPPED HOLE	CLEARANCE		SCREW OR BOLT
		TAP	HOLE	
MAX 1.6256	MAX 1.6256	0.0109	0.0109	1.6147 MIN
MIN 1.6215	MIN 1.6201	0.0014	0.0000	1.6201 MAX

Tolerance for Thread Angle ± 15 Minutes

CHART AND TABLE FOR TAPS, NUTS, SCREWS ETC. WITH LENGTH OF THREAD ENGAGEMENT, 0 TO $1\frac{3}{4}$ INCH (ONCE THE DIAM.)

NOTE: In practice these can be recommended for length of thread engagement to one and one half diam's ($2\frac{5}{8}$") because of the partial rectifying of errors in lead by "flow of metal" see Pars 24 and 25.



ALLOWABLE ERROR IN LEAD PER INCH FOR ACTUAL PITCH DIAMETER

FOR A TAP OR TAPPED HOLE — READ FROM LEFT TO RIGHT

ACTUAL PITCH DIAM	AMOUNT OVER BASIC	ALLOWABLE ERROR IN LEAD PER INCH	
		TAP	TAPPED HOLE
1.6215	0.0014	±0.0004	±0.0005
1.6225	0.0024	±0.0007	±0.0008
1.6235	0.0034	±0.0010	±0.0011
1.6245	0.0044	±0.0014	±0.0015
1.6255	0.0054	±0.0017	±0.0018

FOR A SCREW OR BOLT — READ FROM RIGHT TO LEFT

ALLOWABLE ERROR IN LEAD PER INCH	AMOUNT UNDER BASIC	ACTUAL PITCH DIAM
0.0000	0.0000	1.6201
±0.0002	0.0006	1.6195
±0.0005	0.0016	1.6185
±0.0009	0.0026	1.6175
±0.0012	0.0036	1.6165
±0.0016	0.0046	1.6155
±0.0018	0.0054	1.6147

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TABLE 16

c Next find the actual error in lead per inch with some lead-measuring instrument. If the actual error is within the limits given in the third column, then the tap is correct for both pitch diameter and lead.

Example: For 1/4 in., 20 thread tap, for threads from 0 to 1/4 in. long, refer to Table 1 and under "For a Tap or Nut." Suppose the pitch diameter of a tap is 0.2185 in. Find this figure in the first column; to the right the next column shows the tap as 0.0010 in. over basic pitch diameter, and the third column shows that its lead must be between 0.0018 in. fine (minus) to 0.0018 in. coarse (plus) per inch to be within the limits of this table.

For a Screw:

d Find the actual pitch diameter of the screw with a "V"-thread micrometer. Look in the last column at the bottom of the table for screws for the required size (Tables 1 to 18) for this diameter. If the diameter is less than the first figure or greater than the last figure in the column, the screw is not within the limits required.

e When the diameter is found, read to the left in the next column to the left the amount that it is *under basic* pitch diameter. Read again in the third column to the left the allowable error in lead for this pitch diameter.

f Next find the actual error in lead per inch with some lead-measuring instrument. If the actual error is within the limits given in the third column to the left, then the screw is correct for both pitch diameter and lead.

Example: For 1/4 in., 20 thread screw, for threads from 0 to 1/4 in. long refer to Table 1, and under "For a Screw or Bolt." Suppose the pitch diameter of a screw is 0.2160 in. Find this figure in the last column; the next column to the left shows the screw as 0.0015 in. under basic pitch diameter, and the third column to the left shows that its lead must be between 0.0023 in. fine (minus) and 0.0023 in. coarse (plus) to be within the limits of the table.

For Screws and Taps:

g If the actual pitch diameter for either tap or screw is within the range of the tables, but the exact diameter is not given in the proper column, it can be interpolated, or reckoned as between the two nearest values given, and a proportionate and corresponding limit can be likewise interpolated in order to find the error in lead allowable for the actual pitch diameter in hand.

Example: Same table. Suppose the pitch diameter of a tap is 0.2188 in. In the first column for taps it would come between 0.2185 in. and 0.2190 in. and the value for the next column would be 3/5 of the way between 0.0010 and 0.0015 in. or 0.0013 in., and the value for the third column would be 3/5 of the way between 0.0018 in. and 0.0029 in., or 0.0025 in.

If the length of engagement is greater than that provided for in the tables, reference can be made to the table for a larger size having the required length, and the allowable variations in lead thus found.

Example: Suppose a 1/4-in. 20 screw is to extend into a tapped hole for a depth of 1/2 in., or two diameters. Refer to the diagram Table 5 for a hole 1/2 in. deep, this being for 1/2 in. 13, which allows for a fit 1/2 in. long. This will show by the angular lines what variations in lead are allowable, bearing in mind that the variations in pitch diameter must still be kept within the limits given in Table 1 for 1/4 in.

Example: Suppose a 1-in. 8 bolt is to be used with a nut 3/4 in. thick. Refer to the diagram Table 8, which allows for a fit 3/4 in. long. This allows for a greater variation in lead than the diagram for 1 in., Table 10. The greater limits in pitch diameter allowed for 1 in. can also be used, however.

$1\frac{7}{8}$ (1.875) INCH 5 PITCH U.S.S.

BASIC PITCH DIAMETER 1 7451

Outside and Root Measurements

	FOR A TAP OR NUT FLAT AT BOTTOM OF THREAD SAME AS $4\frac{1}{2}$ PITCH TOOL=0.0278		USS BASIC SIZES	FOR A SCREW OR BOLT FLAT AT ROOT OF THREAD SAME AS $5\frac{1}{2}$ PITCH TOOL=0.0227	
	MIN	MAX		MAX	MIN.
OUTSIDE DIAMETER	1 8775	1 8880	1 8750	1 8750	1 8534
ROOT "	1 6192	1 6273	1 6152	1 6152	1 6031

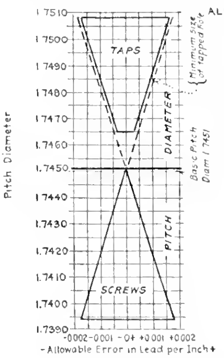
LIMITS ON PITCH DIAMETER AT PERFECT LEAD

TAP	TAPPED HOLE	CLEARANCE		SCREW OR BOLT
		TAP	HOLE	
MAX. 1 7508	MAX 1 7508	0.0114	0 0114	1 7394 MIN
MIN. 1 7465	MIN 1 7451	0 0014	0 0000	1 7451 MAX.

Tolerance for Thread Angle ± 15 Minutes

CHART AND TABLE FOR TAPS, NUTS, SCREWS ETC. WITH LENGTH OF THREAD ENGAGEMENT, 0 TO $1\frac{7}{8}$ INCN (ONCE THE DIAM.)

NOTE: In practice these can be recommended for length of thread engagement to one and one half diam's ($2\frac{13}{16}$") because of the partial rectifying of errors in lead by "flow of metal" see Pars 24 and 25



ALLOWABLE ERROR IN LEAD PER INCH FOR ACTUAL PITCH DIAMETER

FOR A TAP OR TAPPED HOLE READ FROM LEFT TO RIGHT

ACTUAL PITCH DIAM	AMOUNT OVER BASIC	ALLOWABLE ERROR IN LEAD PER INCH	
		TAP	TAPPED HOLE
1 7465	0 0014	±0 0003	±0 0004
1. 7470	0 0019	±0 0005	±0 0006
1. 7480	0 0029	±0 0008	±0.0009
1. 7490	0 0039	±0 0011	±0.0012
1 7500	0 0049	±0.0014	±0 0016
1. 7508	0 0057	±0.0017	±0.0018

FOR A SCREW OR BOLT READ FROM RIGHT TO LEFT

ALLOWABLE ERROR IN LEAD PER INCH	AMOUNT UNDER BASIC	ACTUAL PITCH DIAM.
±0 0000	0.0000	1 7451
±0 0003	0 0011	1.7440
±0 0006	0 0021	1.7430
±0 0010	0 0031	1 7420
±0 0013	0 0041	1 7410
±0 0016	0 0051	1 7400
±0 0018	0.0057	1 7394

TABLE 17

2 INCH $4\frac{1}{2}$ THREADS U.S.S.

BASIC PITCH DIAMETER 1.8557

Outside and Root Measurements

	FOR A TAP OR NUT FLAT ON BOTTOM OF THREAD SAME AS 4 PITCH TOOL=0 0313		USS BASIC SIZES	FOR A SCREW OR BOLT FLAT AT ROOT OF THREAD SAME AS 5 PITCH TOOL=0 0250	
	MIN	MAX		MAX	MIN
OUTSIDE DIAMETER	2 0025	2 0139	2 0000	2 0000	1 9761
ROOT "	1 7158	1 7243	1 7113	1 7113	1 6984

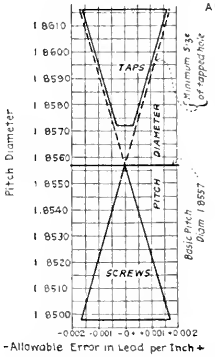
LIMITS ON PITCH DIAMETER AT PERFECT LEAD

TAP	TAPPED HOLE	CLEARANCE		SCREW OR BOLT
		TAP	HOLE	
MAX 1 8616	MAX 1 8616	0 0118	0 0118	1 8498 MIN
MIN 1 8572	MIN 1 8557	0 0015	0.0000	1 8557 MAX

Tolerance for Thread Angle ± 15 Minutes

CHART AND TABLE FOR TAPS, NUTS, SCREWS ETC. WITH LENGTH OF THREAD ENGAGEMENT, 0 TO 2 INCH (ONCE THE DIAM.)

NOTE In practice these can be recommended for length of thread engagement to one and one half diam's (3") because of the partial rectifying of errors in lead by "flow of metal" see Pars. 24 and 25



ALLOWABLE ERROR IN LEAD PER INCH FOR ACTUAL PITCH DIAMETER

FOR A TAP OR TAPPED HOLE READ FROM LEFT TO RIGHT

ACTUAL PITCH DIAM	AMOUNT OVER BASIC	ALLOWABLE ERROR IN LEAD PER INCH	
		TAP	TAPPED HOLE
1 8572	0 0015	±0 0003	±0.0004
1 8580	0.0023	±0.0006	±0.0007
1 8590	0.0033	±0.0009	±0.0010
1 8600	0.0043	±0 0012	±0.0012
1.8610	0.0053	±0.0014	±0.0015
1 8616	0.0059	±0.0016	±0.0017

FOR A SCREW OR BOLT READ FROM RIGHT TO LEFT

ALLOWABLE ERROR IN LEAD PER INCH	AMOUNT UNDER BASIC	ACTUAL PITCH DIAM
±0.0000	0.0000	1.8557
±0.0002	0.0007	1.8550
±0.0005	0.0017	1.8540
±0 0008	0.0027	1 8530
±0.0010	0.0037	1.8520
±0 0014	0.0047	1.8510
±0 0017	0.0059	1.8498

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TABLE 18

Formulæ for Medium-Fit Screws, Nuts, Taps, Etc., Suited for General Use

SYMBOLS USED IN FORMULÆ

Basic full or external diameter	$= D$
Basic pitch diameter	$= E$
Basic root diameter	$= K$
Number of threads per inch	$= n$
Normal lead	$= L$

SCREWS

Max. external diam. $= D$

Max. pitch diam. $= E$

Max. root diam. $= K$

Min external diam. $= D - \left(\frac{0.102}{n} + \frac{0.054}{n+40}\right)$

Min pitch diam. $= E - (0.0045 \times \sqrt{D} - 0.0005)$

Min. root diam. $= K - \left(\frac{0.033}{n} + \frac{25}{n+40}\right)$

Max. error (± normal) allowable in lead per inch. Length of engagement up to one diam. $= \frac{0.57735\,(0.0045 \times \sqrt{D} - 0.0005)}{D}$

(This formula also applies to tapped holes.)

TAPS AND TAPPED HOLES

Max. external diam. $= D + \frac{0.04}{n} + \frac{0.224}{n+40}$

Max. pitch diam. $= E + 0.0045 \times \sqrt{D} - 0.0005$

Max. root diam. $= K + \frac{0.033}{n} + \frac{0.25}{n+40}$

Min. external diam. $= D + \frac{0.112}{n+40}$

Min pitch diam. $= E + \frac{0.0045 \times \sqrt{D} - 0.0005}{4}$

Min. root diam. $= K + \frac{0.02}{n}$

TAPS ONLY

Max. error (± normal) allowable in lead =

$$\text{Max. error } (\pm \text{ normal}) \text{ allowable in lead of screw} - \frac{\left(\begin{array}{c}\text{Max. error } (\pm \text{ normal})\\ \text{allowable in lead of screw}\end{array}\right)}{0.03}$$

Applying Formulæ and Tables for Pitches Other Than U. S. S.

The diagram, Fig. 4, illustrates the relation of the screw to the tapped hole, showing maximum and minimum allowances.

As the formulæ given above for external and root diameters are based on the number of threads per inch, the maximum and minimum limits are not changed by a change in diameter and the allowances given in the formulæ for the U. S. Standard diameter and pitch can be used.[1]

Example: 1 in. diameter, 20 threads to the inch. For external diameter for ¼ in. 20 it will be found from the formula (or by reference to Fig. 7) that the maximum for screws is basic while the minimum is 0.0060 under. The maximum for tap or nut is +0.0057 in., while the minimum is +0.0019 in., these allowances being always the same for 20 threads to the inch for any diameter. The allowances for pitch diameter and lead, however, are based on formulæ having the diameter as a factor.

Example: 1 in. diameter, 20 threads to the inch. It will be found by the formula (or by reference to Figs. 5 and 6) that the maximum pitch diameter of screw is basic. Minimum pitch diameter $= 1 - (0.0045 \times \sqrt{1} - 0.0005) = 1 - 0.004 = 0.996$ min. pitch diam. of screw.

Maximum pitch diameter of tap $= 1 + 0.004 = 1.004$ in.

Minimum pitch diameter of tap $= 1 + (0.004\ \ 4) = 1.001$ in.

Maximum error (± normal) allowable in lead of screws if the length of engagement = 1 diameter (in this example 1 in.) =

$$\frac{0.57735\ (0.0045 \times \sqrt{1} - 0.005)}{1} = 0.0023 \text{ max. error in lead.}$$

If, however, the length of engagement is only ½ in. instead of 1 in., a proportionately greater error in lead can be allowed.

0.0023 ÷ ½ = 0.0046 in. maximum error in lead for 1 in. 20 threads with ½ in. length of engagement.

Maximum error in lead for tap for 1 in. length of engagement

$$0.0023 - \frac{0.0023}{0.03} - 0.0017 \text{ max. error in lead.}$$

For ½ length of engagement, 0.0017 ÷ ½ = 0.0034.

To Find Position of a Tap or Screw in the Chart, Fig. 3

First, find its actual pitch or angular diameter as measured with a "V"-thread micrometer. Subtract from this diameter the basic pitch diameter as given in the table. The difference will be its deviation from basic pitch diameter. If plus, lay off its value to scale above the horizontal coördinate line; and if minus, below the horizontal line.

Second, find the "error in lead per inch" with a lead measuring instrument. If the lead is coarse, equal plus, lay off its value to scale to the right of the vertical coördinate line, or if fine, equal minus, lay it off to the left of the vertical line.

The point where these first and second values intersect is the position of the tap or screw on the chart. If it is within the shaded area, the tap or screw is within the prescribed limits, and if outside of the shaded area it is not up to the standard represented by the chart and table. Taps and nuts must fall within the shaded area above the horizontal line; while screws and bolts must fall within the shaded area below the horizontal line.

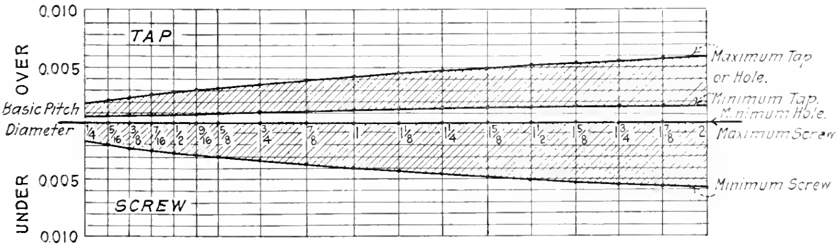

Fig. 5 Maximum and Minimum Clearance, Pitch Diameter

Example for a Tap: Suppose a tap measured 0.001 in. over basic pitch diameter; this value would fall on the horizontal line CK (Fig. 3), and if its lead should be 0.0005 in. fine or minus in 1 in., this value would fall on the vertical dotted line passing through K, and the tap falls within the area of the chart.

Example for a Screw: Suppose a screw measured 0.0010 in. under basic pitch diameter, it would then fall on the horizontal line AL (Fig. 3), and if its lead were 0.0020 in. coarse or plus it would fall on the vertical dotted line passing through L, and the s rew falls outside the area of the chart.

[1] These limits can also be obtained by reference to Figs. 7 and 8.

TABLE 19 MINIMUM AND MAXIMUM PITCH DIAMETERS OF TAPS AND SCREWS AT PERFECT LEAD FOR U. S. STD.

MEDIUM GRADE FOR GENERAL WORK. ALL DIMENSIONS IN INCHES

		TAP		SCREW	
Nom. diam. and threads per inch	Basic pitch diameters	Min. and max. add. to basic pitch diam.	Min. and max. pitch diam.	Max. and min. reduction from basic pitch diam.	Max. and min. pitch diam.
1/4—20	0.2175	0.0001 0.0018	0.2179 0.2193	0.0000 0.0018	0.2175 0.2158
5/16—18	0.2764	0.0005 0.0020	0.2769 0.2784	0.0000 0.0020	0.2764 0.2744
3/8—16	0.3344	0.0006 0.0023	0.3350 0.3367	0.0000 0.0023	0.3344 0.3321
7/16—14	0.3911	0.0006 0.0025	0.3917 0.3936	0.0000 0.0025	0.3911 0.3886
1/2—13	0.4501	0.0007 0.0027	0.4508 0.4528	0.0000 0.0027	0.4501 0.4474
9/16—12	0.5084	0.0007 0.0029	0.5091 0.5113	0.0000 0.0029	0.5084 0.5055
5/8—11	0.5660	0.0008 0.0031	0.5668 0.5691	0.0000 0.0031	0.5660 0.5629
3/4—10	0.6851	0.0009 0.0034	0.6860 0.6885	0.0000 0.0034	0.6851 0.6817
7/8—9	0.8029	0.0009 0.0037	0.8038 0.8066	0.0000 0.0037	0.8029 0.7992
1—8	0.9188	0.0010 0.0040	0.9198 0.9228	0.0000 0.0040	0.9188 0.9148
1 1/8—7	1.0322	0.0011 0.0043	1.0333 1.0365	0.0000 0.0043	1.0322 1.0279
1 1/4—7	1.1572	0.0011 0.0045	1.1583 1.1617	0.0000 0.0045	1.1572 1.1527
1 3/8—6	1.2668	0.0012 0.0048	1.2680 1.2716	0.0000 0.0048	1.2668 1.2620
1 1/2—6	1.3918	0.0013 0.0050	1.3931 1.3968	0.0000 0.0050	1.3918 1.3868
1 5/8—5 1/2	1.5069	0.0013 0.0052	1.5082 1.5121	0.0000 0.0052	1.5069 1.5017
1 3/4—5	1.6201	0.0014 0.0055	1.6215 1.6256	0.0000 0.0055	1.6201 1.6147
1 7/8—5	1.7451	0.0014 0.0057	1.7465 1.7508	0.0000 0.0057	1.7451 1.7394
2—4 1/2	1.8557	0.0015 0.0059	1.8572 1.8616	0.0000 0.0059	1.8557 1.8498

TABLE 20 OUTSIDE AND ROOT DIAMETERS FOR TAPS AND SCREWS — U. S. STD.

MEDIUM GRADE FOR GENERAL WORK. ALL DIMENSIONS IN INCHES

	TAP OR NUT						SCREW				
	Outside Diam.			Root Diam.							
1	2	3	4	5	6	7	8	9	10	11	12
Nominal diam. and threads per inch	Decimal basic outside diam.	Addition to basic O. D.	Min. and max. O. D.	U. S. S. root diam.	Pitch of tool for tap and width across point	New basic root diam.	Min. and max. root diam.	Max. and min. outside diam.	Pitch of tool for thread and width across point	New basic root diam.	Max. and min. root diam.
1/4—20	0.2500	0.0019 0.0057	0.2519 0.2557	0.1850	18 0.0069	0.1863	0.1860 0.1908	0.2500 0.2440	22 0.0057	0.1841	0.1850 0.1792
5/16—18	0.3125	0.0019 0.0061	0.3144 0.3186	0.2403	16 0.0078	0.2418	0.2414 0.2464	0.3125 0.3059	20 0.0062	0.2391	0.2403 0.2342
3/8—16	0.3750	0.0020 0.0065	0.3770 0.3815	0.2936	14 0.0089	0.2955	0.2949 0.3001	0.3750 0.3677	18 0.0069	0.2921	0.2936 0.2871
7/16—14	0.4375	0.0021 0.0070	0.4396 0.4445	0.3447	13 0.0096	0.3459	0.3461 0.3517	0.4375 0.4292	16 0.0078	0.3428	0.3447 0.3377
1/2—13	0.5000	0.0021 0.0073	0.5021 0.5073	0.4001	12 0.0104	0.4015	0.4016 0.4074	0.5000 0.4911	14 0.0089	0.3989	0.4001 0.3928
9/16—12	0.5625	0.0022 0.0076	0.5647 0.5701	0.4542	11 0.0114	0.4559	0.4559 0.4618	0.5625 0.5530	13 0.0096	0.4528	0.4542 0.4466
5/8—11	0.6250	0.0022 0.0080	0.6272 0.6330	0.5069	10 0.0125	0.508[illegible]	0.5087 0.5148	0.6250 0.6147	12 0.0104	0.5053	0.5069 0.4990
3/4—10	0.7500	0.0022 0.0085	0.7522 0.7585	0.6201	9 0.0139	0.6225	0.6221 0.6284	0.7500 0.7387	11 0.0114	0.6184	0.6201 0.6118
7/8—9	0.8750	0.0023 0.0090	0.8773 0.8840	0.7307	8 0.0156	0.7337	0.7329 0.7395	0.8750 0.8626	10 0.0125	0.7283	0.7307 0.7219
1—8	1.0000	0.0023 0.0092	1.0023 1.0092	0.8376	7 0.0179	0.8416	0.8401 0.8469	1.0000 0.9861	9 0.0139	0.8346	0.8376 0.8283
1 1/8—7	1.1250	0.0024 0.0105	1.1274 1.1355	0.9394	6 0.0208	0.9444	0.9423 0.9494	1.1250 1.1094	8 0.0156	0.9356	0.9394 0.9294
1 1/4—7	1.2500	0.0024 0.0105	1.2524 1.2605	1.0644	6 0.0208	1.0696	1.0673 1.0744	1.2500 1.2343	8 0.0156	1.0606	1.0644 1.0544
1 3/8—6	1.3750	0.0024 0.0115	1.3774 1.3865	1.1585	5 1/2 0.0227	1.1618	1.1618 1.1691	1.3750 1.3568	7 0.0179	1.1533	1.1585 1.1476
1 1/2—6	1.5000	0.0024 0.0115	1.5024 1.5115	1.2835	5 1/2 0.0227	1.2868	1.2868 1.2941	1.5000 1.4818	7 0.0179	1.2783	1.2835 1.2726
1 5/8—5 1/2	1.6250	0.0025 0.0122	1.6275 1.6372	1.3888	5 0.0250	1.3928	1.3925 1.4003	1.6250 1.6053	6 0.0208	1.3855	1.3888 1.3773
1 3/4—5	1.7500	0.0025 0.0130	1.7525 1.7630	1.4902	4 1/2 0.0278	1.4950	1.4942 1.5024	1.7500 1.7284	5 1/2 0.0227	1.4863	1.4902 1.4780
1 7/8—5	1.8750	0.0025 0.0130	1.8775 1.8880	1.6152	4 1/2 0.0278	1.6233	1.6192 1.6274	1.8750 1.8534	5 1/2 0.0227	1.6113	1.6152 1.6030
2—4 1/2	2.0000	0.0025 0.0139	2.0025 2.013	1.7113	4 0.0313	1.7173	1.7158 1.7243	2.0000 1.9761	5 0.0250	1.7065	1.7113 1.6984

TABLE 21 INSPECTION LIMITS FOR U. S. S. TAPS

All Dimensions in Inches

¼-IN. 20 U. S. S. BASIC PITCH DIAM. 0.2175		$\frac{5}{16}$-IN. 18 U. S. S. BASIC PITCH DIAM. 0.2764		⅜-IN. 16 U. S. S. BASIC PITCH DIAM. 0.3344		½-IN. 13 U. S. S. BASIC PITCH DIAM. 0.4301	
Actual pitch diam.	Allowable error in lead per in.	Actual pitch diam.	Allowable error in lead per in.	Actual pitch diam.	Allowable error in lead per in.	Actual pitch diam.	Allowable error in lead per in.
0.2179	±0.0005	0.2769	±0.0005	0.3350	±0.0005	0.4508	±0.0006
0.2185	±0.0018	0.2775	±0.0016	0.3355	±0.0013	0.4515	±0.0013
0.2190	±0.0029	0.2780	±0.0025	0.3360	±0.0020	0.4520	±0.0019
0.2193	±0.0035	0.2784	±0.0033	0.3365	±0.0028	0.4525	±0.0025
				0.3367	±0.0031	0.4528	±0.0028

⅝-IN. 11 U. S. S. BASIC PITCH DIAM. 0.5660		¾-IN. 10 U. S. S. BASIC PITCH DIAM. 0.6851		⅞-IN. 9 U. S. S. BASIC PITCH DIAM. 0.8029		1-IN. 8 U. S. S. BASIC PITCH DIAM. 0.9188	
Actual pitch diam.	Allowable error in lead per in.	Actual pitch diam.	Allowable error in lead per in.	Actual pitch diam.	Allowable error in lead per in.	Actual pitch diam.	Allowable error in lead per in.
0.5668	±0.0006	0.6860	±0.0005	0.8038	±0.0004	0.9198	±0.0004
0.5675	±0.0012	0.6865	±0.0009	0.8045	±0.0009	0.9205	±0.0008
0.5680	±0.0016	0.6870	±0.0012	0.8050	±0.0012	0.9210	±0.0011
0.5685	±0.0021	0.6875	±0.0016	0.8055	±0.0016	0.9215	±0.0014
0.5690	±0.0026	0.6880	±0.0020	0.8060	±0.0019	0.9220	±0.0017
		0.6885	±0.0024	0.8066	±0.0023	0.9225	±0.0019
						0.9228	±0.0021

1¼-IN. 7 U. S. S. BASIC PITCH DIAM. 1.1572		1½-IN. 6 U. S. S. BASIC PITCH DIAM. 1.3918		1¾-IN. 5 U. S. S. BASIC PITCH DIAM. 1.6201		2-IN. 4½ U. S. S. BASIC PITCH DIAM. 1.8557	
Actual pitch diam.	Allowable error in lead per in.	Actual pitch diam.	Allowable error in lead per in.	Actual pitch diam.	Allowable error in lead per in.	Actual pitch diam.	Allowable error in lead per in.
1.1583	±0.0003	1.3930	±0.0004	1.6215	±0.0004	1.8572	±0.0004
1.1590	±0.0006	1.3940	±0.0008	1.6225	±0.0007	1.8580	±0.0006
1.1595	±0.0009	1.3950	±0.0011	1.6235	±0.0010	1.8590	±0.0009
1.1600	±0.0011	1.3960	±0.0015	1.6245	±0.0014	1.8600	±0.0012
1.1605	±0.0013	1.3965	±0.0017	1.6255	±0.0017	1.8610	±0.0014
1.1610	±0.0016	1.3968	±0.0018			1.8615	±0.0016
1.1617	±0.0019						

TABLE 22 INSPECTION LIMITS FOR U. S. S. SCREWS

All Dimensions in Inches

¼-IN. 20 U. S. S. BASIC PITCH DIAM. 0.2175		$\frac{5}{16}$-IN. 18 U. S. S. BASIC PITCH DIAM. 0.2764		⅜-IN. 16 U. S. S. BASIC PITCH DIAM. 0.3344		½-IN. 13 U. S. S. BASIC PITCH DIAM. 0.4501	
Actual pitch diam.	Allowable error in lead per in.	Actual pitch diam.	Allowable error in lead per in.	Actual pitch diam.	Allowable error in lead per in.	Actual pitch diam.	Allowable error in lead per in.
0.2170	±0.0012	0.2760	±0.0008	0.3340	±0.0006	0.4495	±0.0007
0.2165	±0.0022	0.2755	±0.0017	0.3335	±0.0014	0.4490	±0.0013
0.2160	±0.0033	0.2750	±0.0027	0.3330	±0.0021	0.4485	±0.0018
0.2157	±0.0040	0.2745	±0.0037	0.3325	±0.0029	0.4480	±0.0024
				0.3321	±0.0035	0.4474	±0.0031

⅝-IN. 11 U. S. S. BASIC PITCH DIAM. 0.5660		¾-IN. 10 U. S. S. BASIC PITCH DIAM. 0.6851		⅞-IN. 9 U. S. S. BASIC PITCH DIAM. 0.8029		1-IN. 8 U. S. S. BASIC PITCH DIAM. 0.9188	
Actual pitch diam.	Allowable error in lead per in.	Actual pitch diam.	Allowable error in lead per in.	Actual pitch diam.	Allowable error in lead per in.	Actual pitch diam.	Allowable error in lead per in.
0.5655	±0.0005	0.6845	±0.0005	0.8025	±0.0003	0.9185	±0.0002
0.5650	±0.0009	0.6840	±0.0009	0.8020	±0.0006	0.9180	±0.0005
0.5645	±0.0014	0.6835	±0.0012	0.8015	±0.0009	0.9175	±0.0008
0.5640	±0.0018	0.6830	±0.0016	0.8010	±0.0013	0.9170	±0.0010
0.5635	±0.0023	0.6825	±0.0020	0.8005	±0.0016	0.9165	±0.0013
0.5629	±0.0028	0.6820	±0.0024	0.8000	±0.0020	0.9160	±0.0016
		0.6817	±0.0026	0.7992	±0.0025	0.9155	±0.0019
						0.9148	±0.0023

1¼-IN. 7 U. S. S. BASIC PITCH DIAM. 1.1572		1½-IN. 6 U. S. S. BASIC PITCH DIAM. 1.3918		1¾-IN. 5 U. S. S. BASIC PITCH DIAM. 1.6201		2-IN. 4½ U. S. S. BASIC PITCH DIAM. 1.8557	
Actual pitch diam.	Allowable error in lead per in.	Actual pitch diam.	Allowable error in lead per in.	Actual pitch diam.	Allowable error in lead per in.	Actual pitch diam.	Allowable error in lead per in.
1.1565	±0.0003	1.3910	±0.0003	1.6195	±0.0002	1.8550	±0.0002
1.1560	±0.0006	1.3900	±0.0007	1.6190	±0.0004	1.8540	±0.0005
1.1550	±0.0010	1.3890	±0.0011	1.6180	±0.0007	1.8530	±0.0008
1.1540	±0.0015	1.3880	±0.0015	1.6170	±0.0010	1.8520	±0.0011
1.1530	±0.0020	1.3870	±0.0018	1.6160	±0.0014	1.8510	±0.0014
1.1527	±0.0021	1.3868	±0.0019	1.6150	±0.0017	1.8498	±0.0017
				1.6147	±0.0018		

GAGING DEVICES

In order to ascertain whether the work comes within the required limits as represented by the triangular zones of the tables, it is desirable to measure simultaneously both the pitch diameter and the lead.

Among the tools suggested for accomplishing this purpose allow for variations in lead. This roll is set to the standard pitch diameter of the work and is adjusted by the micrometer thimble. The floating point is so connected that the longer lever shows the variation in lead and the shorter lever variations in pitch diameter, each pivoting about its own center. The work is placed between the points as shown by the dotted

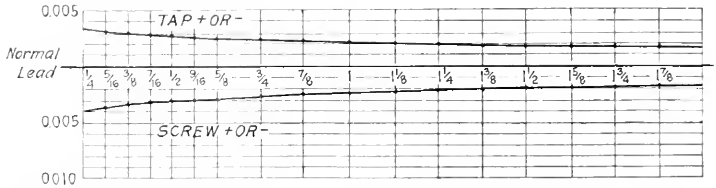

Fig. 6 Allowable Variation in Lead Over or Under Normal for Maximum Error in Diameter

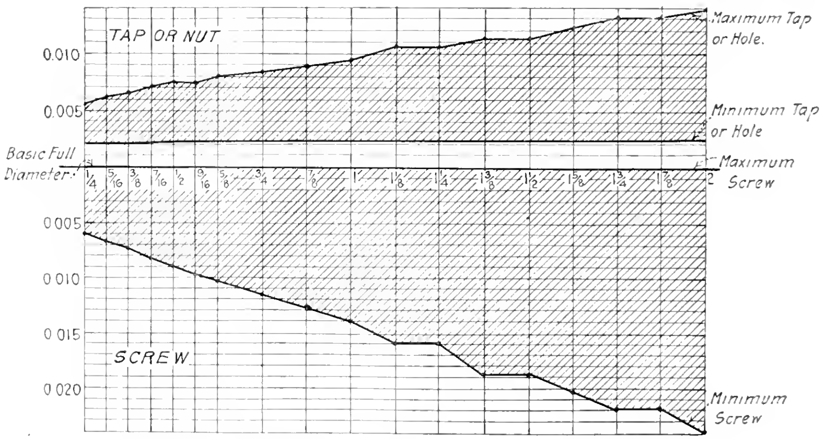

Fig. 7 Maximum and Minimum Clearance, Full or External Diameter

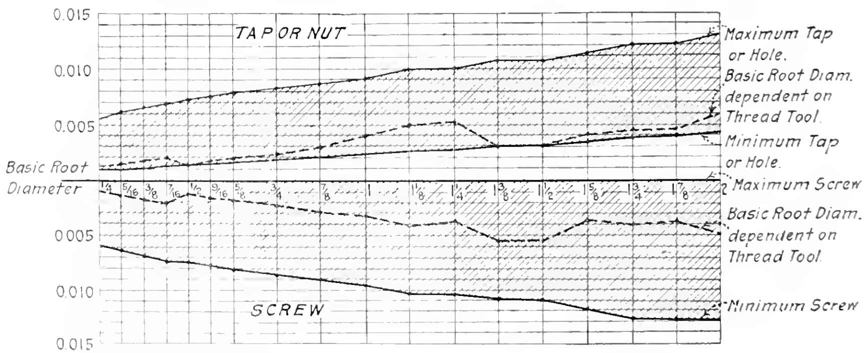

Fig. 8 Maximum and Minimum Clearance, Root Diameter

are the following: In Fig. 9 is shown a gage which is adjustable for a range of diameters, the micrometer thimble being used to obtain the readings for the diameter. An adjustable block supports the work so that it will be held parallel to the center line and can be set to be measured on the center line. The grooved roll fits over the thread and is free sideways to section, and the variations from standard or pitch diameter and lead are read directly in thousandths of an inch.

In Fig. 10 is a combination gage for diameter and lead. Point A is adjustable longitudinally by means of a micrometer screw so that it can be placed in proper relation to B, which is adjustable for different diameters, the pitch diameter of work

being read directly by means of its micrometer. The point C is connected to the indicator, variations being read directly on the scale in thousandths of an inch. A block supports the work in proper relation to the gage points, and is set by means of the micrometer D.

A combination gage for pitch diameter and lead, having a fixed point and two adjustable points, is shown in Fig. 11.

between the screw and nut or tapped hole, work which will pass inspection by the gages will interchange in use, and thus the desired result will be attained.

Where expensive special tools are not available good results can be obtained by measuring the diameter with an ordinary *screw-thread micrometer* shown in Fig. 14, and the lead, with the *lead-measuring indicator*, shown in Fig. 15. By the combined use of gages shown in Figs. 14 and 15, it can readily be determined whether the work will come within the triangular zones on the tables, and thus pass inspection.

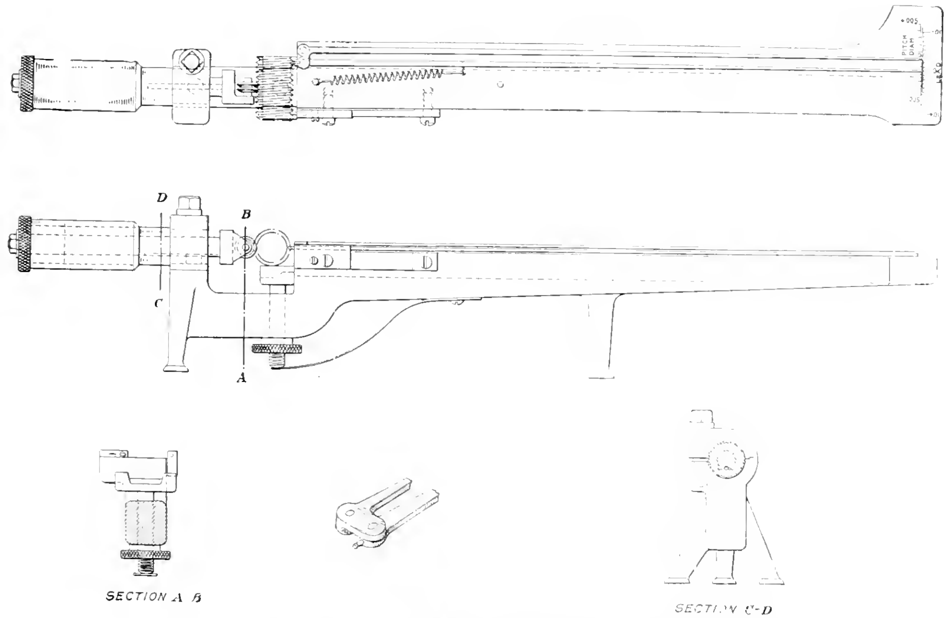

Fig. 9 Combined Lead- and Diameter-Measuring Gage, with Compound Levers

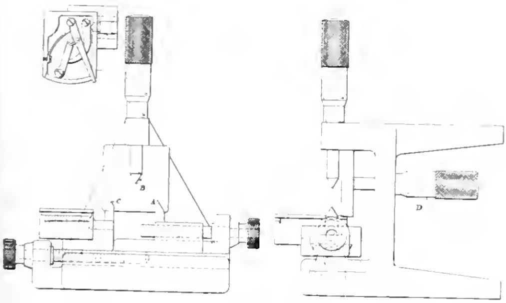

Fig. 10 Combined Lead- and Diameter-Measuring Gage, with Micrometer and Lever Indicator Readings

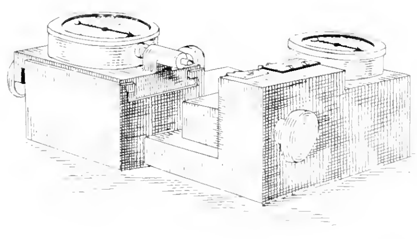

Fig. 11 Gage with Dial Indicator Readings

The variations in both cases are read on the dial indicators in thousandths of an inch. Indicators must be set to a standard before testing the work. An adjustable block may be set by a vernier or micrometer so that work resting on it will have its center line in line with the gage points.

In Figs. 12 and 13 is shown the type of gages now generally in use for measuring screw threads. Gages of this type do not determine the combined error of lead and diameter, but are satisfactory for many classes of work. If the thickness or length of gage is made to correspond with the length of fit

Another lead-measuring instrument is shown in Fig. 16. This uses a commercial test indicator for noting the variations from correct lead.

Fig. 17 shows a simple gage which might be provided at small expense where a block of a thickness of about one or one and one-half diameters is tapped at one end for approximately standard pitch diameter and correct lead, while the other end is made thin and tapped under standard pitch diameter so as to be used as a minimum-diameter gage. A screw which will pass through the standard or thicker gage but will not pass through the thin gage may be presumed to be within

the required limits of tolerances for variation in both lead and pitch diameter.

Many other designs of measuring instruments have been submitted to the committee, having points of excellence, but

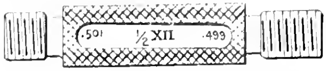

FIG. 12 PLUG GAGE

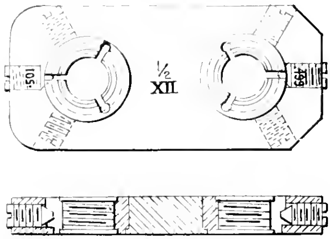

FIG. 13 RING GAGE

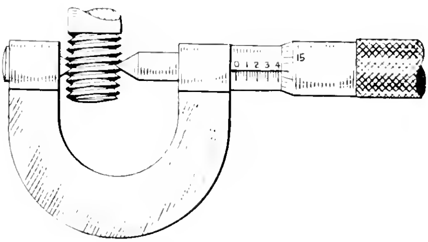

FIG. 14 SCREW-THREAD MICROMETER

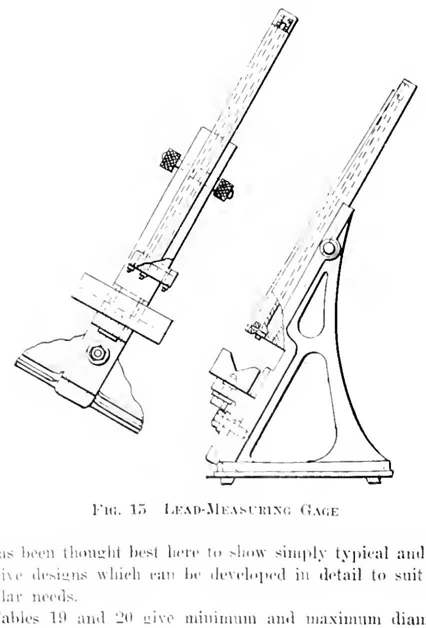

FIG. 15 LEAD-MEASURING GAGE

it has been thought best here to show simply typical and suggestive designs which can be developed in detail to suit particular needs.

Tables 19 and 20 give minimum and maximum diameters for U. S. S. taps, nuts and screws; while Tables 21 and 22 give inspection limits for taps and screws, with the varying allowance in lead for different diameters within the limits specified.

DEFINITIONS AND SYMBOLS

The letter symbols given below are those recommended by the U. S. Bureau of Standards:

Allowance. Variation in dimensions to allow for different qualities of fit.

Angle Diameter. Same as pitch or effective diameter.

Angle of Thread, "A." The total or included angle between the sides or slopes of a thread, in a plane passing through the axis of the screw or nut.

Clearance. The space between a screw and a threaded hole.

Clearance Angle. Allowance on the angles or slopes of the thread for screw threads to fit together.

Clearance, Bottom. Allowance or space at bottom of a thread to prevent a bearing at this point and to provide space for dirt.

Clearance, Outside. Allowance between outside diameter of screw and bottom of tapped hole.

Core Diameter, "K." English term for the root or bottom diameter of a screw and the small diameter of a nut. In the case of the nut it is measured between the crests of the thread. See Root Diameter.

Crest. English term for the top or most prominent part of a thread, whether on the screw or in the nut.

Effective Diameter, "E." English term for pitch diameter and defined as the length of a line drawn through the axis and at right angles to it, measured between the points where the line cuts the slopes of the thread.

External Diameter, "D." Same as full diameter or outside diameter.

Finger Fit. Where the screw fits the tapped hole so as to just be screwed in with the fingers.

Flow of Thread. The movement of metal in a screw or nut, or both, when screwed together by force, to fit in spite of an error in lead.

Flute. The groove cut in taps and reamers to form cutting edges and to allow room for chips.

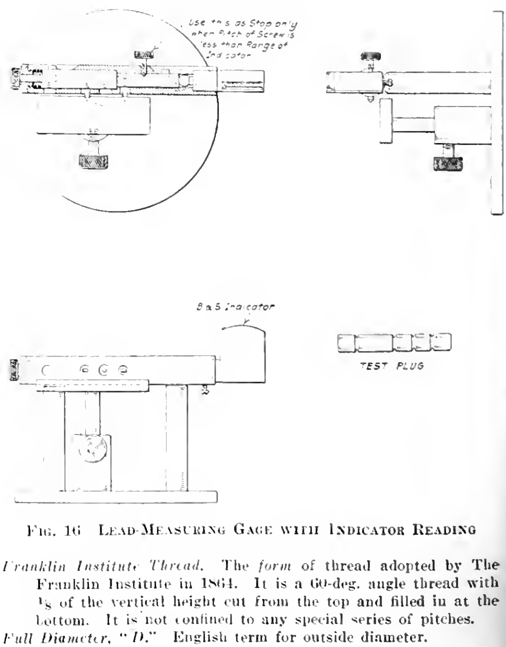

FIG. 16 LEAD-MEASURING GAGE WITH INDICATOR READING

Franklin Institute Thread. The *form* of thread adopted by The Franklin Institute in 1864. It is a 60-deg. angle thread with ⅛ of the vertical height cut from the top and filled in at the bottom. It is not confined to any special series of pitches.

Full Diameter, "D." English term for outside diameter.

Gage, Check or Checking. Gage for checking or testing other gages.

Gage, Limit. A gage for insuring that any given dimension is within the tolerance laid down for the class of work to be produced.

Gage, Master. A gage which is kept as a standard, solely for comparing reference gages.

Gage, Reference. A gage used by the manufacturer and by which the workman's gage is tested. A copy of the Master Gage.

Gage, Shop or Workman's. A gage used by the workman in everyday practice. It is tested by or with the Reference Gage.

Gage, Standard. English term for Master Gage.

Land. The space between flutes on a tap or reamer. It includes the cutting edge and the supporting metal behind it.

Lead, "L." The distance a screw advances in one turn. In a single-thread screw this is the same as pitch.

Lead, Normal. "L." Correct lead.

Lead per Inch. The lead multiplied by its reciprocal. For a perfect thread this equals one inch.

Limits. Two sizes expressed by positive dimensions, the larger being termed the maximum, and the smaller the minimum, limit.

Limit Gage. See Gage, Limit.

Outside Diameter, "D." Diameter on the outside of the thread. External or full diameter.

Pitch. The distance from a given point on one thread to a similar point on the next thread, along the axis of the screw. The same as lead for a single thread. The reciprocal of threads per inch.

Pitch Diameter, "E." Same as effective diameter. Also defined as the diameter of a screw at a point midway of the depth of the thread. Equal to the outside diameter less the depth of one thread. This depth equals:

For "V"-threads $= \dfrac{0.866}{\text{Thds. per inch}}$ For U. S. S. $= \dfrac{0.6495}{\text{Thds. per inch}}$

Relief. The reduced diameter behind the cutting edge of a tap.

Root. Bottom or smallest diameter of thread, whether in screw or nut.

Root Diameter, "K." The smallest diameter, whether for a screw or in a nut.

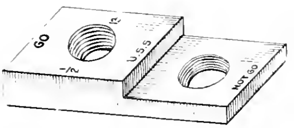

Fig. 17 Cheap Gage for Temporary Use

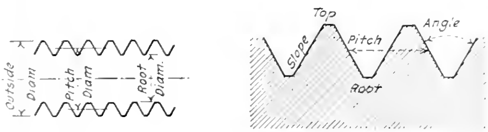

Fig. 18 Diagrams Showing Elements of Thread

Slope of Thread. The angular part which connects the large and small diameters of a thread.

Standard Gage. English term for Master Gage. (See Gage, Master.)

Thread, Modified "V." A form of thread having a 60-deg. angle and such that if carried to a sharp point it would measure to the nominal size, but with the top or bottom, or both, modified usually by being flattened according to conditions or individual ideas.

Thread, U. S. S. The standard adopted by the United States Government, which uses the Franklin Institute form of thread with a definite pitch for each diameter. (See Franklin Institute Thread.)

Thread, "V." A form of thread having a 60-deg. angle and sharp at top and bottom. Impossible in practice and always more or less modified, whether intentionally or not.

Thread, Whitworth. A thread having a 55-deg. angle and a rounded top and bottom. The proportions are:

Depth $= \dfrac{0.640327}{\text{Thds. per in.}}$. Radius of top and bottom $= \dfrac{0.137329}{\text{Thds. per in.}}$

Thread Micrometer. A micrometer caliper with special points for measuring the pitch or angle diameter of the screw.

Threads per Inch, "n." Number of threads in one inch of length.

Tolerance. The allowable variation in size, equal to the difference between the minimum and maximum limits.

Turns per Inch, "N." The number of turns required to advance one inch. Equal to the threads per inch of a single-threaded screw.

Wrench Fit. Where the screw fits the tapped hole so tightly as to require a wrench to screw into place. Used for cylinder studs in steam engines and for similar work.

Respectfully submitted,

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Ellwood Burdsall
Frederic G. Coburn
Fred H. Colvin
A. A. Fuller
James Hartness
Will R. Porter
Frank O. Wells
Walter F. Worthington
Charles D. Young

Committee on Tolerances in Screw Thread Fits

Errata

Table 7, second line of "Note": For $\frac{5}{16}''$ read $\frac{15}{16}''$.

Table 9, Limits on Pitch Diameter at Perfect Lead: Under "Screw or Bolt" read 0.7992 min. instead of 0.8012 min.

Table 18, Allowable Error in Lead per Inch for Actual Pitch Diameter: Under column headed "Tapped Hole" read ± 0.0013 instead of ± 0.0012.

The Food Administration has recently issued a message urging conservation of ammonia. During 1918, it is stated, the Government should have for munitions alone 20,000,000 lb. of ammonia more than it is possible to make by working all the plants producing ammonia in this country to their maximum capacity.

This shortage will be greatly increased by the ammonia that will be furnished ice-making and refrigerating plants, but it is hoped that by appealing to the patriotism and business sense of all ammonia users and urging them to stop all waste and leakage, the usual consumption may be curtailed to such an extent as will permit at least the most efficient plants to run; particularly where natural ice is not available.

The returns lately received show that much ammonia loss is avoidable. Many plants use less than one-twentieth of a pound per ton of ice made; while others use from one-half to one pound per ton. The same inexcusable waste is found in many refrigerating plants. The only reason that can be given for permitting the enormous waste and expense to continue at some plants is that the management has not informed itself as to what is a reasonable consumption and the operating force is indifferent about leaks that might easily be stopped but are allowed to continue.

A saving of 25 per cent in the ammonia consumption of ice and refrigerating plants would mean several million pounds annually for munitions. Each pound will make twenty hand grenades. Late returns show this saving can be accomplished if all will stop the leaks.

The Ford Administration has also given out figures showing that in one ton of garbage there is sufficient glycerin to make the explosive charge for fourteen 75-mm. shells, enough "fatty acid" to manufacture 75 lb. of soap, fertilizer elements to grow 8 bu. of wheat, and a score of other valuable materials essential in munitions manufacture.

DISCUSSION OF SPRING MEETING PAPERS

ONE of the papers presented at the second General Session of the Spring Meeting at Worcester which, by reason of the keen interest now taken in matters relating to the subject of flight and the novel ideas advanced by the author, drew forth much illuminating discussion, was that by Prof. Morgan Brooks, on Air Propulsion.

In this paper, an extended abstract of which was printed in THE JOURNAL for May (p. 390), the author describes experiments with propellers showing that the accepted screw theory of air propulsion does not accord with the facts. In these experiments air was impelled by a propeller at a speed approaching twice the screw advance for small blade angles, hence the theory of reflection or batting action should replace the screw theory. Thrust is shown to be due in greater degree to velocity and less to blade disk area than is commonly supposed.

In presenting the paper Professor Brooks said that although the facts stated seemed impossible to many, their essential accuracy could be absolutely depended upon. The substitute reflection theory advanced he offered without claims as to its correctness, but as a suggestion open to criticism and alteration.

Those contributing to the discussion were N. W. Akimoff, C. W. Howell, G. De Bothezat, Dr. S. W. Stratton, L. R. Gulley, J. C. Hunsaker, M. B. Sellers, Lieut.-Col. J. S. Vincent, W. C. Durfee and H. F. Hagen, whose remarks immediately follow.

AIR PROPULSION

DISCUSSION OF PAPER BY PROF. MORGAN BROOKS

N. W. AKIMOFF (written). Professor Brooks' paper will be welcomed by the profession only in so far as it represents a sincere opinion, purely subjective, of that capable engineer. In itself the paper is open to grave objections. The theory proposed apparently contemplates an infinite space of 30 in. vacuum, in which floats one particle of air, how large is so far unknown. The propeller blade runs into it and, in turn, experiences a little reaction, although the particle feels it much more than the blade itself. Splendid! but what becomes of the hydrodynamics of this delicate problem? All propeller theories that are based on supposing that the air is a material aggregation of separate particles are absolutely worthless: the screws built according to such theories are as likely to give 84 per cent as 48 per cent, because the very foundation is shaky.

The least unsatisfactory theory of propellers is that which takes into consideration the vortex theory of sustentation. Lanchester claims priority to the idea, although many other scientists of not quite so great repute also claim to have discovered it first. (See A Review of Hydrodynamical Theory, etc., by J. S. Hunsaker, International Engineering Congress, San Francisco, September 1915.)

He who looks into the vortex theory of sustentation will at once abandon theories about air particles as related to pitch or slip. Here the lift is made dependent upon a certain section constant, called circulation, and is equal to density times circulation times velocity *ad infinitum*.

The propeller blade can also be considered as a set of regular wing sections, say, RAF 6, or whatever they are, for which the "circulation" is either known or can be calculated. This has been done with satisfactory results; the trouble is that all such methods require a little knowledge, which certainly is most unfortunate; what we would like to have is a pocket book, or a table of some sort, but it does not work that way. Highly delicate is the confounded science of hydrodynamics!

Fig. 3 of Mr. Brooks' paper looks unusual; it has very likely been drawn by inference and not as a result of calculations.

The subject of static tests as a basis for judging of what the dynamic pull will be, is one of extreme difficulty, and here again the vortex theory is the only hope.

For the estimation of what the static pull will be within, say, 15 per cent or so, the writer has recently proposed the following crude formula: Static pull in lb. $= n^2D^4/2750$. (*Aviation*, 1917.) This appears to serve the purpose, but only within the prescribed limits; to estimate the pull of a screw is about the same as to build a helicopter screw—a difficult problem.

CHARLES W. HOWELL[1] (written). Recognition must be accorded the superspeed or acceleration theory so ably set forth by Professor Brooks, if it is desired to clear away the misconception existing as to the result of the application of power to a rotating element having angularly disposed surfaces to produce useful work in such a light and elastic medium as air, and if it is also desired to reduce the proposition to an exact status so that better working formulæ may be had.

Superspeed, as Professor Brooks states, is not readily observed in a static test of a two-blade propeller, but conversely may be directly observed in translational or flying tests of conventional airplanes, which have frequently been observed to fly a greater distance in unit time than the revolutions-times-pitch design of their propellers should fly them. Were this phenomenon confined to airplanes flying *with* the wind, we might assume, with reason, that it was merely the product of pitch minus slip, plus the velocity of the wind, but as the phenomenon may be observed to occur in substantially inert air and to a lesser degree in flying *against* moderate wind, it can only be explained in terms of velocity and impact—i. e., superspeed.

The air structure shown in Fig. 3 is quite characteristic of those produced under static tests by propellers of screw-pitch design. It has been observed, however, to vary radically under flying conditions, a beautifully clear example being shown by a screw-pitch propeller driven by a Gnome motor. This is a rotating-cylinder motor lubricated by castor oil, which frequently causes black smoke to be emitted from the exhaust ports. This smoke does not take the form of a rotating, contracting swirl, but forms into two ribbons or pennants which do not rotate but appear to change position with variation of motor speed.

It has also been noted that propellers differing from the conventional screw-pitch design will set up various forms of air structures. One has been observed to create a column substantially parallel and with small tendency to rotate. This would appear to approach the ideal condition, as it indicates a reduction of interference losses; that is, maximum acceleration or superspeed has occurred.

Experimental research with small model propellers appears to indicate that the air structure formed is influenced largely by the design of the rear or leaving edge of the propeller blade and may have a strong bearing on its efficiency, because the smaller the interference with or the mixing of the super-

[1] Vice-President, Aeronautical Society of America.

speeded air particles, the more parallel will be the lines of force and the greater the efficiency.

May I venture to suggest the term "acceleration" as more indicative of the physical result, and to express the opinion that the problem can be reduced to a precise condition and understanding by throwing out all considerations of screw and pitch and considering velocities and impact only?

G. De Bothezat (written).[1] The following may serve as a basis for a discussion of the flow of a fluid along a section of a propeller blade. Let it be assumed that we know exactly the direction along which the flowing fluid reaches a section of the blade (this theory determines exactly this direction). The following phenomena have then to be considered: If the flow reaches the blade section with a velocity W_1, it leaves it with a velocity W_2 (Fig. 1), which differs from W_1 in magnitude (slightly) and in direction.

At the points of contact of the fluid with the blade section there take place several quite complex phenomena of shocks and eddy formations. If the angle at which W_1 strikes the section of the blade is sufficiently small, then in the first approximation and using the terminology adopted in Professor Brooks' paper, W_1 is reflected on to the plane pp (Fig. 2) normal to the *resultant of pressure* R exerted by the flowing fluid on the section of the blade under consideration. As a rule, this plane pp is not parallel to the chord cc of the section, but for small angles of attack (but not extremely small) the angle between cc and pp is not large. This applies only to small angles of incidence between W_1 and the section under consideration, and is correct only in the first approximation, though sufficiently correct for practical purposes.

I have arrived at this conclusion from a study of the phenomena of flow, and this is only an attempt to indicate more precisely the direction of the plane of reflection experimentally discovered by Professor Brooks. But there is more to it. As the incidence of W_1 with respect to the section increases, then, from a certain moment on, the flow of the fluid in the rear of the section ceases to be permanent, and eddies are formed to the rear of the section (Fig. 3). This fact is beyond all doubt, and is confirmed by numerous experimental investigations, as, for example, those carried out at Teddington. In such a case it is more difficult to speak of the direction of the reflected air current, and it becomes necessary to introduce the conception of a current equivalent to the complex system of flow.

It can easily be seen how really complex is this problem, but the method which I use in my theory enables me to take into account all the phases of the phenomena of flow without having to resort to any simplifying assumptions. However, before I can explain how I attained this result, I have one more remark to make.

Let us consider a section of the blade which the air current strikes successively in the directions W_1, W_2, W_3 and W_0 (Fig. 4). The first resultants of the fluid pressure will be respectively R_1, R_2, R_3 and R_0, which means that as the incidence of W with respect to the section of the blade decreases, the resistance of R comes, so to speak, to lie in the section, and finally a moment arrives when W and R have the same direction. At that moment R has no component in a direction normal to W. I call *zero plane* (*zero* straight *line* on the section) the plane containing R_0 and W_0 when the component of R normal to W is zero. This zero line is located as indicated in the figure for nearly all sections of a propeller blade, and the angle which the zero line makes with chord cc (Fig. 5) depends on the profile of the section and may reach values in excess of 10 deg. For the majority of sections which I have examined this angle is comprised between 3 deg. and 12 deg.

When it is desired to compare a section of the blade to a thin ideal plane (geometric), it is of the utmost importance that the start should be made from the zero line and that all the characteristics of the section should be referred to it. Thus, the incidence or angles of attack should be measured only from

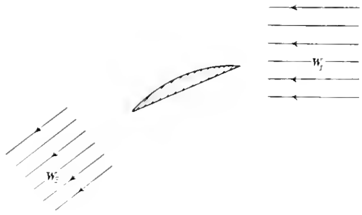


Fig. 1

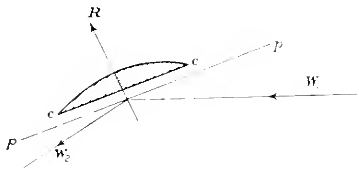


Fig. 2

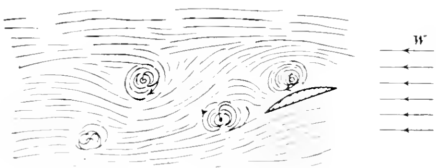


Fig. 3

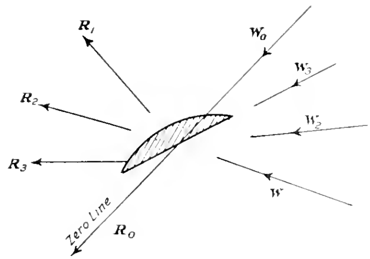


Fig. 4

this zero plane. Likewise the pitch of the sections should be measured from the zero line and not from the chord.

The greater part of all misunderstandings concerning propellers are due to this fact. In Fig. 6, r is the distance from the axis of the propeller of the section under consideration; H is the pitch measured from the zero line, W the velocity of the flow of fluid as it reaches the section under consideration. I call the pitch H when measured in the way indicated above

[1] D.Sc., University of Paris. Now acting in an advisory capacity to the Aircraft Administration, Washington, D. C.

effective pitch as opposed to the geometric or constructive pitch measured from the chord. Only the effective pitch can be considered as the geometric and real characteristic of the propeller, and the author fully agrees with Professor Brooks in that the only possible definition for slip is

$$s = \frac{H - (V/N)}{H} = 1 - \frac{V}{NH}$$

where V = velocity of translation
N = number of revolutions
H = effective pitch.

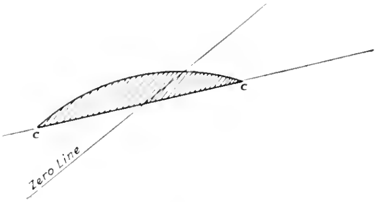


FIG. 5

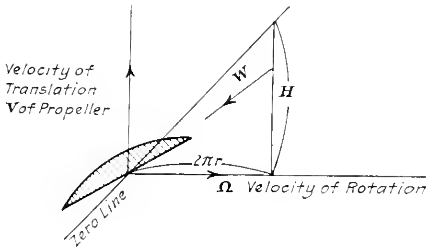


FIG. 6

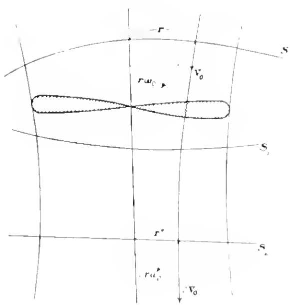


FIG. 7

It is the effective pitch which should be taken in measurements. The *effective pitch* is always greater than the *constructive pitch*, and that is why if for H in the above formula were taken the values of the constructive pitch, it might happen that negative values would be obtained for the propeller slip s, which is contrary to reason. The effective pitch, on the other hand, always gives positive values for s and the consideration of the effective pitch H is all that is necessary in order that the difficulties in the way of understanding the exact results of the experiments of Professor Brooks should disappear completely.

Let us consider the fluid stream generated by the rotation of a propeller; in particular, the case of a propeller rotating on a stationary basis (the following reasoning is, however, perfectly general).

I designate by S_1 (Fig. 7) the furthermost section to the rear of the propeller and by $2v_0$ the velocity at one point of that section. $2v_0$ is the velocity of the fluid parallel to the axis of rotation at the given point and $2r''\omega_0^2$ is the tangential component of this velocity. The real movement of the fluid is obviously helicoidal.

I show elsewhere that the section S in which the velocities of the fluid are v_0^2 and $r\omega_0^2$, that is, exactly one-half of the velocities at the section S_2, must be located necessarily in the front part of the propeller and at a certain distance from it. The propeller is, therefore, necessarily comprised between the sections S and S_2. The section S_1 is that which the eddy phenomena created by the propeller have already ceased to exist and the flow of air has become regular once more. The flow ahead of S is also regular, and my theory gives the exact values of the velocities v_0 and rw_0 (or $2v_2$ and $2r''\ \omega_0$).

The following are the values above referred to:

$$v_0 = r\Omega_0\zeta_0 \tan(\varphi + \beta_0)$$
$$\omega_0 = 2\Omega_0\zeta_0 \tan^2(\varphi + \beta_0)$$

These formulæ will show, in the first place, in accordance

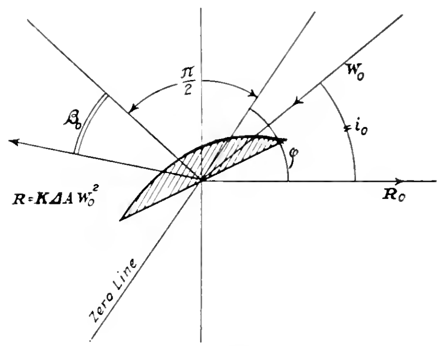


FIG. 8

with the experiments of Professor Brooks, that the ratios v_0/Ω_0 and ω_0/Ω_0 are independent of the number of revolutions $N = \frac{\Omega_0}{2\pi}$. In these formulæ

$$\zeta_0 = \frac{\frac{1}{2}\Delta M(2v_0)^2}{\Omega_0\Delta C_0} = \frac{v_0\Delta Q_0}{\Omega_0\Delta C_0} = \frac{\tan(\varphi - i_0)}{\tan(\varphi + \beta_0)[1 + 2\tan(\varphi - i_0)\tan(\varphi + \beta_0)]}$$

and with i_0 secured from this ratio, we have

$$u = \frac{nb}{2\pi r} = \frac{2\sin^2(\varphi - i_0)}{k_i \cos(\varphi + \beta_0)}$$

These formulæ contain by implication the fact that the velocity at a certain point in the fluid depends only upon the characteristics of the section of the propeller blade swept over by the fluid stream passing at that point, which is true as long as the radial velocities are negligible.

In these formulæ ΔQ_0 and ΔC_0 are the thrust and partial couple which correspond to the section of the blade under consideration and ΔM is the fluid mass which in a unit of time

passes across the annular space swept over by the section under consideration.

Let

φ = the angle of inclination of the zero line of the section under consideration on the plane of rotation

i_0= angle of attack

k_i and β, are the aerodynamic characteristics of the section under consideration (Fig. 8)

n = the number of blades

b = the width of the blades

nb = the total width.

These formulæ for v_0 and w_0 show again that the fluid stream generated by the rotation of a fixed-base propeller is geometrically similar to itself, independently of the velocity of rotation of the propeller, and the rear angles of attack i_0 are independent of the value of Ω. The values of the angles i_0 depend only on the shape of the blade and its pitch.

I have already by experiments confirmed the values of v_0 and w_0 given by my theory.

S. W. Stratton[1] (written). The type of propeller employed by Professor Brooks in his experimental work differs so widely from the types in actual use that the extent to which the air-bat concept can be applied to propeller design cannot be foreseen. The new viewpoint is stimulating and suggestive, and especially welcome in connection with airplane propellers, where it is difficult to visualize what is actually taking place.

L. R. Gulley (written). It was the writer's good fortune to observe a few of the tests made by Professor Brooks, the results of which form the basis of this paper. On first examination, the most evident proof of the superspeed effect was the result obtained from the air helix or propeller arranged with short blades of such width that the entire circumference of the propeller was covered.

This arrangement prevents inert air from passing through the propeller, and would normally be an ideal condition for screw action as applied to hydraulic propellers. Anemometer tests, however, proved that the air was driven from the propeller in a reducing stream at a velocity in excess of the calculated amount derived from blade pitch and rotational speed, while the approaching air was drawn in radially toward the propeller.

The results clearly indicate the reflecting action of air, due no doubt to its volumetric elasticity, and it would seem that further research should develop data of value not only in the design of propellers, but also in improving wing action, and possibly reducing head resistance of the stationary parts of the airplane.

J. C. Hunsaker[2] (written). Professor Brooks' statement in his introductory paragraph that "the accepted theory of air propulsion does not accord with the facts," is not substantiated in his paper.

The aerofoil theory as set forth by Lanchester and Drzewiecki, and now commonly used for the design of propellers, requires no assumption as to how an aerofoil element obtains its thrust, but bases the evaluation of this thrust on actual aerodynamic tests. Professor Brooks in his paper makes an issue of the fact that calculated and actual propeller performances do not agree. This may well be accounted for by the necessary approximations made in design regarding indraft and a lack of definite knowledge of the action of the air at propeller tips and hub.

[1] Director, United States Bureau of Standards.

[2] Naval Constructor, U. S. N., Bureau of Construction and Repairs, Washington, D. C.

Professor Brooks' reflection theory, while it need not conflict with the aerofoil theory, is open to criticism. The assumption is made that particles of air act as independent bodies and not as parts of viscous fluid, and that they rebound from the propeller blade without interfering with the surrounding air. Photographic investigation of the flow of air around models does not show that any rebounding action affects materially the shape of the stream lines. Moreover, a rebounding action from the surface of an aerofoil is not in accordance with Dr. Prandtl's elaborate experiments demonstrating the existence of "bounding layers," nor does it harmonize with the "vortex theory of sustentation" which has been verified photographically.

In the first paragraph of his paper Professor Brooks says that the theory of marine propulsion has been transferred to air propulsion without sufficient regard for the extreme difference in the two fluids as to elasticity. As previously stated, the design of a propeller is based on aerodynamic tests of the particular blade sections employed. Any effect that elasticity of air may have on air-propeller performance is accordingly taken care of in the choice of the proper blade section. There is extensive experimental proof that within certain limitations the same dynamic laws hold for water and for air. Perhaps the most striking example is afforded by a comparison of photographs of flow of air and water by models (Eden British Report No. 49). (In my paper given before the International Engineering Congress, 1915, I showed that the compressibility of air is mainly of theoretical interest.) A comparison of propeller tests made at the Navy Yard, Washington, with tests made by Dr. W. F. Durand, shows that there exists a close agreement between propellers tested in water and those tested in air and that it may be sufficient in particular cases to apply a correction only for the ratio of densities as the compressibility of air is not a serious factor. The important effect of viscosity was not considered in Professor Brooks' paper.

Regarding the conclusions drawn by Professor Brooks for static propeller tests, the following may be said:

No account was taken in his demonstration of "superspeed" for the acceleration of the air before coming in contact with the propeller blade. In consideration of tests made at the National Physical Laboratory and by Eiffel, Professor Brooks' theory does not seem to warrant the neglect of "indraft."

A prediction of full-flight performance from a single static test as suggested does not take into account the critical changes which occur in the thrust of a propeller, as the angle of attack of the blade varies, due to a change in the velocity of translation. It is not clear how a static test can foretell flying performance unless the aerodynamic properties of the particular blade are known.

M. B. Sellers[1] (written). When a propeller is constructed having zero pitch, that is, the face or driving side exactly parallel to the plane of rotation, and having the usual cambered back, it is found that this propeller exerts some thrust and delivers a considerable blast of air. Of course, there can be here no batting action, and yet we have a blast, due, in my opinion, to the fact that the rarefaction at the trailing edge on the back of the blade initiates an air stream. If now we try a similar propeller, but with an appreciable pitch, we find that the air stream now produced is approximately the sum of that due to the cambered back plus that due to the pitch. On the other hand, if we employ a propeller having a blade flat

[1] Member Naval Consulting Board of the United States, Baltimore, Md.

back and front, the velocity of the air stream, correctly measured, will about equal the geometric-pitch speed. It would seem to me, therefore, that the increased velocity of the air stream observed is not due to batting action, but to the effect of the rounded back of the blade.

LIEUT.-COL. J. G. VINCENT[1] (written). I have submitted this paper to our propeller expert, F. W. Caldwell, and have asked him to give me a brief report, which he has done as follows:

"We have had some correspondence with Professor Brooks in regard to his theory of propeller design. He seems to be working under the impression that we wish to produce a noiseless propeller regardless of its efficiency.

"The first model propeller submitted by Professor Brooks to the National Advisory Committee of Aeronautics showed an efficiency of only 38 per cent in contrast with a model of Professor Olmstead's which showed an efficiency of $89\frac{1}{2}$ per cent.

"Professor Brooks' paper is interesting from a theoretical standpoint, except that he seems to have drawn the wrong conclusion from his investigations. He seems to be under the impression that propellers with small diameters will produce good results, whereas all experience and all the usual propeller theories show that under most flying conditions the greater the diameter of the propeller, the better the efficiency obtained."

WALTER C. DURFEE (written). The most interesting explanation of superspeed as noted by Professor Brooks is in terms of the contraction of the jet or blast shown in his Fig. 3. It seems certain that the velocity of flow actually among the propeller blades cannot be great enough to drive the propeller any faster than it is being driven by the motor, unless the apparatus is acting as a windmill and the driving mechanism acting as a brake. The observed superspeed then is acquired immediately after passing the blades or may even exist to an extent at the blades, but in oblique directions. The contraction of the blast shown in Fig. 3 corresponds to a doubling of the speed of the propeller blast almost immediately after leaving the propeller.

An interesting explanation of this contraction and acceleration of the jet speed may be had without detriment to explanation in other terms by trying to study the action of the jet upon itself. The blast of a propeller of low pitch or of many blades is approximately a continuous jet or stream of variable cross section. To describe it we may use the language of vortex motion. It is the same jet in any language. At its center this jet contains a complicated system of vortex motion corresponding to the internal rotation of the jet and the comparative lack of motion along the central axis.

The outside surface or sheath of the propeller blast is the seat of a second vortex system which is mainly responsible for the velocity of the blast and for the annulment of rotation and velocity in external regions. This outer system, which mainly determines the velocity of the jet, coils like a helix around the blast, with its origin at the propeller tips, much like the two serpents which coil about the "caduceus" or winged wand of Hermes, their two heads beneath the wings. Imagine these two serpents or snakes to grow interminably, continually fed from the propeller blades and their bodies rolling along as vortices between the jet and the outer air. Imagine too that every particle of moving air is the servant of these serpents and that the serpents themselves writhe with a motion exactly determined by the influence of all the neighboring coils. The result is a simple example in turbulent motion. The exact calculation of the motion of the serpents or vortices is not without importance if it can be accomplished. The thrust of the propeller, for example, depends on its angle of attack against the relative wind, and this relative wind is the abject slave of the serpents or vortices which feed on the propeller.

For the purpose of studying the reason for the contraction of the jet as mentioned by the author we may imagine that the jet is momentarily made straight and uniform like a pipe, i. e., uniform vortex coils from end to end. Under these conditions there is a collapsing motion at the entrance or beginning of the jet because the motion of the air here is due to the vortices immediately in front which roll inward as viewed from the propeller. The velocity also in the supposed straight-walled blast may be studied. A forward component is provided by all the vortex coils. Within the tube the in uenee of these is felt both in the front and in the rear of any point, so the velocity is greater inside than at the entrance to the tube where the influence is only in front. On the whole, the action of the jet upon itself is in favor of a contraction near the origin, and in favor of somewhat slower motion at the entrance than at a point a little within the jet.

If we could persuade a professional mathematician to "bell the cat" for us it would indeed be a splendid achievement to become able to calculate superspeed as Professor Brooks has suggested will some day happen. Until we can get the exact formulæ which he foresees, I think we should congratulate him very heartily on providing us with useful data on the subject of superspeed.

Mr. Durfee prefaced the presentation of his written discussion by saying that he wanted to defend Professor Brooks' ideas, and to do this the simplest way was to explain practically all the nine different theories of the action of the air going round a blade of a propeller. These theories were: The Screw, Bat, Vacuum, Stream-Deflection, Momentum, Hydraulic, Purely Mathematical (with variations), Impulse, or Side-Pressure, and Vortex, or Whirlwind theories.

The screw theory assumed that air is very nearly solid, on account of its inertia. The propeller was assumed to screw through it as if it were a block of wood. Next the additional

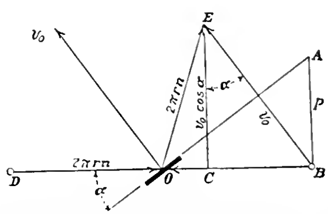


FIG. 9 DIAGRAM ILLUSTRATING TEST CONDITIONS FOR A WIDE-BLADE PROPELLER (BLADE ANGLE $\alpha = 36$ DEG.)

assumption was made that the air is not solid, that it has some slip. This we knew from experience.

The bat theory took account of the motion of the air after it left the blade, and if Fig 9 (Fig. 1 of the paper) were examined, it would be seen that the author had shown the reaction against the blade as perpendicular to the surface. It did not make much difference whether it was a baseball, or a sand blast, or a stream of air; there was not much friction to that surface and the reaction was substantially normal to the

[1] Chief Engineer, Airplane Engineering Dept., Signal Corps, U. S. A.

surface. It had to be. It would also be noticed that the velocity DO branched off and became motion OE. In other words, the stream of air did not lose much energy as it went past, and as far as the mathematics showed, he saw no difference whether it was a baseball or a sand blast or a stream of air. There was not much energy lost; the reaction had to be in about the same direction. He thought the origin of the criticism of Professor Brooks' theory was the feeling that if air consisted of a number of particles they could not all come down to the surface and go back to the same space. There could not be two directions in the same place.

The vacuum theory was based on experiments which showed that the partial vacuum on the top of the wing was numerically larger than the positive pressure underneath the wing. The difference in pressure held the wing up. It was not the vacuum, it was not the pressure; but it was the difference between the pressure below and the vacuum above.

The stream-deflection theory assumed that a stream or layer of the air came along and struck the inclined plane, i. e., the propeller blade, and was thus deflected. The question was: What supplied that force? The trouble with the theory was that one had to decide how big was that stream. The active stream merged into the surrounding air, and it was necessary to assume a stream and guess its proportions and how it was deflected.

Exponents of the momentum theory said, "Never mind what happens around it. If the air strikes against the blade, the air is going down behind it; how fast it is going down is told by the slope of the blade." They calculated the weight of air and how fast the blade was going down with the weight, how much impulse must have been supplied to produce that motion, and they obtained a result.

What he called the hydraulic theory of this sustentation was this: Where the water was going fast through a venturi tube there was a low pressure; where it was going slow there was a high pressure. With a thick wing such as the author mentioned, one could readily imagine that the air went a little faster over the top than over the bottom. Therefore, from the simple theory of hydraulics one could calculate where the pressure was low and where it was high. This pressure difference lifted the wing. The hydraulic theory had advantages when one was calculating the action of a propeller in a pipe. The ordinary theories could not be used as in the open where the air was supposed to stand still and be hit; the back pressures, etc., must be considered.

The mathematical theory assumed a perfect fluid: Find what a perfect fluid would do and thus learn what a real fluid would do. Lord Kelviu had said: "Here is what a perfect ı uid will do. My guess is that if the air had a little bit of elasticity or a little bit of viscosity this action would not occur and a totally different action would take place." Then he proceeded to tell what it would be.

H. F. Hagen said that the screw theory as mentioned in the paper, with the idea that a screw went through a solid mass either in air or water, had never been used by any designer or scientist. As originally presented by Rankine, it allowed for a certain slip. The term slip, however, was rather unfortunate. We were accustomed to say that a propeller could not do any work unless it had a certain slip, but it would be much better to say that a propeller could do no work unless it had produced rotation in the direction of the rotation of the screw. That had been proved by a number of investigators and to disregard it would be entirely incorrect.

The vacuum, stream-deflection, momentum, hydraulic and mathematical theories enumerated by Mr. Durfee he thought could all be combined under the term "stream-line theory." Professor Brooks' theory did not take account of the discharge side of the propeller, and as the speed of the fluid on the discharge side was certainly faster than the speed of the fluid entering, there could be no continuity. That would require water to be broken up into droplets, or air to behave like a cloud of non-interfering dust particles. The chief objection to this was that air or any other fluid did not work that way. Any one who had ever observed the flow of smoke around the blade would have noticed that there was only one stream line really that touched the blade—the others were formed flowing around smoothly.

Any propeller theory to be complete ought to explain both the action in air and water. Both were fluids and the difference between them was not one of elasticity but of compressibility. Air was compressible, water practically non-compressible. Making due allowance for compressibility, density and viscosity it should be possible to predict the performance of the air propeller from that of the water propeller. There were questions as to the latter regarding the shape of the stern of the vessel, the free surface of the water, and the bottom, which all combined, so that although the general theory might bring the two together and reconcile the airplane propeller and the water propeller, he doubted very much whether tests on water propellers could ever be used for air propellers, because although the stream lines might be similar, yet it would be impossible to transfer any quantitative results from one to the other.

Mr. Hagen then entered into the discussion of the air-propulsion theory propounded by Rateau, which, he said, was about the most satisfactory one that had been presented. Owing to time limitations, however, he was unable to complete his remarks but promised to present them later in writing.

A FOUNDRY COST AND ACCOUNTING SYSTEM

Discussion of Paper by Prof. W. W. Bird

In Professor Bird's paper a foundry cost and accounting system was outlined which has been developed as a result of experiments carried on in the commercial foundry at the Worcester Polytechnic Institute. The system, the author stated, is giving good satisfaction and has been found to be thoroughly reliable as a signal system. It is based on the principle that the three most important items of cost are core labor, molding labor and pounds of castings produced, and that each of the other items of cost is a function of one of these. All of the work involved can be done by the regular clerical force of the foundry in a small amount of extra time.

Written discussions of the paper were presented by Benj. D. Fuller, R. S. Denham, R. E. Newcomb and M. J. House, and it was orally commented upon by Dr. R. Moldenke, Malcolm Libby, Wm. L. Walker and William Kent. These discussions are given below.

Benj. D. Fuller[1] (written). The cost system presented by the author is in the right direction and probably satisfactory as an accounting guide for a foundry such as the one where it has been applied; but in my estimation it does not go deep enough to be thoroughly successful in accounting for the costs of a large concern. Too little attention is paid

[1]President, American Foundrymen's Association.

to the question of overhead distribution, which is a very important factor.

Overhead is in some cost systems carried entirely as a percentage on direct labor cost; in others as a percentage added to poundage or weight. A more equitable distribution is to divide, carrying a percentage on labor and another percentage on weight. Some castings require an excess of labor for a minimum of weight, in which case the labor overhead would be the larger in the accounting, and justly so. But imagine a casting of excessive weight and a minimum amount of labor, such as a large floor plate cast in open sand. Here the weight basis of overhead would, in accounting, rightly carry the bulk of load.

Cost systems giving individual casting costs are much more valuable than those where the output is handled in bulk or weight classifications.

In the third paragraph of the paper it is stated that "the three most important items were core labor, molding labor, and pounds of castings produced." To these should be added cleaning labor, which varies widely in cost with the class of work.

The fifth paragraph says that in the general scheme used an account is charged with the amount of the purchases made during the month. Payroll charges in connection should not be forgotten.

In the sixth paragraph it is said that "All expenses are charged to the Expense Account." There should be subaccounts for the various classes of expense to care properly for these charges.

The items Core Work, Molding, and Metal and Melting which the author uses in his records, should each carry a share of building repairs, light, heat, depreciation, insurance, taxes, administration, etc.

ROBERT S. DENHAM[1] (written). Product of whatever kind, consists of materials and the time of formative processes. In this paper the material is Metal, and the formative processes are Core Making, Molding, and Melting.

By analysis we find that the handling of materials or metal involves the expenses of transportation, handling labor, rent of stock yard or room, interest and insurance on investment in material, shrinkage, etc.

Analysis of the formative processes will show that each requires more or less of the following expenses: Rent, heat, building repairs; depreciation, interest, insurance and taxes on equipment, power, light, water, ice, compensation insurance, supplies, repairs to equipment; wages of workmen, etc.

Administration and selling expenses include salaries, advertising, office supplies, telephones, bad accounts and collection expenses, discounts, commissions, etc.

Further, there must be consideration of the expenses of packing and delivering the product to the local consumer or freight house.

Professor Bird arbitrarily selects the process of core making and charges it with the expenses of wages and supplies, the latter being charged on the basis of 30 cents to each dollar of wages paid to coremakers. None of the other expenses is considered in connection with core making.

He then burdens the molding with all of the other expenses of the business, including all of the operating and administrative expenses required by the core making and melting except an unexplained charge of 30 cents per 100 lb. on the melting process. His basis for the charge of this mass of unrelated items is the wages of the molders.

[1]Consulting Cost Engineer, Cleveland, Ohio.

For some reason, also unexplained, he selects the items of supplies from the mass and charges for these at the rate of 6 per cent, while what he calls "Expense" is charged at the rate of 75 per cent on the wages of molders. Since both have the same basis in his plan the same result would be obtained by a single charge of 81 per cent.

A practical degree of exactness is essential in a matter as vital as the cost of production, and the writer holds the following principles to be fundamental:

1 The cost of an item of product is the sum of the expenses involved in its production and distribution up to the moment at which cost is determined.

2 Every cost element (expense item) is definite in amount, and purpose, and anticipates a beneficial equivalent in service or commodity.

3 In the distribution or charging of expenses consideration should be given to the benefit derived that the charges may be justly assessed where the benefit is conferred and in true proportion to the measure of benefit.

If each of the above-mentioned items of expense be now considered it will be found that not one of them bears a relation to wages such that the benefit conferred by the expenditure increases or decreases with fluctuation in wages, or as between the product of men receiving different rates of wages. Neither is there a relation between the wages paid and the total of these items applicable to the product of the workmen.

No scheme of cost accounting which involves the distribution of a mass of expenses under the title of "overhead" or "burden" will bear analysis. The correct determination of cost of product can be accomplished only through the comparatively new analytical method known as Cost Engineering, in which each process is considered separately and each item of expense individually applied by measurement so that expense and benefit are in identical proportions, making it impossible for one process to carry any of the e pense belonging to another.

ROBERT E. NEWCOMB (written). It is axiomatic that in the management of any business, facts, not surmises, must form the basis for operating.

While the costs of core materials, molding materials, expense and melting may be functions respectively of the core labor, molding labor and pounds of castings produced, they are at the same time variable functions and hence, basically, surmises which cannot form an accurate basis for operating.

The object of cost accounting is to establish and fix profits, and a cost system should strive to get the absolute facts and figures. To arrive at proper cost, the following well-established formulæ must be used:

Cost of Material + Direct Labor = Prime Cost
Prime Cost + Direct Factory Expense = Factory Cost
Factory Cost + General Expense = Cost to Make
Cost to Make + Selling Expense = Cost to Make and Sell

and in foundry cost accounting it is essential that the cost be built up from the following items representing the total of accumulated details: Core Labor, Supplies, Mold Labor, Chipping Labor, Miscellaneous Labor, Melting, New Metal, Scrap, Other Expense, each item in sum total.

The accumulated details should be obtained from the record of the actual number of units of material used from day to day and the actual number of hours of labor. The cost of material delivered during a current cost month should not be used as a basis of establishing costs, as is apparently suggested by the author, as it would not give a true cost for the

reason that the material entering the castings, especially in a foundry carrying a stock of iron, may have been delivered at a price differing considerably from the cost for the current month. This difference in price may make a considerable fluctuation in the selling price, which would apparently cause the foundry using this method to quote both low and high prices at the wrong time. A better method would be to average the cost of the pig iron and material in stock, preventing fluctuation in apparent cost and selling price.

As a signal system to indicate the drift of the cost, a daily estimate may be made based as follows, assuming a specific case for illustration:

Let M = total number of men = 175
T = total melt in tons = 35
P = average proportion of good castings in melt = 0.7
L = average cost of labor per man-hour = \$4
I = average cost of metal at ladle per ton of good castings = \$25
S = average cost of supplies per ton of good castings = \$10
m = average men per ton of good castings
$= M/(T \times P) = 175/(35 \times 0.7) = 7.10$
l = average labor cost per ton of good castings = $m \times L = 7.10 \times 4 = \$28.40$
C = total cost per ton of good castings
$= l + I + S = \$28.40 + \$25.00 + \$10.00 = \$63.40$

The above figures are actual or based upon the previous month's accurately established costs, and from day to day are reasonably reliable signals indicating to the live foundryman the drift of the cost for the current month; and in the respect that they are available from day to day corrective measures may be taken to reduce greatly increasing costs before having run to a disastrous extent.

M. J. House[1] submitted an extended written discussion of the paper, in which he indicated wherein it appeared to him that the author's plan failed to provide adequately for cost and accounting requirements under the ordinary conditions of a commercial foundry.

While not doubting in the least that, as stated, the system was giving excellent satisfaction, that the data it kept before the foundry officials were thoroughly reliable according to the plan and that clerical work required but little extra time, it did not follow that the costs were "fairly accurate." Numerous systems were in use which fully satisfied those who used them and, in many plants, statistical data of great importance were compiled, yet the costs obtained were far from dependable.

In the third paragraph the author set up three independent variables, namely, Core Labor, Molding Labor and Pounds of Castings Produced, as the most important ones and considered all other items of cost as "functions" of some one of these.

As a general proposition, however, there were seven variables equally important, owing to their direct influence on costs although not in like proportions. These seven were Pattern Labor, Core Labor, Molding Labor, Melting Labor, Cleaning Department Labor, Materials and Supplies and Pounds of Castings Produced. Like a majority of founders, the author ignored the fact that labor employed in the pattern shop was directly related to production, was chargeable directly to jobs or classes and was not an item to be prorated over production as a whole if of consequence; there was no more reason for doing so than for the diffusion of Molding Labor in the same way.

The difficulty referred to in respect to split payrolls, Mr. House believed, was more imaginary than real; as, if accounting classification was properly devised and followed, the manufacturing accounts might be tied in with financial records without use of split payrolls and the twelve cycles for comparison annually might consist of two periods of four weeks and one of five weeks each three months.

He was not prepared to dispute the statement that the cost of melting varied directly with pounds of castings produced, but unless the quantities of the several patterns cast were identical each month, he was at a loss to understand how such a result could be achieved, as the cost of melting actually varied according to quantities of gates, sprues, defectives, over-metal etc. Unless the product was practically uniform from month to month, the melting credit could not possibly parallel the production.

Mr. House then outlined a cost accounting plan that he had found to be very simple, highly accurate and easy of application. In it melting and departmental expense rates were predetermined, all expense was concentrated into six rates and—when cost computations were made—which might be at any time a lot of castings was finished, the only factors to be dealt with to obtain Shop Cost were Metal and Castings, Direct Materials, Direct Labor, Departmental Rates and—sometimes—special costs in the form of patterns, flasks or other special rigging.

R. Moldenke. I find that Professor Bird's work, while of an extremely varied character, is still a work which is a continued operation. His cores and molds are about the same all the time; there may be large castings and small castings and varied work, but they repeat themselves to an extent that will allow him to draw his conclusions. This system is good for his work but may not be fit for different work, and these discussions fall back on the fact that they want more exact cost where the work varies, whether there are few castings or many castings. The pilot-light system is a good one when applied to current practice. We want to know costs as exactly as we can get them. There comes a time when it may be good to get some percentage division, particularly of the overhead in the nature of the work. For instance, few shops differentiate from the ordinary floor plate of the engine bed or light casting. It is important that they should do so because the overhead should be differently distributed from one class of work to another. It may be found that line work is produced at large cost but small profit. There should be a division of the work into classes. Then comes the system of Professor Bird to distribute the overhead, particularly after some of the fundamental costs on the different classes are known, to show which line of work should be continued. I like the paper because it attempts to give a method of finding a system which will tell quickly whether one is making or losing money.

Malcolm Libby. It is to be hoped that Professor Bird will present at an early date this question of prices and bids because it would make clear many of the points of the paper, and in the discussion especially so, inasmuch as the judgment which is made on the foundryman, i. e., the superintendent's efficiency and capability, involves several factors. He mentioned an all-important one, namely, the selling price turned immediately back to production. Some companies are in a fortunate position in that they are able to establish the market price. Their cost systems must involve the principle which covers the ques-

[1] With C. E. Knoeppel & Co., New York City.

tion of determining the price quite as much as determining the costs.

William L. Walker. The idea of connecting the cost-accounting system with the accounting department, and being sure that in the costs in the foundry all the expenses found in the account books are so used, is important. Many plants have cost-accounts systems based upon the estimated account. The costs are never carried into finance the books closed, but at the end of each year there appears a large balance of unabsorbed expense. In Professor Bird's foundry the work likely goes along about the same, and the element of error entering into the factor of indirect overhead expense would not be as great as in a large foundry producing many items where there are different kinds of furnaces, of molding machines, and of departments. It is necessary to distribute the overhead expense by departments, by various types of operation, and put it there as an indirect cost, allowing for space cost, building depreciation, insurance, taxes, repairs, and other items entering into the expense. By a system of classification of expense these items may be put in the account records. In any cost system we can not get absolute accuracy—it is impossible. Costs can be put on in a manner that will show the results as nearly accurate as it is practical to go, i. e., to where it does not cost more to get the cost than the actual difference in the method involved.

William Kent. For the purposes of this particular foundry this system may give a close enough approximation to what Professor Bird wants to get; but I agree with the speakers who have preceded me in saying that the system will not do for any foundry operated on different kinds of products, and that some other system must be used. The objection to his method is that he uses factors and percentages. Generally speaking, averages and percentages and factors should be avoided. What we want is items summed up into totals and these totals put into proper reports, and if possible charted so that we can see how things are going. The idea of using an accounting system as a signal is good. The best signal is found not in an accounting system, but in the reports of tonnages and other items that are put in a table of monthly averages. The discussion will contribute largely to the value of the paper.

The Author. I do not believe in the cost system. If you want to see how our system works, go to our office. If those who criticize this paper can show a system comparable with ours in regard to the cost of keeping this system, I challenge them to bring it along. Our bookkeeper runs off this balance sheet, and he does not know anything about the foundry business, yet when the trial balance is made up we have our result. There is no other system that will give anything like that. I have made a study of the foundry business; I am president of the Broadway Iron Foundry, Cambridge, Mass., where we have used the system fifteen or twenty years. It is not a question of cost. We want to know if we are making money. This paper describes a cost-of-account system. This is a cost system based, or which starts, if you will, on the top of a pyramid. All the cost systems I have ever seen start at the foundation. We start at the very top. How much did you make last month? We have it immediately. I am glad one of the speakers pointed out that it is essential that costs should be tied up with the accounting system. That is seldom done. Some one asked why we did not put something in about labor. We consider that we purchase our labor; the labor is in the purchases. Understand, the paper deals with a cost-of-account system, not a cost system.

AN INVESTIGATION OF THE FUEL PROBLEM OF THE MIDDLE WEST

Discussion of Paper by A. A. Potter

In this paper the author showed by figures received from numerous power plants in the Middle West that their increased cost of producing power during the past winter was due to: *a* The increased cost of fuel; *b* The necessity of burning fuels of different grades with equipment suitable for one particular grade; *c* The greater amount of ash and other non-combustible matter; *d* The increased cost of labor and the poorer quality of labor available; *e* The increased cost of repairs, supplies and new equipment.

He then discussed the effect of increased expenses and fuel scarcity on isolated plants, detailed the various efforts which have been made to obtain better fuel economy, and outlined the work accomplished by the Fuel Administration Boards of Iowa, Louisiana and Illinois.

His conclusions were that future emergencies in the Middle West plants could be averted by more adequate fuel storage, by greater attention to fuel economy, and by the more careful regulation on the part of the Government of the quality of fuel leaving the mines and of the fuel-transportation facilities.

Written discussions embodying pertinent comment were contributed by Alex. D. Bailey, John D. Riggs and E. A. Uehling, and are as follows:

Alex. D. Bailey (written). Referring to the second paragraph of the author's conclusions, the cost of $15 per ton capacity for subaqueous coal storage pits might be very discouraging to anyone considering for the first time the storage of coal, as under ordinary methods of figuring fixed charges this would mean an annual cost of at least $2 per ton for the coal-storage equipment, exclusive of handling. Using locomotive cranes for handling coal into and out of open coal piles on the ground, approximately 10,000 tons per acre can be stored, and the depreciation due to weathering would be negligible compared with the cost of subaqueous storage plants.

By storing only screened or washed coal the danger from spontaneous combustion is reduced to a minimum; further, it is advisable to store the best coal obtainable, as in this way the maximum heat value is obtained per dollar invested in land and coal-storage equipment as well as in the coal itself. This applies also to the cost of handling, as good coal can be handled as cheaply as poor coal, both into and from storage, as well as in the boiler room, and as this storage is generally used under emergency conditions, when weather conditions are unfavorable, and when not only the coal-handling equipment but the operators are taxed to their utmost, the maximum return is assured for each ton of coal handled.

It should be borne in mind also that storage coal is generally required during extremely cold weather when shipping facilities are hampered and when everything is badly frozen. For this reason precautions should be taken to keep the storage as dry as possible to facilitate handling, as it can be readily seen that coal which is flooded in a storage pit, and frozen solid, will be unobtainable when needed most.

John D. Riggs (written). In regard to proper furnace design for small one-boiler plants using high-volatile coal, it has been observed that the combustion chamber is usually too small when working near full capacity, but ample at half load or less. This trouble may be partly overcome by having a rather large grate area, and bricking over a portion of it.

when working light. It would seem that better arrangements might be provided for lowering the grates and bridge wall in the fall, and for raising in the spring of the year, or when the load is to be light for a time. We think it is quite common practice with men accustomed to such coals to use a thin fire, and not attempt to crowd the boiler. With some other bituminous coals, especially the "dry-burning," we have noted the use of smaller grate surfaces, much thicker fire bed, higher chimneys, and a tendency to crowd every working boiler to the limit, even where a plant has several extra boilers.

During the past winter some householders had to burn bituminous coal of one class for a period of perhaps twelve days, then change to another class for a similar period, and then change again, until when spring finally came, we found that about six varieties of fuel had been used, some bearing unfamiliar names, and one lot with no name at all. The net result of this may be estimated as 30 per cent extra coal on account of an unusual winter, and another 30 per cent extra on account of unusual conditions, beyond control.

Now comes the slogan, "Buy Your Fuel Early." This is common practice for the man who heats with coke or anthracite, but not at all for the one who uses many of the western bituminous coals, and even dangerous practice to some men who have often seen an outside coal pile at a power plant on fire. Such fires seldom do much damage at the power plant, but may lead to the destruction of a home.

E. A. Uehling (written). Early in the paper the author says: "Suggestions have been made by power-plant engineers that the Fuel Administration should regulate the supplies from the different mines in such a manner that individual plants would get their supply of uniform grade." This would be a wise procedure if it could be carried out, but in the case of acute fuel shortage, when whatever is available must be taken, it will not work out. The Government's zoning proposition if properly carried through should operate in favor of this suggestion.

It goes without saying that it is more difficult to burn heterogeneous mixtures of coal efficiently than coal of a uniform grade; but even the most uniform grades of coal are liable to vary appreciably in their ash and moisture content as well in the ratio of coarse to fine, and will not run over the grates uniformly with the same stoker speed, and the air supply will therefore require frequent readjustments at best. The proper slogan for the engine room should be: *Watch your adjustments and keep them right and your results will be right,* but that for the boiler room must be: *Watch your results and change your adjustments to keep them right,* if attainable efficiency is to be achieved and maintained. There is no such a thing as fixed adjustments in the economic operation of steam boilers. Automatic adjusting devices do not and cannot produce maximum economic results.

The steam gage is the monitor of the boiler room. Combustion must be increased or decreased as its hand points below or above the standard pressure. The steam-flow meter indicates whether the boiler responds to the accelerated or slackened steam production dictated by the steam gage; neither gives any information as to whether the fuel is being burned economically or wastefully; but unless this information is continuously before the fireman, he is working in the dark, and the highest economy attainable under the prevailing operating conditions cannot regularly result.

The percentage of CO_2 in the products of combustion is a true index to combustion efficiency. It is a correct measure of the excess air supplied and the continuous CO_2 indicator at or near the boiler front is the only practical means by which the fireman can tell with any degree of certainty whether his draft is properly adjusted to meet the variable combustion requirements economically. I hold that a fireman can operate a given boiler equipped with a continuous CO_2 meter to guide him more economically, burning coal of variable grade and composition (within reasonable limits), than he can with coal of a normally even grade without such a guide.

Mr. Potter cites many instances where coal of abnormally high ash content was foisted upon helpless consumers during the fall and winter of 1917-1918 by unscrupulous coal operators, the coal in some cases carrying from three to si: times its normal ash content. "In general," he says, "the ash content in the fuel used during 1917-1918 was at least 5 per cent greater than in former years, due to faulty methods at the mines."

When we consider how intensely the shortage of coal required by the industries was aggravated by the e cessive ash and slate contents of the coal, and that the shortage was not due to lack of miners or mining facilities but to car shortage and transportation overburdened by something like fifty million tons of slate and the ten to twenty million tons of coal required to melt it into clinker-obstructing boiler operations, we should not let this catastrophe pass over by merely stating that it was due to "faulty methods at the mines."

When we further consider the retarding effect on the production and shipment of most vital and urgently necessary war supplies, the damage done to the industries of this country in general, and last but not least, the intense suffering caused to millions of poor and even many well-to-do people, I think the "faulty methods" should be stigmatized as nothing short of criminal profiteering, in comparison to which the notorious embalmed-beef scandal of our misconducted Spanish war was an insignificant episode.

Upon the recommendation of its technical committee the Compressed Air Society has adopted the following definitions of certain terms in order to eliminate confusion as to their exact meaning.

Displacement. The displacement of an air compressor is the volume displaced by the net area of the compressor piston.

Capacity. The capacity should be expressed in cubic feet per minute and is the actual amount of air compressed and delivered, expressed in free air at intake temperature and at the pressure of dry air at the suction.

Volumetric Efficiency. Volumetric efficiency is the ratio of the capacity to the displacement of the compressor, all as defined above.

Compression Efficiency. Compression efficiency is the ratio of the work required to compress isothermally all the air delivered by an air compressor to the work actually done within the compressor cylinder as shown by indicator cards, and may be expressed as the product of the volumetric efficiency, the intake pressure and the hyperbolic logarithm of the ratio of compression, all divided by the indicated mean effective pressure within the air cylinder or cylinders.

Mechanical Efficiency. Mechanical efficiency is the ratio of the air indicated horsepower to the steam indicated horsepower in the case of a steam-driven, and to the brake horsepower in the case of a power-driven, machine.

Overall Efficiency. Overall efficiency is the product of the compression efficiency and the mechanical efficiency.

The Society further recommends that the use of other expressions of efficiency be discontinued.

ECONOMIES IN MANUFACTURING IN THE CANNING INDUSTRY

By J. H. Shrader,[1] Washington, D. C.

This paper, which was presented at a meeting of the Baltimore Section on March 12, 1918, outlines the general procedure followed in tomato canning and points out the numerous sources of loss. The manufacture of concentrated tomato products is described and in particular that of tomato paste, a seedless and coreless food product which, compared with ordinary canned tomatoes, cuts down the fruit waste from 50 per cent to 5 per cent, requires much less labor in its preparation, saves two-thirds of the expenditure for tin plate and greatly reduces shipping costs.

At the same meeting a paper entitled Investigation of the Uses of Steam in the Canning Industry was presented by Prof. Julian C. Smallwood, of Johns Hopkins University, which was again presented at the Spring Meeting of the Society in Worcester and printed substantially in full in the May issue of The Journal. In this paper Professor Smallwood analyzed the different heat processes employed in the canning of food, described the various forms of apparatus used, and pointed out actual and ideal steam consumptions and methods of minimizing waste. The two papers taken together form a valuable survey of the present technical status of this important food-preserving industry.

When one interests himself in the manufacturing aspect of the great steel industry, he finds the whole procedure made up of a number of more or less isolated processes each complete in itself but contributing its share to the completion of the whole. He sees machinery everywhere and most intimately connected with the whole process of steel manufacture from extracting the iron from the ore to turning out the finished goods. As perfect as the whole operation seems, the intelligent investigator will not be surprised when told that the technologists operating the plant can point out most serious deficiencies in many places, and that the whole staff is continually striving for improvements. One also expects to find great technical developments in the copper industry. Large engineering and chemical staffs are employed to devote all their time to surmounting difficulties and controlling operations. In these great industries we expect complexity and its attendant problems.

But when one considers such industries as that of canning, he naturally wonders where there might be any difficulties of moment, and where there can be the need for much mechanical application. Surely, if the activities of our wives and mothers during the canning season are any criterion, the whole procedure seems simple enough. So seems the iron industry when one seeks to make 5 lb. of iron in a day or two, with a whole forest back of him for charcoal and no time factor to be troubled with. It was the economic pressure of quantity against time that forced the ironmasters from counting pounds to counting tons. The same conditions forced food manufacturing likewise from the pound basis to that of tons. But the necessity of this capacity consideration is only the first of a number of problems. If the ironmaster unexpectedly has an extra lot of ore dumped at his plant, or if his plant shuts down for any reason, the iron ore can be readily stored until such time as the superintendent calls for it. His operating season is the whole year.

The canner, however, figures on a brief season of a few months of intensive effort in which he has to make whatever he can and then close up and wait three-quarters of a year until the next season. Consequently he plans to keep his plant running nearly to capacity while the running is good. Any unexpected glut of raw material together with factory shutdowns always accompanying capacity stride means a slip somewhere—either a loss due to inefficient operation or spoilage, or both, for raw food products can not be readily stored but begin to spoil before they are well on their way to the factory. It means get them into cans at once or lose them.

The operation of commercial canning consists of the following steps, and in general applies to about all the fruits and vegetables used:

1 Preparation of the material for canning, such as sorting out the spoiled, washing and trimming
2 Packing into cans, either by hand or machine
3 Adding the necessary juice, likewise by hand or machine
4 Exhausting, or reducing the pressure within the can
5 Sealing either by the old method of soldering the top or by the new so-called sanitary method by which the top is pneumatically crimped on to the can
6 Sterilizing by heat in continuous or non-continuous retorts: and
7 Inspecting the cans for imperfect sealing, then labeling, boxing and shipping.

Procedure Followed in Tomato Canning

As applied to tomato canning, the above procedure operates as follows: Tomatoes in the Tri-State District (Maryland, Delaware, New Jersey) are usually shipped either by boat, car or wagon in what is known as the ⅝-bu. basket, stacked, and piled several high at the destination. About the only advantage this method of shipping possesses is that the baskets are easily handled, are light and when stacked afford ventilation through the pile, thus reducing the inevitable spoilage to a minimum.

The tomatoes are then dumped into a scalder at the rate of about twenty baskets per minute, more or less, according to size and condition of tomatoes and rate at which they are used by peelers. This machine washes the fruit and by means of a continuous chain belt carries it through a jet of live steam, then quickly under a curtain of cold water. The short duration of the steam application localizes the heat mostly at the skin, while the sudden bath in comparatively cold water cracks the skin, thus rendering the latter easy to be removed. The procedure from here differs somewhat, but the essential point is that the scalded fruit is then dumped from the scalder belt into shallow pans or other receptacles which travel along a table provided with a moving belt about which are stationed the women who peel. As the latter are in need of tomatoes they slide the basket or pan of tomatoes from the moving belt on to a small shelf in front of them, peel the tomatoes over a trough or pan, and place the peeled fruit into a bucket. Sometimes tomatoes are brought to them and dumped into a stationary receptacle out of which the peeling is done. When the bucket of peeled tomatoes is full, the peeler is paid on the spot and is directed to place her bucket of tomatoes on the same or another belt, according to the system used. The peeled tomatoes are thus carried to the filling machines. In some factories the tomatoes are placed on a long table around which stand the girls who pack them into the cans by weight. In other cases the tomatoes are dumped into filling machines set to deliver a so-called constant quantity of the fruit into cans automatically placed to receive it, and in the same way carried away when filled.

[1] Chemical Technologist, Bureau of Plant Industry, Drug and Poisonous Plant Investigations.

The cans containing solid, comparatively speaking dry or drained tomatoes are then delivered to belts which convey them to machines where they are filled with tomato juice even with the top. This juice is collected from the receptacles of tomatoes, for after peeling the fruit loses juice continually all along the line until canned. Then the cans pass into the exhaust box.

The object of exhausting is to heat the contents of the can to a slightly elevated temperature so that when capped and cooled to atmospheric temperature the contraction of the contents causes a slight diminution in pressure. This is called exhausting. This heating is effected by live-steam jets and may last several minutes, depending upon the condition of the fruit, duration of contact, intensity of heating and quality sought.

From this box the cans are capped. If the old soldering process is used, the cans pass under a machine which washes off the top. A cap is placed over the hole by a girl and is soldered either by hand or by a machine. In the newer or so-called sanitary method the can passes directly from the exhaust box to the closing machine which sets the top on and crimps it pneumatically to the flange of the can.

Since tomatoes may be sterilized by heating to either 212 deg. fahr. for, say, 30 min., or 240 deg. for 10 min., it follows that in the first case an open tank of boiling water is sufficient, while in the latter event a closed retort similar to the autoclave of the bacteriological laboratory may be used.

After this treatment, called processing, the goods are stacked on the floor long enough to enable all faulty cans to manifest themselves, which they do in a manner never to be forgotten by any one who ever passes through a factory where they are stored! They are then labeled by hand or machine, boxed and shipped.

Sources of Loss in Tomato Packing

All of this sounds as if the packer's whole effort is to start the operation and all will then go well. The starting is the easiest of all. To maintain the pace and yet pack with a minimum of waste and lost motion is the important problem. Great as have been the strides in developing the art of canning, we have not half covered the ground from the standpoint of avoiding waste of material, not to mention the almost criminal waste of heat.

If the pack represents 50 per cent of the weight of the original raw stock, the packer congratulates himself on the successful yield. Sometimes it yields 65 per cent. Often it is down in the thirties. This means that if we take a 50 per cent yield as our basis, in Maryland we lose 71,000,000 cans or over $2,000,000 at $15 per ton of raw tomatoes, and in the United States 785,000,000 cans, or nearly $5,500,000.

The first place where good engineering practice is necessary is in the devising of an efficient sorting table. This is the tomato conveyor belt along the sides of which stand the women who pick out the unsound material. The object sought is a procedure whereby the unsound fruit can be detected without picking up each individual tomato to inspect the condition of the underside, and at the same time too rough treatment of the delicate fruit be avoided. Since much of the fruit is very ripe and all of it very juicy, any rough treatment will crack it, resulting in loss of juice and deterioration of quality. Efficient sorting consists in inspection of the whole tomato with ready means of removal and disposal of the unsound ones. Machines which rotate the tomato tend to crush the soft goods; spraying machines with strong sprays designed to dig out the decayed portions of the fruit, operate to destroy sound but at the same time very ripe stock; while plane belts equipped with ridges over which the tomatoes will tumble either do not work in a jam or contribute to shrinkage by cracking soft fruit.

The greatest actual loss occurs in the operation of peeling. Now give a woman time and she can doubtless peel a tomato with but little loss over that naturally expected due to core and juice. But if she is doing piece work and is paid by the basket, is not charged with the raw material and does not pay for the waste, then she ruthlessly cuts away much of the tomato in her haste and the packer pays double.

A 50 per cent yield is fair and one of 65 per cent extraordinary. The rest is absolute waste. The solid part is hauled away at a net loss; the juice, containing as much food and condiment value as the so-called solid portions, flows into the sewer. And we cry, "Increase the tomato acreage."

Another source of loss is the tomato filling machine. Imagine the effect on a tomato when it is forced up into a cylinder closed at one end by a piston and discharged through the small top into the can by the descending piston. To say the least the tomato is badly torn and the valuable juice flows away. Other types of fillers exist but each has its serious objections; most all of them not only tear the fruit more or less, but give unequal fills of the so-called solid matter by their inability to prevent the liquid portions from settling to the bottom of the hopper and leaving the upper ones dry. This is largely why the housewife complains that often she opens a can and finds it mostly juice with here and there a lonely piece of tomato. Of course, hand filling obviates such factors contributing to loss of quality as well as the very material one of loss of juice, but up goes the cost of packing!

The cans varying from half-full to overflowing of drained solids go to the juice filler. This is kept full of hot tomato juice and fills the can with juice even with the top. As explained above, this juice is from the drained fruit after peeling. It contains just as much food and condimental value as the more solid portion of the tomato and hence should be incorporated into the pack as an integral part of it. No machine has been invented which will fill a can to within a given distance from the top. If the tomato filler is working satisfactorily, from 5 to 10 per cent of juice is necessary to give the can a correct fill. If the filler gets out of adjustment due to a sudden change in the quality of the stock, or if the hopper is delivering too large a quantity of juice from the tomatoes crushed by the weight of those above, then the can comes through half-full of tomatoes. But the unthinking juice machine fills up the can with juice and we have another case of a watery looking pack. The top cannot be soldered on or crimped on to an absolutely full can. Provision is made by a dumper or other spilling device whereby this excess of juice is removed, leaving the level of the contents of the can approximately constant. Loss here may amount to as much as 15 per cent of the contents of the can.

The legitimate skin, core and seed waste amounts to about 5 per cent of the original tomato. The yield of goods in cans is 50 per cent, leaving a net loss of about 45 per cent. Almost all of this can be recovered and will amount to more than twice what the Government has commandeered to feed an army.

Manufacture of Concentrated Tomato Products

Wastes are not the only phases of tomato packing commanding the attention of engineers. Several other lines of tomato manufacture have been opened up involving engineering questions which are of moment not only to this industry but to

several others. This is the manufacture of the more or less concentrated products of pulped tomatoes used in soup and ketchup. Tomatoes are pulped in commercial practice by more or less disintegrating them either by crushing or a slight cooking, and passing them continuously into what is known as a "cyclone" machine (described later on) which separates the skin, seed and core from the juice and flesh of the tomato. A mixture of flesh and juice passes through together while seed, skin and cores are discarded as waste. This mixture of juice and disintegrated flesh is called cyclone juice and differs only from what is known as tomato pulp in the fact that it is not concentrated. This concentration of cyclone juice to the various pulps, sauces and pastes is an engineering problem pure and simple, and its successful operation can only be attained by applying engineering methods.

Concentration of tomato cyclone juice is effected by boiling out the water. It is this boiling that presents such problems to the industry. When one considers that the market value of the product depends on its thickness and color, he can realize that the factors determining quality militate against each other. Thus, to overcome this darkening by heat is the great problem. Since this is doubtless due to a chemical reaction, it possesses the factors of temperature and time. In other words, if we cook the juice quick enough or at a low enough temperature, good results may be effected. Vacuum evaporation secures the latter and gives a splendid product.

But this operation applied to tomato products does not present the simplicity of evaporation in vacuo of homogeneous liquors such as sugar syrups. Excessive foaming, caking in the heating surfaces of the pulpy fibrous mass, introducing the flavoring ingredients and handling the more or less pasty finished mass, all present problems which only recently have been satisfactorily handled by engineers.

Many tomato-pulping plants are not able to install the expensive equipment for vacuum evaporation or maintain the skilled service necessary for its control. To meet this demand engineers have endeavored to effect evaporation by several methods, all seeking to expose the rich and fibrous material to the action of air and temperature for as short a period as possible. Continuous evaporation, forced draft applied to ordinary steam-jacket kettles whereby dry air is continually removing the saturated air over the boiling mass, evaporating machines incorporating a rapid stirring of a small amount of juice exposed to a large heating surface for a brief interval, mechanical separation of fiber from the clear, colorless juice with high concentration of the latter, and then addition and mixing of the uncooked fiber to it, and boiling in wooden tanks with closed steam coils to insure absence of metallic contamination together with rapid boil, are all now being tried out.

Continuous evaporators seek to minimize labor but require careful control to secure a product of uniform consistency. I know of none on the market simple in construction and which operate more efficiently than an ordinary steam-jacket kettle.

Another large problem necessary to be solved is a method for storing and holding cheaply large quantities of tomatoes. As stated previously, the packer buys pretty closely up to his capacity, but the uncertainty accompanying transportation often results in a glut. This means either a driving of the factory to use up the goods or great loss from spoilage, usually both. In the Middle West some firms use a large tank of water into which the tomatoes are dumped. Others spray the piles of tomatoes in baskets or crates, while many merely stack them loosely to insure good ventilation. But to be a success the method developed must be considered in the light of the fact that the canned-tomato industry is widely distributed over the country, is composed of a large number of small plants, some near water and some not, and is not an industry operated by a very high class of labor.

Tomato Paste a Product That Cuts Waste Fifty Per Cent

That the tomato industry is a fertile field for the application of economies in operation is evidenced by the development of a tomato product which contains all the food and condimental value of the tomato, reduces loss from 50 per cent to 5 per cent and produces a product which can be sold for about one-half of the price of the regular canned tomato, figured on the basis of equal content of raw material. I refer to the tomato-paste industry.

In the manufacture of this product, tomatoes pass through large washing machines, then over sorting belts where the unsound material is picked out by hand, thence into a crusher and immediately into the previously mentioned cyclone machines. These consist of horizontal perforated metallic cylinders slightly open at each end, about two feet in diameter and three or four feet long, provided with a paddle rotating on the axis of the cylinder and barely escaping the sides. The violent beating of this paddle forces the juice and flesh of the tomato through the perforations while the seed, skin and cores, deprived of their juice, pass out through a small gate at one end of the cylinder. This dry material, comprising about 5 per cent of the original tomato, is called cyclone waste, and will be referred to again.

The juicy mass of liquor and ground tomato flesh from the cyclone perforations is called in the trade "cyclone juice," as distinguished from the more or less clear, watery looking liquid in the tomato which is familiar to all. This cyclone juice is then concentrated in the proportion of about 5 or 6 to 7, according to the character of the raw stock and the quality of the finished product. This industry, while a subsidiary of that of the whole tomato, has developed quite a respectable technology of its own in which is a splendid field for good engineering practice.

For instance, the market value of the finished pasty mass, called tomato paste, is proportional to the bright red color; the freshness of the tomato flavor, and the thickness, and, as stated previously, the ordinary concentrating methods of evaporation serve to destroy color and taste, while pastiness renders it difficult to handle in the kettles without burning or to transfer from the kettles to the fillers. To save color we are inclined to sacrifice pastiness (concentrate loss); to make it thicker and thus put more tomato in a can, there is a tendency to sacrifice color, taste and ease of operation.

Economies Now Obtained

Thanks to the prodding of necessity, these baneful effects have been minimized by adopting more efficient means of evaporation both at atmospheric pressure and in vacuo, while the handling of the pasty mass likewise has now reached a state of satisfactory development. Overcoming difficulties of concentration and handling, together with mechanical applications as substitutes for the hand labor of the ordinary peeling processes, is an eloquent example of the potentialities in engineering practice as it may be applied to food problems. This development cuts down the labor necessary to handle about 5000 baskets per day from somewhere near 140 persons to about 35, reduces the tomato waste from about 50 per cent to about 5 per cent, eliminates all waste to the consumer by giving him a product free from seeds and cores, saves tin plate by using a can containing 30 sq. in. in comparison with one containing 91 sq. in., reduces shipping cost from the fact that the standard paste can contains 6 oz. net weight while

the can of standard tomatoes of equal weight of tomato solids contains 32 oz. net weight, and at the same time materially lessens storage and conserves transportation space. This tomato-paste manufacture of course puts the goods in a form somewhat different from that with which the housewife is familiar, but a publicity campaign should demonstrate to the intelligent housewife that not only is she effecting a direct saving of 50 per cent of her bill for tomatoes, but also indirectly in that by this means she is enabling what is now waste to be utilized for other food purposes, directly as edible fat (oil) and cattle food (press cake).

But if we again apply economies in operation we find that even this 5 per cent of cyclone waste can be utilized. As stated above, it consists of the comparatively speaking dry cores, skins and seeds of the pulped tomatoes in the proportion of about two-thirds wet skins and cores, water, and one-third wet seed. These seeds contain a valuable edible oil which closely resembles olive oil, in fact, so much so that in Italy it has been largely used for the adulteration of olive oil. The press cake remaining after removal of the oil is valuable for stock feed. Inasmuch as the cake is ground up for this use, the skins can be ground in with it, thus insuring absolutely no loss, and rendering all of the tomato entering the plant a valuable commercial commodity.

The Industry in Need of Engineering Direction

Thus we see that simple as tomato packing seems to be, it is, notwithstanding, an industry in great need of development. It has grown to huge proportions in volume of business, but has not developed in the mechanical end at all commensurate. Thanks to the operation of the Food and Drugs Act, and the meritorious activities of the state inspection and control service, the industry has been raised from one of indifferent sanitation to a high state of excellence. But until men trained in engineering take hold of the problems awaiting solution, the industry will continue to blunder on and develop under the guidance of men whose whole engineering viewpoint is circumscribed by the narrow confines of their own establishments. Wastes await reclamation, factory procedure needs the application of approved engineering knowledge, and the time-worn practices of forty years need to be revised in the light of applied science.

TEMPERATURES AND THEIR DURATION DURING THE HEATING SEASON

By REGINALD PELHAM BOLTON, NEW YORK, N. Y.

THE unusual e treme of low temperatures which particularly affected the City of New York during the heating season of 1917-1918 invites careful study as to the effect of similar possible occurrences upon the installations of apparatus designed to effect the heating of buildings. The prevalence of extremely low temperatures in the vicinity of New York City is very limited as regards time, and the writer has pointed out on previous occasions that the existence of a temperature below zero has not usually prevailed beyond the early hours of the morning, but is followed by a sharply rising temperature about sunrise, and has rarely been at zero in the working hours of the day. In December 1917 and January 1918 such low temperatures were maintained, on some occasions, all day, with great inconvenience and suffering, due to the incapacity of heating apparatus to meet such a condition.

The length of time during which any given temperature below 70 deg. may prevail during a season affords an interesting comparative study, and a summary of the figures recorded by the Meteorological Observatory in the City of New York is presented in Figs. 1-3, in which the temperatures are inverted on the vertical scale, and the period of time is shown on the horizontal scale. Fig. 1 is the record of the season of 1904-1905; Fig. 2 that of 1913-1914; and Fig. 3 that of 1917-1918.

An examination of the mean temperatures recorded during the past 49 years shows that the average was 40.4 deg. This may be compared with the extreme low temperatures of the past heating season, the average of which was 37.66 deg. Compared by months, the average temperatures were as given in Table 1. It may be observed from this that at the end of the last season the average monthly temperatures were higher than usual.

Another interesting point which may be observed is that the temperature of 32 deg. and below was maintained in the past cold season about 35 per cent of the time of the season, which is very similar to that in Fig. 1, representing an average condition.

Reference to Fig. 2 shows that during about 50 per cent of the whole season the temperature ranged between 50 and 30 deg., and for about 25 per cent of the season the temperature was above 50 deg.; while in Fig. 3 the period during which

TABLE 1 COMPARISON OF AVERAGE TEMPERATURES (DEG. FAHR.) DURING THE HEATING SEASON

	Mean, 49 Years	Season of 1917 1918
October	55 6	52 6
November	44 1	41 4
December.	34 2	25 0
January	31 2	21 5
February	30 5	30 7
March..	37 5	41.6
April .	49 1	50 1

temperatures of 50 deg. and excess prevailed was not much more than 22 per cent.

It has generally been assumed that the lowest temperature for which provision must be made in heating the buildings of New York City is that of zero, and consequently the capacity of boilers or of heating apparatus is usually installed upon that basis. Reference to these diagrams indicates the extent to which the capacity of the heating apparatus or boilers is utilized, both as regards output and time, and the relatively insignificant period during which the lowest temperatures prevail. It is for this comparatively minute demand that a large part of the investment in boilers and heating systems is necessarily installed, and the relative expense of providing for this extra heating capacity seems disproportionate to the results achieved. Thus it will be seen that in the season of 1904-1905, which was one fairly representative of average conditions, the percentage of the season, when the temperature was 10 deg. or less, was only 0.8 per cent, yet it will be evident that at least one-seventh of the entire investment in boilers and heating apparatus

had been provided for use in this quite insignificant period of time.

In the season of the year 1913-1914 (Fig. 2), in which unusually low temperatures prevailed, and which was perhaps our coldest recorded season prior to last year, the period of

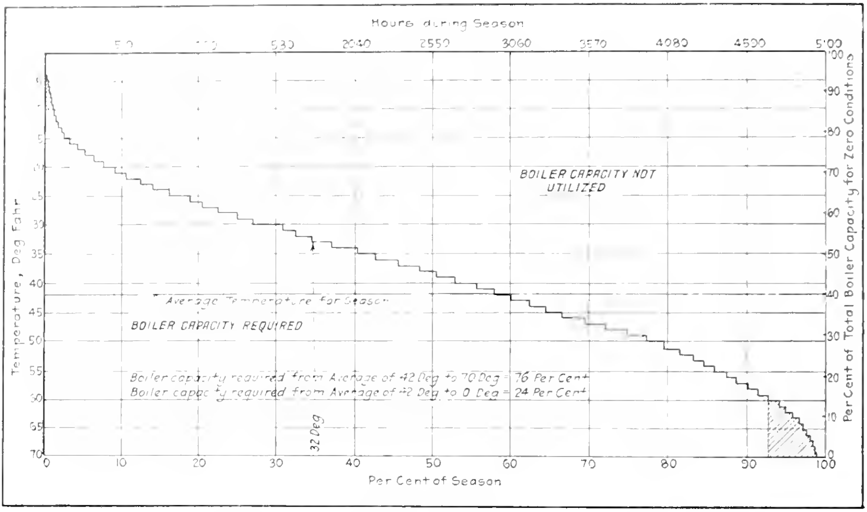


FIG. 1 TEMPERATURES AND PERIODS DURING HEATING SEASON OF 1904-1905, MANHATTAN

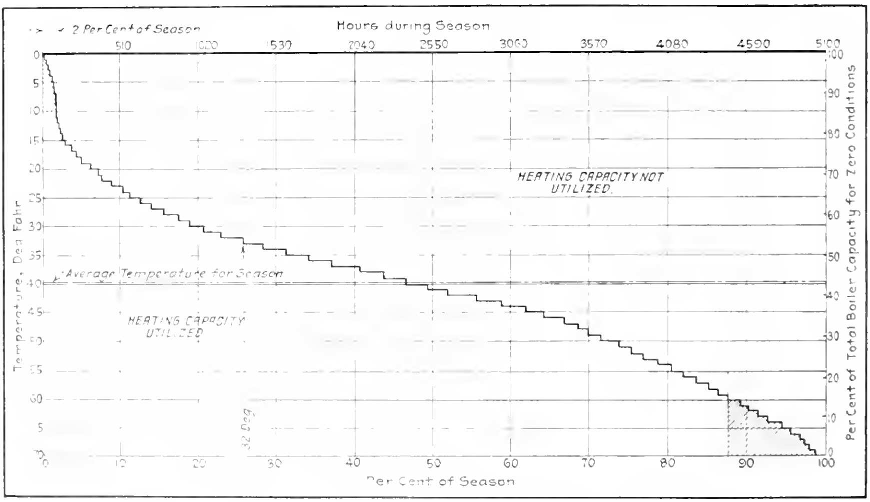


FIG. 2 TEMPERATURES AND PERIODS DURING HEATING SEASON OF 1913-1914, MANHATTAN

time during which the temperature of 10 deg. or less was in existence, was only 2.1 per cent of the heating season, as shown by the shaded space at the upper left-hand corner of the diagram.

During the past extremely cold winter (Fig. 3), when our temperatures descended as low as 12 deg. below zero, this proportion of the season during which the temperature was 10 deg. or less was only 1.8 per cent. It would thus seem that the use which is made of the extra capacity of our heating installation is not in excess of 5 per cent of the total period of the heating season. This leads to some consideration as to whether other means could not be found which would relieve the owners of property of the investment in a large amount of expensive apparatus so unprofitably utilized, and indicates a direction in which the ingenuity of the heating engineers of the country might very well be applied, to the advantage of all concerned.

It is possible that if some means for the substitution of gas or electricity as an auxiliary heating agent could be introduced at less expense for installation than the usual boilers, piping and radiators, it would be profitable to make use of those supplies of heat, even at prices greatly in excess of the actual cost of producing steam or hot water.

As a matter of fact, much fuel is wasted by overheating residences and apartments at times when the exterior temperature is above 60 deg. If auxiliary gas or electric appliances were

installed the use of steam might in some buildings be discontinued when the temperature rose above 60 deg., which even in the past cold season was the case during 295 hours, or about 6 per cent of the total.

The subject has acquired a certain aspect of necessity, since the past winter disclosed the fact that there may upon occasions occur temperatures falling substantially below zero, and prevailing for many hours at a time. For such conditions it may be said there are but few installations of heating apparatus in New York City proportioned to provide the necessary heating capacity. Boilers may indeed be forced to deliver additional output, but radiators and piping are not capable of relative increase to meet a condition such as that which prevailed during last winter on several occasions.

To add to heating apparatus for the purpose of meeting this contingency, so limited in period of time and yet so urgent in character, would involve enormous expense. The situation was met only to an inadequate extent last winter by the purchase and use of a multitude of oil heaters, electric heaters, gas radiators, and the wasteful burning of gas in flame burners, kitchen ranges and gas logs.

Looking at the other end of the scale of time and temperatures, as shown in these diagrams, we find another period of time during which such auxiliary apparatus might be utilized. It is that during which temperatures of 60 deg. and above prevail.

In the season of 1904-1905 such temperatures were in existence for upward of 400 hours, or 8 per cent of the season, during which time the capacity of an installation proportioned on heating at zero was utilized to an extent of less than 15 per cent. It would seem that during such a period economic use might be made of whatever auxiliary appliances and methods of supply of heat were provided to meet the excess conditions required during extremely low temperatures at the upper end of the diagram.

It is interesting also to note in this connection that during an average season, such as that of 1904-1905, the entire use which is made of the installed capacity of heating apparatus is only 24 per cent. up to the average temperature of 42 deg., while the capacity in use above that temperature to the limit of 70 deg. is 76 per cent. This again indicates the relatively expensive provision required to be made to maintain the temperature of our buildings during the prevalence of the lower temperatures of the season.

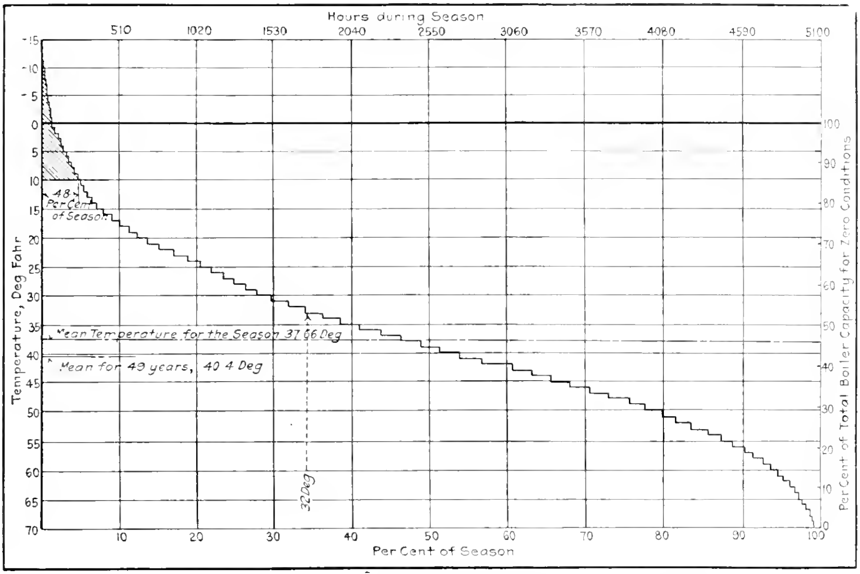
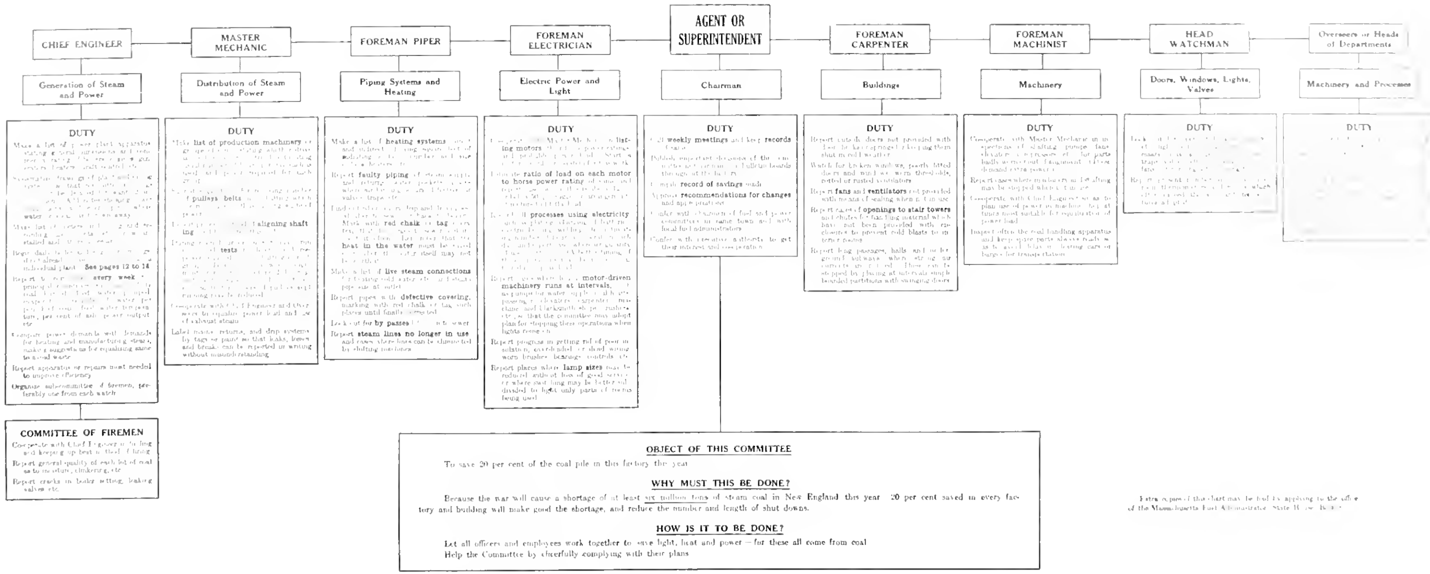


Fig. 3 Temperatures and Their Duration, Heating Season of 1917-1918, New York City

Owing to the enormous increase of Government war work, the governmental departments at Washington are being flooded with letters of inquiry on every conceivable subject concerning the war, and it has been found a physical impossibility for the clerks, though they number an army in themselves now, to give many of these letters proper attention and reply. There is published daily at Washington, under authority and by direction of the President, a Government newspaper—*the Official U. S. Bulletin*. This newspaper prints every day all the more important rulings, decisions, proclamations, orders, etc., as they are promulgated by the several departments and the many special committees and agencies now in operation at the National Capital. This official journal is posted daily in every post office in the United States, more than 56,000 in number, and may also be found on file at all libraries, boards of trade and chambers of commerce, the offices of mayors, governors and other state and federal officials. By consulting these files most questions will be found readily answered; there will be little necessity for letter writing; the unnecessary congestion of the mails will be appreciably relieved; the railroads will be called upon to use fewer correspondence sacks and the mass of business that is piling up in the Government departments will be eased considerably. Hundreds of clerks, now answering correspondence, will be enabled to give their time to essentially important work, and a fundamentally patriotic service will have been performed by the public.

FACTORY FUEL AND POWER COMMITTEE — ORGANIZATION CHART



Bulletin of Advisory Engineering Committee of Massachusetts Fuel Administration

The Society's membership is taking an active part in the various states in the conservation of fuel. In Massachusetts, the Advisory Engineering Committee, appointed by James J. Storrow, Massachusetts Fuel Administrator, consists of seven members, of whom six are members of this Society, as follows: Ira N. Hollis, *Chairman*, 11 Boynton Street, Worcester; Charles T. Main, 201 Devonshire St., Boston; William G. Starkweather, 53 State Street, Boston; George P. Gilmore, 46 Dudley Street, Fall River; Arthur T. Safford, 66 Broadway, Lowell; Joseph A. Skinner, Holyoke, and Thomas Hawley (non-member), 115 Huntington Avenue, Boston.

This committee has just issued a report specifically for use in Massachusetts, but which, as expressed by one fuel engineer, "would be an admirable report for the whole 'United States,' if these two words were substituted on the cover for the word 'Massachusetts.'" The report is known as Bulletin No. 1 and deals concisely with the following subjects:

1 Necessity for reduction of demand for coal by all users.

2 Methods for saving coal, including a discussion of general principles and the special conditions to be met in mills, factories, shops and power stations, including consideration both of central stations and purchased power. Detailed suggestions are further given for the boiler room, the engine room, manufacturing processes, heating of shops and work rooms, the lighting system and the power-transmission system.

3 Methods for saving coal in business and apartment buildings, hotels, schools, churches and public buildings.

4 Methods of saving coal in residences and smaller public buildings.

The bulletin concludes with forms for daily boiler-room and engine-room records and power-station reports. Its distinctive feature is the information given regarding the Massachusetts plan, which has been successfully tried out and is now recommended for universal adoption for the organization in each plant of a Fuel and Power Committee composed of employees of the company, whose duty it is to see that fuel is burned economically, and of even more importance, to prevent the waste of steam and power after the heat or power have been generated. This affords a means for coöperation, and it is felt to be imperative that all district fuel committees should see that the industries coming within their reach are so organized. In fact, it has been proposed that the delivery of coal should be conditional upon such organization.

In order to clearly outline the functions and scope of such a Fuel and Power Committee, the report publishes an organization chart which is reproduced herewith for the benefit of other communities, as well as those in Massachusetts. The chart is so clearly arranged that no further explanation is necessary.

CORRESPONDENCE

CONTRIBUTIONS to the Correspondence Departments of The Journal by members of The American Society of Mechanical Engineers are solicited by the Publication Committee. Contributions particularly welcomed are suggestions on Society Affairs, discussions of papers published in The Journal, or brief articles of current interest to mechanical engineers.

Second Law of Thermodynamics

TO THE EDITOR:

Mr. Okey's letter published on page 467 of the June number of THE JOURNAL brings another instance of the periodic outcropping of misunderstanding of the "Second Law of Thermodynamics." This misunderstanding may be as much the fault of the teachers of thermodynamics as of the pupils, but in either case the widespread confusion of mind is deplorable.

First, as to Mr. Okey's "operative" apparatus, this constitutes no infraction of the Second Law. It develops its power quite normally from the heat flowing from the warmer body (the air surrounding the boiler) to the colder one (the air chilled by atmospheric evaporation) quite as any heat engine develops power from fuel heat flowing to refrigerator. Air is everywhere being chilled by atmospheric evaporation; but it has to be warmed first by sun heat before it can do it. If Mr. Okey's turbine had not been interposed, the atmospheric evaporation would have chilled the air surrounding his boiler just the same.

This is exactly as all the sun heat reaching this earth eventually must re-radiate into space. If the process be temporarily interrupted by the storage of the heat in coal beds, with the incidental driving of human engines before it is allowed to escape to refrigeration, it is not altered thereby. The Second Law holds at every point.

The trouble in Mr. Okey's case does not lie in his apparatus, but in his explanation of it. His confusion of mind arises from the fact that he has been told that heat is convertible into work, and that our prime movers are "heat engines." They are not. There is no such thing, in careful phrase. They are all "temperature engines." The basic laws explaining these statements follow.

Every form of energy is partially convertible into every other form of energy, with conservation of quantities. This is, in reality, the proper statement of the "First Law" of thermodynamics. The transformation of heat into work is merely one instance of this general law, which runs through all fields of energetics.

No form of energy is wholly convertible into any other form. This is a basic law of energetics as important as either the so-called "First" or "Second" laws. Yet, so far as the writer is aware, it nowhere finds expression in the textbooks of thermodynamics. It should be called the Second Law, and what is now called the Second be made the Third.

Each form of energy is convertible into any other *only to the degree that range in its intensity factor (in the case of heat—temperature) exists in the environment.* This is, in reality, the general statement of the so-called "Second Law," preferably to be called the Third, in a form applying directly to problems in energy transformation. Of this law the limitation to "heat engines"—and the thing which proves that they should be called "temperature engines" is the basic formula: $(T_1 - T_2)/T_1$—is merely a single instance. We have not yet acquired any foundation for computing efficiencies nor for comprehending actions until we have the significance of this cosmic law well in mind.

None of these laws constitutes any denial of the possibility of deriving work from the heat of the atmosphere. The earth's atmosphere, particularly near the earth's surface, is relatively a quite warm thing, heated by sun heat. Wherever may be found a spot colder than the local atmosphere—in the sea, on the mountain tops, in the upper atmosphere, etc.—there many a means for the development of power by the connection and interaction of the two places may be devised. Not one of these devices would give any surprise to the thermodynamicist, because none would infringe the basic laws against thermodynamic perpetual motion.

This frequent evidence of confusion of mind regarding the fundamental principles underlying the transformation of energy—one of the most widespread fields of applied science—is ground for deep regret that not even a single technical school boasts a chair in *Energetics*, teaching pure mechanics, thermodynamics, electrical and chemical energetics simultaneously, as one subject.

SIDNEY A. REEVE.

New York, N. Y.

TO THE EDITOR:

I have been greatly interested in Mr. Okey's very ingenious little fallacy regarding the second law of thermodynamics in the June number of THE JOURNAL.

It is possible that you already have had many much better explanations of the situation than I can offer.

In the first place, I would like to compliment Mr. Okey on the entire arrangement. It is not often in these days that any new thermodynamic system is originated. Mr. Okey has set forth what seems to me to be quite a novelty, and has carried it out in a very ingenious way. I hope to be able to inspect the original apparatus before a great while.

The only point to which I take exception is the statement that the second law of thermodynamics is violated. This is not the case.

In order to completely understand the matter, we must include with the apparatus such part of the atmospheric action as will make a complete closed cycle.

This is that portion of the room which will take away the water vapor from the SO_2 condenser and return condensed water. We can do this without destroying Mr. Okey's principles in the least. Suppose that there is a closed chamber surrounding the SO_2 condenser as shown in Fig. 1, in which the parts which are added are shown in dotted lines. This chamber takes the water vapor which is evaporated, and by extracting heat from it, by contact with the coldest of the surrounding bodies, condenses the water, which is then returned to be re-evaporated.

There will be a certain constant pressure in the added chamber. The saturation temperature corresponding to this will be the temperature at which heat is taken away in the cycle, and will be the lower temperature of the second law of thermo-

dynamics. The upper temperature — of course the temperature at which heat is added in the SO boiler.

I think it will be found that the completed apparatus is

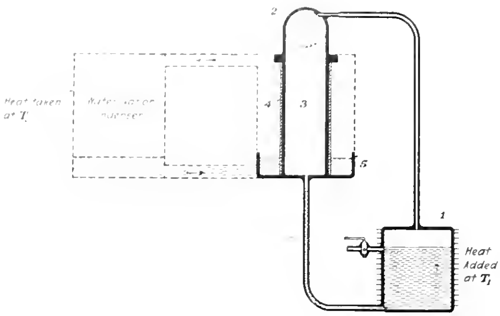


FIG. 1 MODIFIED FORM OF OKEY APPARATUS FOR OBTAINING MECHANICAL WORK FROM THE HEAT IN THE AIR

entirely consistent with the second law. It forms, in fact, a binary-vapor cycle, exactly identical with some such cycles which have already been fully worked out.

S. A. MOSS.

West Lynn, Mass.

Committee on Development Proposed

TO THE EDITOR:

Referring to the A.S.C.E. resolutions creating a Committee on Development [see p. 712—EDITOR], I cannot help but feel that a most important and timely step has been taken by the Civil Engineers. The social, industrial and economic changes to which the preamble properly calls attention have been the result of a development with which the engineer has been more closely associated than any other profession or group. Therefore they demand our earnest and constant study, and in the opinion of many they necessitate a readjustment and a restatement of the aims of our various engineering societies.

Another problem requiring an early solution is the organization of all engineering societies, national and local, in such a manner as to harmonize and coördinate their efforts toward promoting the interests of the engineering profession and serving the community. It may be said—I believe without danger of contradiction—that the principal aims of all the engineering societies, according to the conception of their membership, are more or less identical (although expressed in various ways), and that the points of difference relate to professional and geographical limitations. Organization must therefore look toward joint action where the aims are general and identical and toward separate action where aims are specific and individual. In view of the magnitude of such an organization, however, and in view of the difference in structure and in scope of the many units to be coördinated, a plan for coöperation must be preceded by thorough discussion and clear statement of the present-day aims of the units to be combined.

These considerations make me feel that our Society should take up at the earliest possible time a broad and thorough examination of its aims, and that such examination would best be coincident with similar action in other national, and preferably also local, engineering societies. Previous attempts and discussions in our Society have not carried us very far, largely, I believe, because they have not been sufficiently general. May I suggest, therefore, that a committee of our Society similar to that of the A. S. C. E. might be of incalculable benefit just at this time, and that pressure upon other national societies, also to follow the lead of the A. S. C. E., would be appropriate. If constituted along the lines indicated in the resolutions referred to, i. e., composed mostly of section representatives, such committees of national societies could not help but spread the interest and discussion of this vital subject to every city, town and hamlet of the country where engineers are found.

If a committee as suggested were soon appointed, a report could no doubt be submitted to the Council previous to the Annual Meeting in December, so that a general discussion on the part of the whole Society could then take place.

LOUIS C. MARBURG.

Philadelphia, Pa.

Economic Effects of Impurities in Coal

TO THE EDITOR:

In discussing the subject of low-grade fuels and impurities in coal at the Spring meeting, Mr. Pigott made the statement that the principal effect of burning a lower-grade coal in the boiler furnace was the reduction in boiler capacity. With coals from the Middle West there is a considerable decrease in efficiency as well, as with coals containing a high percentage of ash there is inevitably a greater ashpit loss than with better coals, and it should be borne in mind that while the average fireman can burn good coal economically with the proper equipment, it takes an exceptionally good man to burn poor coal so as to get the most out of it. In this connection the cost of handling the excess ash and moisture in the coal should be considered as well as the disposition of the increased amount of refuse from the furnace; further, with poor grades of coal increased capacity can be obtained only with increased ashpit loss, and under ordinary conditions and variations of coal it is extremely difficult to determine the most economical point of operating.

In order to obtain the required capacity for peaks some of the companies who have experienced considerable difficulty in obtaining good coal have made it a practice to purchase only enough good coal to carry them over the peaks, as it is possible to get along during off-peak periods with the lower grades of fuel, which are cheaper and more easily obtainable. This good coal is segregated so that it can be distributed to the boilers by hand or by special equipment during the peak periods, after which the boiler rooms return to their regular operation as soon as possible with the coal ordinarily received.

ALEX D. BAILEY.

Chicago, Ill.

"The Wonder Ship of the World" was launched at the Bethlehem Shipbuilding Corporation, Union Plant, Alameda, when the *Defiance*, a 12,000-tonner, slid off the ways just 38 calendar days from the laying of the keel.

Director-General Schwab called the *Defiance* the "Wonder Ship." Mr. Schwab declared that the building of this boat in 38 days, including Sundays and holidays, really is the most remarkable performance in shipbuilding history. On a basis of tons of steel fabricated into the vessel daily, the building of the *Defiance* was about 30 per cent better than the *Tuckahoe*, the 27-day ship built by the New York Shipbuilding Corporation. This comparison is not absolutely accurate, but it is considered fair. (*Emergency Fleet News*, vol. 1, no. 19, July 11, 1918, p. 16)

SOCIETY AFFAIRS

A Record of the Current Activities of the Society, Its Members, Council, Committees, Sections and Student Branches; and an Account of Professional Affairs of Interest to the Membership

PRESIDENT MAIN said that "it was number 7" when the latest member of his personal staff left for War Work. This, in addition to his personal devotion to the service of the Government to the exclusion almost of his own business, will explain, if explanations are necessary, the earnestness with which the President has just appealed by letter to the membership for the services of every competent engineer in the country in the interest of the Government.

It is here that announcement should be made of the summons of the Committee on Emergency War Training to Mr. Ernest H. Hartford of the Society's Staff, to go to Washington and assist in the important work of organizing the Emergency War Training of technical men, throughout the United States. Forty thousand men are now being given an emergency training in the various schools and colleges and by the end of the year it is hoped to bring this number to one hundred thousand.

There is one feature relating to the appeal for enrollment of engineers for war service which requires explanation, namely: that while we are continuously furnishing names of men in response to specified requests by the different Bureaus of the Government, and the industries generally, only in rare cases are we able to reverse the operation and place a man anxious to serve. We have first to await the request, and the patience of such members is requested in this respect.

There is unfortunately small prospect, so far as we are able to judge, that the war will come to a speedy close, and in consequence thousands and even millions of men will probably be required. There is small doubt but that ample opportunity will eventually come to every one to contribute his services.

An interesting event in engineering circles which has come to our notice is the inauguration of the Engineering Institute of Canada, of which our esteemed member, Mr. H. H. Vaughan, is president. The intention of the Institute is to broaden the field of usefulness formerly covered by the Canadian Society of Civil Engineers, by uniting "all the Engineers in Canada, to whatever branch of the profession they may belong, into one Society."

We are just in receipt of the first number of their Journal, and it is of interest to know that it is uniform in size with our own JOURNAL, that is, nine inches by twelve. If any one doubted the wisdom of adopting this size, it would be well to observe that the nine-by-twelve size, which was determined upon by our Society a number of years ago, is used by a large proportion of the 1200 periodicals received in our Library from all portions of the world.

It will be the desire of this Society to coöperate with the Engineering Institute of Canada in all possible ways, and it may be that we can do this best by interchanging matter for the Engineering Survey and reviews of technical literature which we have developed; this is uniform with the practice of giving Engineering Survey material to the Research Information Committee of the National Research Council.

There is still further opportunity to coöperate in the matter of standards, President Vaughan having been appointed the Canadian representative on the British Engineering Standards Committee.

A noticeable feature of the policy of the Engineering Institute seems to be the emphasis placed upon sections and branches and the benefits to be obtained by participation of the Institute and also of each branch in matters of legislation. A conspicuous division of the Institute's committees comprises the legislative committees and there is besides a strong committee in each of the branches of the Institute throughout the Dominion. This is in keeping with the announcement of the object of the Institute, which is—

"To facilitate the acquirement and interchange of professional knowledge among its members, to promote their professional interests, to encourage original research, to develop and maintain high standards in the engineering profession and to enhance the usefulness of the profession to the public."

CALVIN W. RICE,
Secretary.

War Industries Readjustment Committee

THE National War Industries Readjustment Committee of the Society has been hard at work and has received numerous requests from manufacturers desiring to handle war orders. Government bureaus have been assisted in placing such orders. The Committee is anxious to learn of manufacturers who have an excess of work or whose production is lagging and would like to sublet part of their work.

For various reasons the output of war material is far below what it should be. Some of the main reasons are congested transportation, lack of material and lack of coördination. The purpose of our Committee is to do what it can to overcome such difficulties. To this end the Chairman, Mr. Parsons, has just returned from Washington, where he has been in conference with Messrs. George N. Peek and Charles A. Otis, of the War Industries Board. Mr. Otis is Chief of the Resources and Conversion Section, and has worked out a splendid regional plan with regional advisers as follows:

Bridgeport, B. D. Pierce, Jr., care Chamber of Commerce
New York, William Fellowes Morgan.
Philadelphia, Ernest T. Trigg, 322 Race St.
Pittsburgh, George S. Oliver, care Chamber of Commerce
Rochester, Esten A. Fletcher, care Chamber of Commerce
Cleveland, W. B. McAllister, care Chamber of Commerce
Detroit, Allan A. Templeton, Detroit Board of Commerce
Chicago, D. E. Felt, 29 So. LaSalle St.
Cincinnati, Edwin C. Gibbs, 31 East Fourth St.
Birmingham, T. H. Aldrich, 322 Brown-Marx Bldg.
Kansas City, F. D. Crabbs, care Chamber of Commerce
St. Louis, Jackson Johnson, care Chamber of Commerce
St. Paul, D. R. Cotton, care Chamber of Commerce
Milwaukee, August H. Vogel, Pfister & Vogel Leather Co.
Dallas, Louis Lipsitz, 407 Southland Life Bldg.
San Francisco, Frederick J. Koster, care Chamber of Commerce

Atlanta, Baltimore, Boston and Seattle appointments will be made very shortly.

The idea is that through this means it will be possible to place Government requirements in communities or regions, and expedite production through the cooperation of the various organizations and facilities within those regions. In order that our Society may do its utmost, it has been decided to cooperate in each of these regions. To this end President Main has appointed the following representatives to work with the above regional representatives of the War Industries Board in their several localities:

Bridgeport, Conn., Harry E. Harris, P. O. Box 852
New York City, G. K. Parsons, 29 Pine Street
Philadelphia, Pa., C. N. Lauer, care Day & Zimmerman
Pittsburgh, Pa., J. M. Graves, 435 Sixth Ave.
Rochester, N. Y., Ivar Lundgaard, 208 Culver Road
Cleveland, Ohio, F. H. Vose, 3203 Whitethorne Road, Euclid Heights
Detroit, Mich., G. W. Bissell, Mich. Agri. College, East Lansing, Mich.
Chicago, Ill., A. D. Bailey, 21 Elmwood Ave., La Grange, Ill.
Cincinnati, Ohio, Fred A. Geier, 2301 Grandview Ave., E.W.H.
Baltimore, Md., W. W. Varney, 710 North Carey St.
Atlanta, Ga., Robert Gregg, 960 Ponce de Leon
Birmingham, Ala., W. P. Caine, Ensley, Ala.
Kansas City, Mo., J. L. Harrington, Rockhill Manor
St. Louis, Mo., R. L. Radcliffe, 701 Laclede Gas Bldg.
Milwaukee, Wis., W. M. White, 747 Summit Ave.
Dallas, Tex., A. C. Scott, Scott Engineering Co.
San Francisco, Cal., B. F. Raber, 2027 Delaware St., Berkeley, Cal.
Seattle, Wash., R. M. Dyer, Puget Sound Bridge & Dredging Co.
Boston, Mass., A. C. Ashton, 33 Columbus Ave., Somerville, Mass.
St. Paul, Minn., Oliver Crosby.

It is the desire of the War Industries Board that our members act in an advisory capacity in the several regions. The reason for this is that our members being largely connected with industry are in the best position to advise regarding the feasibility of manufacturing, the interpretation of specifications, the adaptation of machines and processes, and the facilitation of production. In each of the regions there will be subcenters, and it will probably devolve upon our Society to be represented in each of these centers. It is likely that committees will be formed for specific technical and semi-technical questions, and our advice will be valuable in these committees. Further, it behooves us to be ready to fit in to the organization as it is developed by the War Industries Board.

The relation of our national War Industries Readjustment Committee to the several regional representatives of our Society will be that of the clearing house, supplying information and describing the methods which others are using, thus keeping our members informed of the best that is being done in other regions.

This Committee will be glad to answer inquiries and help in every way that it can to coördinate the activities of our representatives and the War Industries Board. The present headquarters of the Committee is in care of the Chairman, G. K. Parsons, President of the G. K. Parsons Corporation, 29 Pine Street, New York City.

Dr. Garfield to the Society

A letter of commendation has been received by President Main from Dr. Harry A. Garfield, U. S. Fuel Administrator, on the work accomplished by the Fuel Conservation Committee in preparing the Fuel Symposium for the Worcester Meeting of the Society, and for its use by the Publication Committee in The Journal. The letter is given below:

Washington, D. C.,
June 25, 1918.

The American Society of Mechanical Engineers.
Mr. Charles T. Main, President.

Dear Mr. Main:

Your Society is to be congratulated on its efforts for fuel conservation as set forth in this fuel-economy symposium. True Americanism calls for the most careful and efficient use of fuel—the driving force of war and industry.

Coal production, hand in hand with railroad service, has been increasing tremendously during recent weeks; but regardless of the supreme efforts being exerted, some parts of the country and some industries will have less coal than they want during the coming winter.

The demands of our great war machine are increasing hour by hour and they must be met. War requirements call for more coal, more raw materials of all kinds. Our transportation lines are clogged with the moving of the coal, of all the other raw materials and of the finished products.

Communities that have heeded the nation-wide warning to order early will be in far better position than those that have failed to heed the warning. War industries will be supplied. Other industries will receive coal and oil in proportion to their importance and the measure of their supply will depend on how faithfully everybody practices conservation.

Yours very truly,
(Signed) H. A. Garfield,
United States Fuel Administrator.

French Books Sent from the War Zone

The following is a letter which the Secretary has recently received from one of our members at the front, which gives an interesting personal note. The writer is a Canadian and was employed before enlisting in the capacity of assistant works manager in the Canada Machinery Corporation, Ltd., Galt, Ont. He is now in the 3d Brigade of the Canadian Field Artillery.

The books referred to have been received and placed in the library of the Society. Their titles are L'Essai des Combustibles, a translation of Fischer's Manual, and Résistance de Matériaux, by Ch. de Mussan.

Dear Mr. Rice:

Some time ago I sent you a couple of French textbooks which I picked up in the ruins of an engineering school. This school was evidently conducted by a mining association as an educational institution for the sons of miners. From scraps of drawings which were lying about, it must also have served as an engineering office for quite a large section of the mining area. At the time I found the books our brigade was in action in the town quite close to the place, and when things were quiet I used to dig around the building to break the monotony. One trip there I shall not forget, because Fritz opened up on the building while I was there and I am not a lover of flying bricks or steel. The place stands on a hill and as it is only a little over two miles from the enemy trenches, it is often used as a calibration point for his artillery.

I hope the books are of interest and some day I hope to be able to send you the pieces which I cut from the front pages showing the name of the town and school.

I wish there were time to write even a short synopsis of the work of the Canadian Field Artillery as I have seen it since January 1917. It is a most interesting branch of the service and especially during periods of open warfare. Sometimes the shelling around our positions is terrific and at other times there are quite long periods of comparative inactivity on the part of Fritz. But whether Fritz is active or not, the harrassing fire by our little guns goes on day and night, the intensity depending on the importance of the front. It is our policy to fire on every German who can be reached, and our 18-pounders can reach considerably farther than is generally known.

No doubt the enemy intends to make a big drive again very

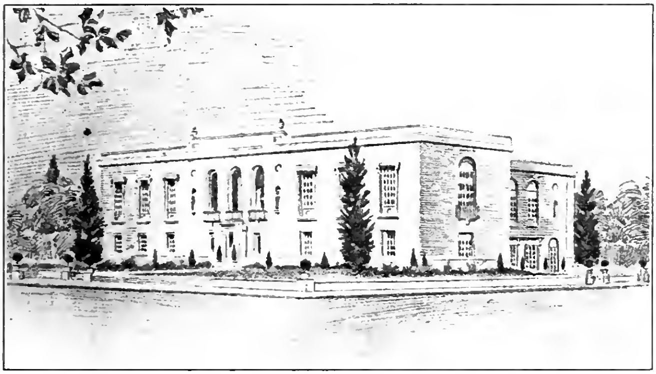
soon. It is like living on a volcano, but we all feel extremely confident that the showing to be made by the Allies will far surpass those in the past. Every one is working hard and as far as I can judge the stage is set for the greatest battle in history. We are all grateful to Uncle Sam for the real response he is making to our call for assistance. The American soldiers I have seen here are just the type we Britishers are proud to have as fighting partners, and with such men as you are sending over, together with the wonderful French and Italian soldiers, there can be only one result, a clean win for our side.

Bdr. P. G. Welford.

The Dayton Engineers' Club and Its New Building

An ideal home, yes, and more than that, a home of ideals.

This characterizes the Engineers' Club of Dayton in its new home, which it was the pleasure of the Secretary to visit a short time ago during a trip through the West and South. Our Society, in company with others, had been cordially invited to the original organization meeting of the Dayton Engineers' Club several years ago; and similarly to the dedication of its beautiful new clubhouse last February, which, however, the Secretary was unfortunately unable to attend. Suffice to say that whereas there may be engineers' club buildings which have cost more, as in the case of the Engineers' Club in New York, nevertheless, there is no more beautiful and well-appointed engineers' clubhouse in the world than the one which can now be found in the city of Dayton.



New Home of the Engineers' Club of Dayton

The original conception recognized that a meeting place permitting the fearless and thorough discussion of engineering problems, coupled with the fostering of good fellowship, was quite worth while and would confer lasting benefits upon the community. The splendid building came as a result of the generous desire of two of Dayton's public-spirited engineers, both of whom, incidentally, are members of our Society. The building is located on a choice lot facing the river, with adequate grounds to give it a setting, and is substantially constructed with a view to permanence and utility. The entrance to the main floor is generous and attractive. On the right is a common room, with piano, comfortable divans and pool tables. In the center are the main stairs up. To the left are the lavatories and rooms for checking wraps. Two or three steps down and in the center are the main rest rooms, with possibilities for dining *al fresco*. Upstairs is the main auditorium, with a large lounge on the right and library on the left.

Notwithstanding the excellence of the architecture and setting of the building, which, obviously, are so favorable, the impressive feature of all is that the Dayton Engineers' Club is dedicated to:

The dissemination of the Truth.
The promotion of useful education and civic righteousness.
The fostering of good-fellowship among our Miami Valley Engineers.
The professional advancement of our members.
The inspiration and encouragement of the younger men.
The making of a technical City, where creative endeavor finds reward.

Nothing could so hearten the work of the engineer, and particularly of the young engineer, as to see this evidence of idealism and devotion to the higher things of life in relation to his daily work.

History of the Providence Engineering Society

In the Providence Magazine for May 1918, published by the Providence Chamber of Commerce, there appears a history of the Providence Engineering Society, written by Luther D. Burlingame, Mem.Am.Soc.M.E., from which the account given below is taken. This society bears the distinction of having been originated, and until within a few years conducted, in the interests of those in the mechanical engineering profession. For several years past it has been affiliated with the American Society of Mechanical Engineers.

As far back as 1789 the Providence Association of Mechanics and Manufacturers was organized for the purpose of "promoting industry and giving a just encouragement to ingenuity, that our manufactures may be improved." This association had on its rolls the names of many distinguished men. The meetings were held in the Old State House, where an important library was collected, which became in 1877-1878 the nucleus of the present Providence Public Library.

Following the dissolution of this old organization, a group of men interested in mechanics and mechanical engineering, came together in 1894 to form an organization devoted to the interests of those mechanics branches. A constitution was adopted and the society started on its work with twenty-seven charter members. Arthur A. Fuller, now with Stone & Webster Co., Washington, was the first president. The name Rhode Island Association of Mechanicians was first adopted but as it did not seem to fit the ambitions of the leaders of the new organization, the name was soon changed to the Providence Association of Mechanical Engineers, under which title its activities were carried on for more than twenty years.

The first regular technical meeting was held on March 12, 1895, and was a lecture on electricity by Marion C. Happoldt, one of the charter members. During the first year practically all of the lectures and papers were by members and local engineers. In the early years a group of men from the Brown & Sharpe Manufacturing Co. were especially active in the organization and Luther D. Burlingame was the second president.

In 1911 the Association broadened its field of activities by becoming affiliated with The American Society of Mechanical Engineers, and joint annual dinners with the officials of that

Society, the first of which was held May 3, 1911, became important and regular events. In November 1915, at a joint meeting and dinner, with several hundred members of the Boston Engineering Society as guests, plans were consummated for the merging of the old Providence Association of Mechanical Engineers into the present Providence Engineering Society. The purpose of the reorganization was to bring together all classes of engineers in a single organization, modern requirements being such that all the various branches of engineering are found to have much in common, even though there may be wide variation in the technical requirements of each branch. The spirit of coöperation was shown at a recent meeting when there were present as speakers the presidents of the mechanical, civil and electrical national engineering societies.

In order that the specific interests of each group of engineers may be properly cared for in the larger organization, sections have been organized, representing each of the engineering interests most prominent in Rhode Island. These comprise sections on efficiency, municipal engineering, structural work, designing and drafting, power, machine shop, and chemistry. In addition there is a student section, making it possible for student engineers to be identified with engineering activities, with which they may later find themselves connected in a professional way.

An important program has been arranged for next season. During the past year there have been held eleven regular meetings of the society and fifty section meetings. Addresses on matters of current interest have been presented by engineers of national prominence at the regular meetings while the section meetings have been devoted especially to matters of engineering connected with the war.

The society has in operation an employment bureau for the reciprocal benefit of its members. It also publishes a monthly bulletin containing the program for future meetings and other items of interest to the members. Quite recently the society carried out a complete classification of the engineers throughout the state showing their availability for military or auxiliary civilian service. In addition to this work the society made several suggestions, which were later adopted, with reference to the proper guarding of public utilities and the securing of emergency fire-fighting apparatus. During the past year there has been an increasing number of the society members in the Service, and the service flag now contains thirty-five stars.

The present president of the society is Robert W. Adams and it is due largely to his energy and interest that the society is steadily progressing, the membership now being approximately 500. The society has attractive headquarters in the Dr. Carr building, 29 Waterman Street.

Edgar Marburg

Edgar Marburg, professor of civil engineering in the University of Pennsylvania and secretary-treasurer of the American Society for Testing Materials, died suddenly in Philadelphia on June 27.

Professor Marburg was graduated from Rensselaer Polytechnic Institute in 1885 with the degree of civil engineer and served successively in the engineering departments of the Keystone Bridge Co., the Phoenix Bridge Co., the Edge Moor Iron Co. and the Carnegie Steel Co. In 1892 he was named for and accepted the position of the head of the civil-engineering department in the University of Pennsylvania.

In 1898 Professor Marburg was one of the group to organize in Philadelphia the American Section of the International Association for Testing Materials and early in 1902 he was elected secretary of the section. Within a few months he had written to the executive committee such a clear statement of the purposes which an American testing society should fulfill that the committee decided to recommend the termination of the existence of the section as such and the establishment of a new society, which would hold membership as a body in the international association and, while affiliated and forming the American branch, be free to set forth its aims independently and adopt its own mode of procedure. The plan for the new society was drawn up on the lines laid down by him—which are those followed today—and the new body formally launched as the American Society for Testing Materials in June 1902 with Dr. Charles B. Dudley as president and himself as secretary-treasurer.

What the success of the society has been is not necessary to recount in detail. It is sufficient to say that the membership is now 2261, the annual receipts $39,687, while the standards it has adopted number 107. So excellent has been the work accomplished that the Government has in the last two years translated certain of the specifications into foreign languages, thus making the society work a helpmeet in the extension of American foreign trade.

While the profession knows him chiefly for his work in the society, Professor Marburg was no less successful as a teacher. In conjunction with his colleague in mechanical engineering, the late Prof. Henry W. Spangler, he deserves credit for having planned the excellent engineering laboratories of the university. The most important of his writings was his book on Framed Structures and Girders, published in 1911. For years he was a contributor of editorials to the *Engineering Record*.

Professor Marburg was a member of the American Society of Civil Engineers, past-president of the Engineers' Club of Philadelphia, past-secretary of the Society for the Promotion of Engineering Education and past-chairman of the committee on science and arts of The Franklin Institute. He was honored with the degree of doctor of science by the University and of doctor of laws by Franklin and Marshall College.

Dr. James Douglas

Dr. James Douglas, honorary member of the American Institute of Mining Engineers, died June 25, 1918, at the age of 81, in his home in New York. He was a scholarly man of the highest professional attainments. Besides being rated one of the foremost metal and mining authorities in the world, he had a deep interest and sympathies in the field of philanthropy.

To the engineering profession he contributed not only from his knowledge but also from his possessions. In 1915 he made an initial gift of $5000 to the Engineering Societies Library for an endowment fund, to which he added $95,000 in 1916, making his total donation $100,000. By the provisions of his will a bequest of another $100,000 has been made to the American Institute of Mining Engineers for library purposes.

A brief review of his life shows an unusually versatile and brilliant mind, which led him to make important contributions to an extraordinary variety of professions.

Dr. Douglas was born in Quebec, Canada, in 1837 and educated at the University of Edinburgh where he began his study of medicine, and at Queen's University, Kingston, Ontario. He traveled extensively in Europe and the Orient, visited Egypt several times, and brought back from his travels important archaeological collections which he later donated to the Metropolitan Museum of Art.

After the period of travel he returned to Edinburgh and continued his studies in medicine and surgery, and subsequently entered the ministry with the idea of combining the

two professions. In the full swing of his studies in medicine, theology and literature, however, his plans were suddenly changed. His father had invested heavily in gold and copper mines in Canada and seemed in danger of losing his entire fortune because there was no economical process of extracting the two per cent copper ore the mines contained. Dr. Douglas had been much interested in chemistry and the jeopardy of his father's finances led him to take up the subject practically in connection with mining. He returned to Canada again where, in collaboration with his friend, the late Dr. Hunt, he worked out the well-known Hunt & Douglas process for the extraction of copper.

Dr. Douglas came to this country in 1875 and became connected with several copper companies in applying his theory of extraction, finally entering into business relations with the firm of Phelps, Dodge & Co., of which he later became president and chairman of the board of directors. It has been said that Dr. Douglas supplied the imagination which, added to the money and careful business management of the members of the firm, raised this company to its very high place among mining industries.

It was on his suggestion that the first traction engines used in the Southwest were employed in hauling coal from Bisbee to the railroads. He built the railroad from Bisbee to Fairbanks to further facilitate the handling of the ore, and otherwise developed facilities for conducting mining operations on a large scale for the delivery of the coal.

Dr. Douglas' liberality and broadmindedness made him the friend of the engineering profession. His mines and smelting plants were always open to other engineers, with whom he believed an exchange of ideas mutually beneficial. In this connection H. W. Hardinge tells that a chance remark of Dr. Douglas' resulted in changing the whole method of copper smelting in Colorado. The remark led Mr. Hardinge to convert his lead stack into a composite lead and copper furnace, a change which increased the profits in smelting so largely and rapidly that other smelters hastened to adopt similar methods.

Both Queen's University and McGill University conferred the degree of LL. D. on Dr. Douglas, and he was the recipient of the gold medal of the Institution of Mining and Metallurgy, as well as the John Fritz Medal, which was awarded to him for notable achievements in mining, metallurgy, education and industrial welfare.

Dr. James Douglas

His writings include a long list of articles on mining, metallurgy and railroads, besides several important historical volumes.

ANNUAL REPORT OF THE SECTIONS ACTIVITIES

The year just closed has been marked by progress in the development of the Sections, both in strengthening the local organizations and in mutual service between the parent body and the Sections.

Several innovations have contributed to this progress. The new By-Laws, approved by the Council Meeting in October and published in the November issue of The Journal, govern the activities of each Section to the extent of insuring that its procedure is in conformity with the Constitution of the Society. They leave each Section free to carry out the details of its coöperative work with other societies' sections and its activities of local interest.

At the Annual Meeting in December 1917 the importance of the Sections received official recognition in the first Sections' Session. Delegates from each Section gave a three-minute talk, followed by a general discussion. Many interesting suggestions for development were given at the Sections Session of the Annual Meeting. The possibilities for increasing the membership of the Society through the Sections seemed very practicable. The mechanical engineer, whose work is most often in the industries, is in the forefront of industrial life at this time, and the number of men in this profession is increasing rapidly. At the Spring meeting the Sections Conference contributed still further toward carrying out the ideas evolved in December, and in giving national impetus to the Society's plans for speeding up war industries. An amendment to the Constitution of the Society whereby the voting membership would elect the Nominating Committee, using the organizations of the Sections to effect the election, is a further step in democracy in the Society and was presented at the Spring meeting.

The plan of the Sections Committee of holding its meetings in cities where there are Sections of the Society and where they can get in direct touch with some of the Sections has also been a strong factor in keeping the Sections closely in touch with the Society. Meetings of this kind have been held in Bridgeport, St. Louis, Milwaukee, Chicago, Detroit and Philadelphia during this year.

The first state Section has been organized this year in Connecticut and includes branches in Bridgeport, Hartford, Meriden, New Haven and Waterbury.

Work Undertaken this Year

While the work undertaken in the different Sections has been quite varied, the dominant idea has been that the only worth-while activities were those relating to the war. The

part taken by the engineering profession in local activities of all kinds this year is noteworthy and in line with the enlarged field for engineering as it has been recently outlined. In Atlanta the influence of the local Section brought about the establishment of an advisory board of consulting engineers for the city, thus raising the engineering department beyond the reach of politics. This Section was also instrumental in getting a department of mechanical engineering for the city of Atlanta, which is believed to be the only city in the United States with such a department. In Philadelphia, one of the Sections papers dealt with a mathematical analysis of the Federal Income Tax Law, in which the defects of this law were clearly set forth; this is an interesting example of the engineer's application of his principles to the broader problems of life. The Baltimore Section has been recognized by the Fuel Administration and one of its committees asked to work on material for that adminstration. Baltimore has also given considerable discussion to the subject of economies in the canning business, which is one of Maryland's most important industries; this subject has been discussed from the standpoint of savings in the actual handling of the material to be preserved as well as in the fuel and equipment of the plants. In Detroit the problem of technical education for women has been given considerable attention and a movement set on foot to interest other localities and colleges in this work. The New York Section has discussed the question of labor turnover, thus recognizing the fact that the engineer is the connecting link between labor and capital in a large part of the industries of the country. The non-essential industries have also formed the subject of one meeting of the New York Section, in the discussion of which a resolution was passed to the effect that the Society organize to develop the use of any of the available equipment and working forces of plants not engaged directly in manufacturing war necessities.

SECTIONS AND THE JOURNAL

The Sections Committee has been desirous that the Sections should contribute a share of papers for publication in THE JOURNAL, and to that end requested that each Section submit two papers to the Publication Committee each year. Sixteen papers given at Section Meetings have been published this year. A splendid suggestion in this regard was made at the Sections Session of the Annual Meeting, which was to assign a subject to two or three Sections where that topic is of special local interest; for example, the Boston, Chicago, San Francisco and New Orleans Sections might work up a symposium on shipbuilding. It was felt that the Sections might contribute important aid to the country in this way.

In this connection, the Committee also recommended that something be done in the line of research work, the importance of which at this time is urged upon us by the action of our Allies in this direction. Many of the Sections have appointed committees to give special attention to research work in connection with local colleges and industries.

SECTIONS AND VISITS OF OFFICERS

In the fall of 1917 President Hollis visited the Sections at St. Louis, Los Angeles and San Francisco, and spoke on behalf of the Society at El Paso, Seattle and Portland. At the same time the Sections Committee was meeting with the Sections of the Middle West.

Secretary Rice's visits to a large number of the Sections are believed to have been extremely valuable in correlating the war activities which the Society can carry on only through the medium of its Sections. All the Sections presented a patriotic atmosphere, and everywhere the enormous part played by the engineers in war activities was most striking. Mr. Rice or Mr. Hartford attended meetings at Indianapolis, Cincinnati, New Orleans, Chicago, Toronto, Detroit, Bridgeport, Meriden, New Haven, Boston, and a joint meeting at Birmingham of the Atlanta and Birmingham Sections, besides attending meetings of engineers at Toledo, Dayton and Duluth. In all localities it was the consensus of opinion that meetings of engineering organizations are well worth while at this time.

The Council visited the Chicago Section on November 16, and the Philadelphia Section on April 23, holding its regular monthly meetings at those respective places and times. On each occasion the Council attended the meeting of the Section, in the evening.

COÖPERATION WITH STUDENT BRANCHES

The value of coöperation was well illustrated when the New York Section turned its April meeting over to the Metropolitan Student Branches at Columbia University, New York University, Polytechnic Institute of Brooklyn and Stevens Institute of Technology. This event brought out an attendance of 300 persons in the afternoon, more than 400 at dinner, and between 600 and 700 in the evening.

OUR PRESENT SECTIONS

This year the Society has added the new formation of the Connecticut State Section. The affiliation of the Providence Engineering Society, whose proceedings are reported in THE JOURNAL, still continues a source of mutual benefit. The rest of the Sections are located in Atlanta, Baltimore, Birmingham, Boston, Buffalo, Chicago, Cincinnati, Detroit, Erie, Indianapolis, Los Angeles, Milwaukee, Minnesota, New Orleans, New York, Ontario, Philadelphia, St. Louis, San Francisco and Worcester. A map published in the November issue of THE JOURNAL shows the geographical locations of the Sections to be fairly well distributed over the country. The total number of Sections is now twenty-one, one of which has five branches, and the establishment of several new Sections is contemplated at present.

MEETINGS AND ATTENDANCE

More than 150 meetings have been held in the various Sections this year, all of which have been reported in THE JOURNAL. The Buffalo Section holds weekly meetings, and Indianapolis reports one all-day session with morning, afternoon and evening sessions. The reports show the various meetings to have been very well attended. At Meriden over 175 engineers were present at the June meeting; 200 attended in Bridgeport, and in Boston more than 400 gathered at one meeting in June.

NEW RECORD BOOK

A new record book has been sent to all local sections in order to assist the secretaries of the various Sections in keeping their records. This is of value in systematizing and simplifying the routine work of the Sections and should allow more time to be spent in the more important work of the Sections—that of preparing, selecting and reporting the papers of the meetings. Another good feature of the book is the information concerning other Sections, which is especially valuable at this time when we are engaged in war work. The Committee on Sections would be glad to receive suggestions from members regarding any additions or alterations to this book.

Detailed annual reports from each Section will be published in the September and subsequent issues of THE JOURNAL.

PERSONALS

In these columns are inserted items concerning members of the Society and their professional activities. Members are always interested in the doings of their fellow-members, and the Society welcomes notes from members and concerning members for insertion in this section. All communications of personal notes should be addressed to the Secretary, and items should be received by August 15 in order to appear in the September issue.

CHANGES OF POSITION

WILLIAM F. PARISH, formerly aeronautical mechanical engineer, Signal Corps, Equipment Division, Specification Section, has assumed the duties of chief of Oil and Lubrication Branch of the Supply Section of the Department of Military Aeronautics.

F. RAYMOND JACKSON has severed his connections with the firm of J. E. Sirrine, mill engineer and architect of Greenville, S. C., and has accepted a position in the mechanical section, department of concrete ship construction, of the Emergency Fleet Corporation, U. S. Shipping Board, Philadelphia, Pa.

DAVID S. WEGG, until recently manager of the Telluride Realty Company, Salt Lake City, Utah, is serving as supervising inspector of ordnance material in the Chicago district, with headquarters at the plant of the Standard Steel Car Company in Hammond, Ind.

C. B. BANCH has accepted a position with the U. S. Steel Corporation, ordnance department, Ambridge, Pa., as designing engineer. He was formerly in the employ of Corrigan, McKinney and Company, of Cleveland, Ohio, in a similar capacity.

CHARLES F. MERRILL has resigned his position as chief engineer of the James Hunter Machine Company, North Adams, Mass., to take a position in the Southern sales department of the Draper Corporation at Atlanta, Ga. Mr. Merrill was for several years connected with the engineering department of the Draper organization at Hopedale, Mass.

LEWIS S. MAXFIELD has resigned from the motive-power department of the Interborough Rapid Transit Company and New York Railways Companies, New York, to become associated with the Nate-Earle Company, engineering contractors of the same city, as assistant engineer.

W. HERMAN GREUL, for some years identified with the Otis Elevator Company, New York, has been made president of the Standard Plunger Elevator Company, Worcester, Mass.

ARTHUR SEUBERT, formerly instructor in mechanical engineering, Polytechnic Institute of Brooklyn, Brooklyn, N. Y., has entered the service of the New York Edison Company, New York, in the capacity of assistant to mechanical engineer.

CHARLES W. VOCKE, formerly mechanical engineer with the Nitrogen Fixation Corporation, New York, has become affiliated with the National Aniline and Chemical Company, Wappingers Falls, N. Y.

AUGUSTUS H. LANE has left the employ of the Grant Hammond Manufacturing Corporation, of New Haven, Conn., and has taken a position in the engineering department of the Government at Watervliet Arsenal.

FRANCIS L. BARSTOW has become affiliated with the Falulah Paper Company, Fitchburg, Mass. He was formerly connected with the Worden-Allen Company, Chicago, Ill.

WILLIAM R. CRUTE has resigned his position of chief engineer of the Champion Fiber Company, Canton, N. C., to accept the position of aero mechanical engineer, naval aircraft factory, Navy Yard, Philadelphia, Pa.

HARRY B. CHAPMAN, formerly manager of the Chapman Engineering Company, Texas City, Tex., has entered the service of the Westinghouse Electric and Manufacturing Company Machine Works, East Pittsburgh, Pa.

JOHN W. KITTREDGE, until recently designer with the Firestone Tire and Rubber Company, Akron, Ohio, has accepted a similar position with the Diamond Match Company, of Barberton, Ohio.

JOSEPH E. SHEEDY, assistant manager, Seattle Construction and Dry Dock Company, Seattle, Wash., has become associated with the Erickson Engineering Company of the same city.

JOSEPH H. CHEETHAM, formerly chief mechanical engineer, McNab and Harlin Manufacturing Company, Paterson, N. J., has assumed the duties of superintendent of the Kunkle Valve Company, Fort Wayne, Ind.

C. EDWIN CLARKE has assumed the duties of master mechanic, Saucon plant of the Bethlehem Steel Company, Bethlehem, Pa. He was formerly affiliated with the Wilmington Steel Company, Wilmington, Del., in the capacity of chief engineer.

JOSEPH J. NELIS, formerly with the Babcock and Wilcox Company, Cincinnati, Ohio, has accepted a position with the U. S. Shipping Board, Emergency Fleet Corporation, Technical Division, Philadelphia, Pa. Mr. Nelis will be engaged in boiler work.

ANNOUNCEMENTS

JOSEPH N. MAHONEY has severed his relations with the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., to take up the practice of consulting mechanical and electrical engineer, with offices in New York. He will specialize in the design and application of railway brake and control apparatus of the mechanically, electrically or pneumatically operated forms; also industrial and power electrical control and switching equipment.

FREDERIC F. GAINES, superintendent of motive power, Central of Georgia Railway, Savannah, Ga., has become a member of the Board of Railroad Wages and Working Conditions, with headquarters at Washington, D. C.

B. M. BAXTER, for nine years associated with H. B. Prather, consulting engineer of Cleveland, has severed his connection with Mr. Prather and has opened an office in the same city to conduct a consulting engineering business in steam-power-plant and mill-building work, specializing in paper-mill engineering.

OLIVER C. IRWIN, until recently associated with the Frick Company of New York, as refrigerating engineer, has opened an office at 291 Broadway, New York, under the firm name of O. C. Irwin and Company, Engineers.

R. SANFORD RILEY, president of the Sanford Riley Stoker Company, Ltd., Worcester, Mass., and of the Murphy Iron Works, Detroit, Mich., has been requested by the Emergency Fleet Corporation to arrange for supervision of trial trips of all merchant ships now being turned out in this country. He has undertaken the organization of this department for the Emergency Fleet Corporation, but has an arrangement by which he will retain supervision of his other interests during his connection with the Corporation. Before going into the stoker business, Mr. Riley had an extensive experience in marine engineering and shipbuilding. His qualifications were called to the attention of Mr. Charles M. Schwab by former shipbuilding associates, which resulted in his call to service.

F. L. CHURCHILL has enlisted in the service of the U. S. Shipping Board for the duration of the war, and is now stationed on the S. S. *Suriname*. He was formerly affiliated with the Fafnir Bearing Company, of New Britain, Conn.

A. C. THOMAS has assumed the duties of equipment superintendent, liquid air department of the Air Nitrates Corporation, Mussel Shoals, Ala.

John R. Shea left on July 15 for Tokyo, Japan, to represent the Western Electric Company's manufacturing interests there. He was formerly connected with the Chicago plant of the company, as head of the production methods division.

William F. Schweigert has been elected secretary of the Niagara Machine and Tool Works. He will continue to give special attention to the sales department by attending to the most important work on the road. Mr. Schweigert has been affiliated with the company for 30 years.

Miller Reese Hutchison, associated for several years as chief engineer of the laboratory in West Orange with Thomas A. Edison, President of the Naval Consulting Board, has resigned from the Edison interests to devote his entire time to the prosecution of the war. Dr. Hutchison is a member of the Naval Consulting Board.

Harry Cowen, until recently assistant engineer of car equipment, Interborough Rapid Transit Company, New York, has been transferred to the position of general foreman of the mechanical department of the New York Railways Company, New York.

Warren C. Drake, for the past 12 years connected with the stoker-engineering department of the Westinghouse Electric and Manufacturing Company, New York, has resigned this position. He has entered into partnership with H. S. Sleicher, and has opened an office in New York, under the firm name of Sleicher and Drake, for the handling of power-plant equipment.

Joseph Breslove, until recently sales engineer with the Allis-Chalmers Manufacturing Company, Pittsburgh, Pa., has opened an office in the same city, and will carry on a general consulting practice, specializing in power-plant work.

Frank C. Turner, formerly representative of the Southern Wheel Company, Birmingham, Ala., has assumed the duties of vice-president of the same company, with headquarters at St. Louis, Mo.

Max K. Grossheim is now in charge of the engineering department of L. O. Koven and Brothers, boiler makers and engineers, of Jersey City, N. J. His former duties with this concern were those of designer.

APPOINTMENTS

Col. Charles C. Jamieson, Lieut-Col. H. B. Hunt and Lieut-Col. W. P. Barba are among the members of a board appointed by General C. C. Williams, Acting Chief of Ordnance, to represent the Ordnance Department in the preparation and approval of plans for the construction of the Neville Island plant for heavy cannon and projectiles to be constructed by the United States Steel Corporation. The board will coöperate with the corporation in the planning, construction and operation of the plant.

H. H. Esselstyn, associated with the U. S. Shipping Board, Emergency Fleet Corporation, has been appointed Commissioner of Public Works, Detroit, Mich., and will assume his office when he obtains his release from the U. S. Shipping Board. Mr. Esselstyn is senior member of the firm of Esselstyn, Murphy and Hanford, of the same city.

John W. F. Bennett, member of the firm of Goodrich, Hoover and Bennett, consulting engineers of New York, has been appointed Major in the Construction Division of the Quartermaster's Corps, National Army.

Ross Anderson has been appointed manager at the Accessory Plant of the American Locomotive Company, Richmond, Va. Mr. Anderson was superintendent at their Pittsburgh plant for the last year, and prior to that manager of the Poole Engineering and Machine Company, Baltimore, Md.

Albert G. Suttill has been appointed inspector for the Merchant Shipbuilding Corporation, of Bristol, Pa., in charge of the Boston district.

George R. Henderson has been appointed Administrative Engineer for Pennsylvania, under the Federal Fuel Administration.

ROLL OF HONOR

Abernethy, A. A., U. S. Naval Reserve Force, in training at U. S. Steam Engineering School, Hoboken, N. J.

Allison, John R. A., Second Lieutenant, Engineer Officers' Reserve Corps, General Engineer Depot, U. S. Army, Field Inspection Service.

Arnold, John A., Camp Meade, Md.

Barba, W. P., Lieutenant-Colonel, Ordnance Department, N. A., Ordnance Department Board of Construction of U. S. Steel Corporation Plant.

Barton, Warren H., Co. H, 2d Engineers' Regiment, Camp Humphrey, Va.

Bates, D. M., Major, U. S. Army.

Bennett, John W., Major, Construction Division, Quartermaster's Corps, N. A.

Berliner, R. W., Major, Quartermaster's Corps, U. S. Army.

Budwell, Leigh, Second Lieutenant, Engineer Officers' Reserve Corps, 61st Engineers, Fort Benjamin Harrison, Ind.

Childs, Harold P., First Lieutenant, Truck Co. No. 2, First Battalion, 23d Regiment Engineers, American Expeditionary Forces, France.

Coleman, R. J., First Lieutenant, Ordnance Officers' Reserve Corps, Ordnance Department, American Expeditionary Forces, France.

Cox, Abraham B., Captain, Ordnance Officers' Reserve Corps, Ordnance Department, American Expeditionary Forces, France.

Derry, Gardner C., Ensign, U. S. Naval Reserve Force, U. S. Naval Academy, Annapolis, Md.

Dilts, Frank B., Captain, Ordnance Officers' Reserve Corps, Ordnance Department, U. S. Army, stationed at Watervliet Arsenal, N. Y.

Drake, Charles L., First Lieutenant, Ordnance Officers' Reserve Corps, Sandy Hook Proving Ground, Fort Hancock, N. J.

Edimann, Frank L., Ensign, U. S. Naval Reserve Force, Aviation.

Frankel, Monroe J., 4th Battery, Field Artillery, Officers' Training Camp, Camp Zachary Taylor, Ky.

Fuhr, Harry E., Ensign, U. S. Navy.

Gates, S. J., Captain, Engineer Officers' Reserve Corps, American Expeditionary Forces, France.

Haney, James B., Captain, Ordnance Officers' Reserve Corps, Ordnance Department, U. S. Army, American Expeditionary Forces, France.

Hunter, H. C., Co. C, 304th Battalion, N. A., Camp Colt, Gettysburg, Pa.

Irwin, K. M., U. S. Naval Reserve Force.

Kemble, Parker H., Lieutenant, U. S. Naval Reserve.

McLindie, First Lieutenant, Ordnance Officers' Reserve Corps, Rock Island Arsenal, Rock Island, Ill.

Marshall, Waldo H., Colonel, Ordnance Officers' Reserve Corps, Production Division, Ordnance Department, U. S. Army.

Mayer, James Leo, Lieutenant, 109th Engineers, Camp Cody, N. M.

Myers, Curtis C., Captain, Ordnance Officers' Reserve Corps, U. S. Army.

Peter, Albert G., First Lieutenant, Ordnance Officers' Reserve Corps, stationed at the Philadelphia District Ordnance Office.

Rosenthal, Emanuel, Sergeant, Co. D, 19th Platoon, 56th U. S. Engineers, American Expeditionary Forces, France.

Ruppel, Richard L., Captain, Quartermaster's Corps, N. A., Construction Division.

Sanders, Walter C., Lieutenant, Battery F, 64th Heavy Artillery (C. A. C.), American Expeditionary Forces, France.

Shearer, David R., First Lieutenant, Aviation Section, Signal Officers' Reserve Corps, Finance Department, Approvals Section, U. S. Army.

Sladky, A. C., Captain, Ordnance Officers' Reserve Corps, Production Division, Ordnance Department, U. S. Army.

Swift, Henry, First Lieutenant, Ordnance Officers' Reserve Corps, Inspection Division, Ordance Department, U. S. Army.

Taylor, Charles Fayette, Lieutenant (Junior Grade), U. S. Naval Reserve Flying Corps, stationed at Washington Navy Yard.

Tayman, George S., Chemical Section, Division of Mechanical Research, N. A., American University, Washington, D. C.

Teague, Newton N., Second Lieutenant, Aero Engineer Officer, Air Service, N. A., U. S. Army.

Treuhaft, A. A., Ordnance Engineering School, Aberdeen Proving Grounds, Md.

Wagenseil, E. W., Lieutenant (Junior Grade), U. S. Naval Reserve Force, Naval Reserve Flying Corps Repair Base, France.

Warner, First Lieutenant, Engineer Officers' Reserve Corps, American Expeditionary Forces, France.

Woobank, Wilfred, Private, Meteorological Section, Signal Corps, U. S. Army, Texas A. & M. College, College Station, Tex.

Wood, C. E., Chemical Warfare Section, N. A.

Worthen, Charles B., Second Lieutenant, Military Aeronautics Division, U. S. Army.

Yardley, R. W. E., Captain, Ordnance Officers' Reserve Corps, Ordnance Department, U. S. Army.

CANDIDATES FOR MEMBERSHIP

TO BE VOTED ON AFTER SEPTEMBER 10

BELOW is the list of candidates who have filed applications since the date of the last issue of THE JOURNAL. These are classified according to the grades for which their ages qualify them, and not with regard to professional qualifications, i.e., the ages of those under the first heading place them under either Member, Associate or Associate-Member, those in the next class under Associate or Associate-Member, those in the third class under Associate-Member or Junior, and those in the fourth under Junior grade only. Applications for change of grading are also posted. Total number of new applications, 253.

The Membership Committee, and in turn the Council, urge the members to scrutinize this list with care and advise the Secretary promptly of any objections to the candidates posted. All correspondence in this regard is strictly confidential. Unless objection is made to any of the candidates by Sept. 10, and provided satisfactory replies have been received from the required number of references, they will be balloted upon by the Council. Those elected will be notified about Oct. 15.

NOTE. The Council desires to impress upon applicants for membership that under the present national conditions the procedure of election of members may be slower than under normal conditions.

NEW APPLICATIONS

FOR CONSIDERATION AS MEMBER, ASSOCIATE OR ASSOCIATE-MEMBER

Alabama

RICHARDSON, WILLIAM, JR., Construction Engineer, Tennessee Coal, Iron & Railroad Co., Ensley
WATSON, CHARLES E., Chief Engineer, Alabama Dry Dock & Shipbuilding Co., Mobile

California

JOHNSSON, MONS J., Outside Superintendent, Pacific Portland Cement Co., Cement
MEESE, CONSTANT, President and Directing Manager, Meese & Gottfried Co., San Francisco
SCHWEITZER, R. R., Vice-President and General Manager, Western Machinery Co., Los Angeles

Colorado

BIER, PETER, Mechanical Engineer, Construction Department, Great Western Sugar Co., Denver
GILBERT, GEORGE T., Consulting Engineer, Denver
LESTER, WILLIAM, General Superintendent and Chief Engineer, Vulcan Iron Works, Denver

Connecticut

ARCHER, SYLVANUS, Assistant Superintendent, Bank Lock Dept., Yale & Towne Mfg. Co., Stamford
BARNES, FRED L., Estimator and Salesman, Eastern Machinery Co., New Haven
CLEVELAND, FRANK W., Assistant to Superintendent of Equipment, Pratt & Whitney Co., Hartford
COLVIN, BENJAMIN J., Power Engineer, Sidney Blumenthal & Co., Inc., Shelton
CROCKER, JOHN F., Comptroller, Bridgeport Brass Co., Bridgeport
LINTON, SAMUEL A., Foreman, Pratt & Whitney Co., Hartford
MARSHALL, CARL, Welfare Manager, Pratt & Whitney Co., Hartford
VALENTINE, AUGUST L., Superintendent, Pratt & Whitney Co., Hartford

Delaware

BARSTOW, JOHN S., Engr., E. du Pont de Nemours & Co., Wilmington
BERGLAND, WILLIAM S., Engineer, E. I. du Pont de Nemours & Co., Wilmington
LAIRD, WALTER J., Construction Engineer, du Pont Co., Wilmington
NORBOM, TORLEIF S., Superintendent of Marine Machinery, The Pusey & Jones Co., Wilmington

District of Columbia

BROOKS, HENRY W., Mechanical Engineer, U. S. Ord. Dept., Inspc. Div., Washington
CHAPLIN, MERLE P., 1st Lieutenant, Engineer R. C., Engineer Branch, Motor Transport Service, Unit F, 7th Wing, Washington
DAHLQUIST, CHARLES S., Major, Q. M. C. N. A., Motor Transport, Supervisor of Inspection, Inspection Division, Washington
HARRIS, GLENN B., Gauge Engineer, Inspection Div., Ord. Dept., Washington
McCONNELL, JAMES W., Master Mechanic, Torpedo Tube Shop, Washington Navy Yard, U. S. Naval Gun Factory, Washington

Florida

RAGONNET, EUGENE L., Mechanical Engineer, Cuba Cane Sugar Corp., Miami

Georgia

TUFTS, R. BARRY, Engineer and Contractor, Private Practice, Atlanta

Illinois

BENNETT, WILMER C., Structural Engineer, Private Practice, Chicago
COLE, AUSTIN, President and General Manager, Western Valve Bag Co., Chicago
FRYE, RAYMOND P., Chief Draftsman, Amalgamated Machinery Corp., Chicago
GOOLEY, JOSEPH E., Sales Engineer, The Imperial Brass Mfg. Co., Chicago
PEACOCK, CHARLES M., Mechanical Engineer, Equipment, D. A. Wright, Chicago
WACHS, CHARLES L., Vice-President, The E. H. Wachs Co., Chicago

Indiana

BAYLOR, CHARLES A., Superintendent, Great Western Mfg. Co., La Porte
BERTSCH, LAWRENCE H., Vice-President and Chief Engineer, Bertsch & Co., Cambridge City
JACOB, WILLIAM, Chief Car Draftsman, C. C. C. & St. L. Ry., Indianapolis
LEWIS, EDWIN H., Assistant to Inspection Manager, Inspection Div., Ordnance Dept., Standard Steel Car Co., Hammond
LUTEN, DANIEL B., Designing and Consulting Engineer, Private Practice, Indianapolis
PILKINGTON, ROBERT G., Automotive Engineer, Dodge Mfg. Co., Mishawaka

Kentucky

MOORE, CLARENCE S., Chief Engineer, Lex. Laundry Co., Lexington

Louisiana

GRANT, ARTHUR A., New Orleans Mgr., Freeport & Mexican Fuel Oil Co., New Orleans

Maryland

MORGAN, MERTON W., Chief Draftsman, Poole Engineering & Machine Co., Baltimore
WILLIAMS, JESSE W., Master Mechanic, By Product Coke Oven Dept., Bethlehem Steel Co., Sparrows Point

Massachusetts

AMES, BRADFORD L., President, Monarch Soot Remover Co., Boston
BALLENTINE, JOEL E., Mechanical Engineer, A. C. Lawrence Leather Co., Peabody
BENGSTON, CARL, Power Engineer, Norton Co., Worcester
CHASE, ALBERT M., Draftsman, C. W. Praray, Mill Engineer, New Bedford
COPPUS, FRANS H. C., President, Treasurer, Coppus Engineering & Equipment Co., Worcester
DOE, THOMAS B., General Manager, United States Cartridge Co., Lowell
FARNHAM, WALTER E., Head of Engineering Department, New Bedford Textile School, New Bedford
GOLDSMITH, GEORGE H., General Superintendent, James Hunter Machine Co., North Adams
GOUGH, CHARLES M., Construction Department, Watertown Arsenal, Watertown
HOWARD, HENRY F., Engineer, Worcester Mfg. Co., Worcester
HUGHES, JOHN L., Designing and Development Engineer, General Electric Co., Pittsfield
ISLEY, GEORGE H., Mechanical Engineer, Private Practice, Worcester
LAWRENCE, HOWARD B., Engineer, John A. Stevens, Consulting Engineer, Lowell
LOWELL, KARL P., Mechanical Engineer, Fred T. Ley & Co., Inc., Springfield
MAIN, CHARLES R., Special Assistant, Charles T. Main, Engineer, Boston
PENNEY, LOREN W., Mechanical Engineer, Saco-Lowell Shops, Newton Upper Falls
RAMSDELL, THOMAS S., Constructing and Operating Engineer, Monument Mills, Housatonic
SMALL, ERNEST M., Engineering Draftsman, Power House Design, Edison Ill. Co., Boston
SYME, JAMES M., Superintendent, Brown Bag Filling Machine Co., Fitchburg
SZEPESI, EUGENE, Senior Engineer, Cooley & Marvin Co., Boston
WARFIELD, GEORGE L., Superintendent, Thorndike Co., Thorndike

WHEELER, Benjamin A., Chief Draftsman, Whitcomb-Blaisdell Machine Tool Co., Worcester
WILSON, Henry L., Mechanical Engineer, Atlantic Dyestuff Co., Boston

Michigan

FITZGERALD, John W., Engineer, L. A. Young Industries, Inc., Detroit
GIFFORD, W. Arthur, President and Manager, Gifford Engine Co., Lansing
McDONALD, William F., Heating Engineer, William F. McDonald Co., Detroit
NESBITT, James W., Assistant Mechanical Superintendent, Packard Motor Car Co., Detroit
POULSEN, Eugene, Chief Draftsman, The Prescott Co., Menominee
RADFORD, Fred L., Chief Draftsman, Reo Motor Car Co., Lansing

Minnesota

UHL, Willard F., Sales Engineer, Private Practice, Minneapolis

Missouri

MALLINCKRODT, Edward, Jr., Manufacturer, Mallinckrodt Chemical Works, St. Louis

Nevada

CAFFEREY, Willis G., Electrical Engineer, Nevada State Hospital for Mental Diseases, Reno

New Jersey

BARRI, Joel G., Field Mechanical Engineer, c/o T. A. Gillespie Loading Co., South Amboy
CAREW, William A., General Superintendent, Morgan Engineering Co., Jersey City
CARLISS, Oswald T., Chief Inspector of U. S. A. Ordnance, National Vitaphone Corp., Plainfield
CHASE, George C., President, Chase Adding Machine Corp., Orange
FRENCH, Charles M., 1st Lieutenant, Engineers R. C., 34th Engineers, Camp Dix
HOHL, George L., Mechanical Engineer, Any Package Wrapping Machine Co., Newark
NILIUS, Bruno, Assistant Chief Mechanical Engineer, American Can Co., Edgewater
VANDERHOOF, Arnold H., Ensign, U. S. N. (Retired), Officer in Charge, U. S. Naval Radio Station, New Brunswick
WARNER, Murray, in Charge of Utilities, Camp Dix

New York

BARRY, Joseph C., Mechanical Draftsman, N. Y. Edison Co., New York
BERMAN, Louis K., Vice President, Raisler Heating Co., New York
BISHOP, Clarence A., President and General Manager, The Bishop Calculating Recorder Co., New York
CARL, Fred H., Engineer, Westinghouse Church, Kerr & Co., New York
CASEY, Albert O., Engineer on Telephone Apparatus, Western Electric Co., Inc., New York
CUNDALL, Robert N., Consulting Engineer, Cundall & Powell, Buffalo
DIBERT, Herbert M., General Sales Manager, W. & L. E. Gurley, Troy
EMMONS, Charles L., Factory Manager, Aeolian Co., New York
GAZIN, Lewis M., Engineer, Federal Light & Traction Co., New York
GLATHE, Bernhard, Chief Engineer, The Cuban American Sugar Co., New York
GLENDENNING, William J. A., Consulting Engineer, Mech. Rubber Goods & Asbestos Packing, New York
HAMMOND, John W., Secretary, Lake Erie Engineering Works, Buffalo
JENNINGS, Wilfred B., Works Engineer, Worthington Pump & Machinery Corp., Buffalo
LUTHER, George W., Mechanical Engineer, The Luther Mfg. Co., Olean
MURRAY, Howard J., Electrical Engineer, Gibbs & Hill, New York
OLSON, John H., Engineer, M. H. Treadwell Co., New York
PATTERSON, J. Clifford, Testing Department, The Solvay Process Co., Syracuse
PHILIPS, William D., Manager of Engineering and Sales, A. S. Nichols Co., New York
ROBLIN, Wilmot H., Inspector of Ord., U. S. O. D., Watervliet Arsenal, Watervliet
SEABROOKE, William L., William L. Seabrooke, Chemicals, New York
SHARP, John, Mechanical Engineer, Ferguson Steel & Iron Co., Buffalo
SIMMONDS, Philip R., Eastern Sales Manager, Kernchen Co., of Chicago, New York
SLOCUM, Herbert J., Jr., President, Slocum, Avram & Slocum, Inc., New York
SMITH, Engineer, United Gas & Electric Engineering Corp., New York
STEELE, Hugh E., Manager West Coast Machinery Business, W. R. Grace & Co., New York
WETMORE, Miner P., Treasurer and General Manager, The Hygrade Engineering Co., New York
WHITE, Robert H., Engineer of Construction, American Locomotive Co., Schenectady

Ohio

BRADLEY, W. H., Vice-President and General Manager, Bedford Coal Co., Coshocton
HUBER, Frank W., Assistant Superintendent, Forge & Foundry Dept., American Rolling Mill Co., Middletown
MORRIS, John F., Superintendent of Maintenance, Whitaker Glessner Co., Portsmouth
WILSON, Alexander M., Professor Electrical Engineering, University of Cincinnati, Cincinnati
WILSON, Harland H., Designing Engineer, McKinney Steel Co., Cleveland

Oregon

BALE, Charles W., Chief Engineer, Albina Engine & Machine Wks., Inc., Portland

Pennsylvania

ALBRECHT, Albert J., Draftsman, Midvale Steel & Ord. Co., Philadelphia
BENNETT, William H., Rolling Mill Supt., Clairton Wks., Carnegie Steel Co., Clairton
BENSON, Harry L., General Foreman, Machine Shop, The Midvale Steel Co., Philadelphia
CHAPMAN, Washington H., Engineer, U. S. Ship Building Emergency Corp., Philadelphia
CUPITT, A. Warren, Equipment Engineer, Midvale Steel Co., Nicetown
GECK, Albert A., Superintendent, Colburn Machine Tool Co., Franklin
HARRIS, Henry S., Sales Engineer, Ingersoll Rand Co., Philadelphia
HARRIS, Leslie M., Assistant to Vice-President, American Engineering Co., Philadelphia
HATCH, Charles W., Assistant Chief Draftsman, American Sheet & Tin Plate Co., Pittsburgh
HENDERSON, Richard, Works Engineer, Stanley G. Flagg & Co., Pottstown
HOCKENSMITH, Wilbur D., General Manager and Vice-President, Hockensmith Wheel & Mine Car Co., Penns Station
JAUSS, August C., Chief Draftsman, Artillery Dept., Midvale Steel & Ordnance Co., Nicetown
LAUBENSTEIN, Albert R., Manager and Treasurer, Laubenstein Mfg. Co., Ashland
LYONS, Robert J., Assistant Purchasing Officer, Emergency Fleet Corp., Philadelphia
MATTHEWS, John J., Director of Shops, Swarthmore College, Swarthmore
MEYER, Carl F., Sales Manager, Landis Machine Co., Waynesboro
MUNZ, William, Mechanical Engineer, Ballinger & Perrot, Philadelphia
OBERSTADT, Carl, Mechanical Expert and Efficiency Engineer, Iron City Products Co., Pittsburgh
OSWALD, Harry A., Assistant General Superintendent, Naval Aircraft Factory, Navy Yard, Philadelphia
OTTO, William F., Sales Engineer, Eynon-Evans Mfg. Co., Philadelphia
ROBERTS, William E., Lieutenant, U. S. N. R. F., Asst. Genl. Supt., Naval Aircraft Factory, Navy Yard, Philadelphia
SCOTT, C. Linford, General Superintendent, Harrisburg Mfg. & Boiler Co., Harrisburg
TOLSTED, Elmer B., Engineer, Independence Bureau, Philadelphia
VAUCLAIN, Jacques L., an Assistant to the Vice-President, The Baldwin Locomotive Works, Philadelphia

Rhode Island

OSTBY, Raymond E., General Superintendent, Ostby & Barton Co., Providence

South Carolina

KENNEDY, Alfred D., Vice-President and General Manager, American Machine & Mfg. Co., Greenville

Texas

STEVENS, Harry L., Consulting Refrigerating Engineer & Supply Co., El Paso

Virginia

HILDEBRAND, Clarence K., Designer and Southern Rep., The Ludington Cigarette Mch. Co. of Waterbury, Conn., Salem

Washington

BALLWEG, John H., Electric Engineer, U. S. Spruce Cut Up Mills, Vancouver

Wisconsin

ATHERTON, Donald H., Instructor Mechanical Engineering, University Extension Div., University of Wisconsin, Madison
RICHARDS, Forest A., Engineer for Mr. Edward Hutchens, Consulting Engineer, Eau Claire
SPRINK, Isaac W., Special Inspector and Investigator Engineering Department, Four Wheel Drive Auto Co., Clintonville
ZANTOW, Henry C., Assistant to Wisconsin State Power Plant Engineer, Mr. John C. White, Madison

Canada

HODGE, Charles A., Instructor, Nova Scotia Technical College, Halifax, N. S.
LANG, James, Estimating and Contracting Engineer, John Inglis Co., Ltd., Toronto
VIBERG, Ernest R., Mechanical Engineer, Canadian Car & Fdy. Co., Ltd., Montreal

England

FOWLER, Sir Henry, Lieutenant-Colonel, Royal Flying Corps; Superintendent, Royal Aircraft Factory, Derby

Norway

RIDDERVOLD, L. Dahl, Vice-President and Manager, Gustav Nielsen A. S. Toldbedgaten, Christiania

FOR CONSIDERATION AS ASSOCIATE OR ASSOCIATE-MEMBER

California

RIX, HAROLD P., Machinery Merchant, Vice-President, Rix Compressed Air & Drill Co., San Francisco

Delaware

HATCH, JOSEPH R., Fire Protection Engineer, Old Hickory Works, E. I. du Pont de Nemours & Co., Wilmington

Illinois

MILLER, PAUL B., Chief of Section, Apparatus Drafting Dept., Western Elec. Co., Inc., Hawthorne

Iowa

PRAY, JOHN W., Superintendent, City Water Department, Dodge

Massachusetts

CANNITY, ERNEST, Chief Draftsman, Hunter Machine Co., North Adams

WEBSTER, OSCAR A., General Foreman, Machine Shop, Stafford Co., Readville

WHITCOMB, FORREST R., Superintendent, American Radio & Research Corp., Medford, Hillside

New Jersey

GORDON, ROBERT J., Power Engineer, Hercules Powder Co., Kenvil

WHITMORE, RALPH D., Supervising Engineer, American Standard Metal Products Corp., Paulsboro

WOEHL, FRANK, Draftsman and Designer, Babcock & Wilcox Co., Bayonne

New York

DOWNS, CHARLES L., Captain, Army Inspector of Ordnance, U. S. A., Artillery and Artillery Ammunition, New York Air Brake Co., Watertown

Ohio

CLASGENS, JOSEPH H., Assistant Superintendent, The J. & H. Clasgens Co., New Richmond

GIBSON, WILLIAM A., Mechanical Engineer, The Aluminum Castings Co., Cleveland

KER, HENRY W., Sales Manager, Wapakoneta Machine Co., Wapakoneta

WADSWORTH, HOWARD L., Manager, American Foundry Equipment Co., Cleveland

Pennsylvania

COHN, HERBERT A., Chief Draftsman, Works Power Engr. Div., Westinghouse Elec. & Mfg. Co., E. Pittsburgh

FERNSLER, PENROSE A., 135 So. 11th St., Lebanon

GODWIN, ROY M., Mechanical Engineer, Barrett Co., Philadelphia

LEROY, LEO F., Leading Locomotive Draftsman, Designer and Checker, Mechanical Department, Erie R. R., Meadville

OGLE, GEORGE M., General Engineer, Westinghouse Elec. & Mfg. Co., E. Pittsburgh

SEVERN, ARTHUR B., Equipment Pilot Engineer, Baltimore & Ohio R. R., Pittsburgh

Wisconsin

HAY, EARL D., Professor of Drawing and Machine Design, State Normal School, Oshkosh

FOR CONSIDERATION AS ASSOCIATE-MEMBER OR JUNIOR

Colorado

BYERS, HARRY R., with Babcock & Wilcox Co., Denver

Connecticut

CARVETTE, CHARLES W., Military Engineer, Remington Arms Union Metallic Cartridge Co., Bridgeport

McGARVEY, JOSEPH T., Sub-Inspector of Ordnance Navy Dept., American & British Mfg. Co., Bridgeport

MAC INTYRE, JAMES R., Chief Designer, H. E. Harris Engineering Co., Bridgeport

District of Columbia

HATTON, MERLE W., Mechanical Expert, Chem. Warfare Service, Research Div., American University Experiment Sta., Washington

Illinois

PARMENTER, LAURENCE L., Private, Edgewood Plant, Edgewood Arsenal, Edgewood, Md., Detachment "D" Chicago & N. W. R. R., Chicago

SIMPSON, ARTHUR M., Sales Engineer, Wood Equipment Co., Chicago

WOOD, KENNETH V., Night Enginehouse Foreman, C. C. C. & St. L. R. R. Co., Mt. Carmel

Indiana

MENKE, EDWARD W., Assistant Engineer, United Chemical & Organic Products Co., Hammond

RETTERER, RAY W., Assistant Mechanical Engineer, C. C. C. & St. L. Rwy., Beech Grove

SMITH, DAVID W., Assistant Mechanical Engineer, Rubber Regenerating Co., Mishawaka

Massachusetts

NAKASHIAN, LUKE L., with Jefferies-Norton Corp., Worcester

PALMER, RAYMOND E., Chief Engineer, Construction Div., Kalmus, Comstock & Westcott, Inc., Cambridge

SODERBERG, ROBERT B., Lieutenant Ord. R. C., Army Inspector of Ordnance and Acting Quartermaster for Gray & Davis, Inc., Amesbury

WESLEY, HARRY B., Designing Engineer, Brown Bag Filling Machine Co., Fitchburg

New Jersey

KNOWLES, CHARLES H., Principal Assistant Engineer, The Arnold Co., U. S. General Hospital No. 3, Colonia

New York

CAHILL, JOHN E., JR., Ampudia & Cahill, Industrial Engineers, New York

FISHER, PIERCE H., in Charge Mechanical Development, Medical Research Laboratory, Mineola

McNULTA, J. JOSEPH, Chief Engineer, Vacuum Ash & Soot Conveyor Co., New York

RAYMOND, GEORGE G., Industrial Engineer, Gunn, Richards & Co., New York

SHELDON, WILLIAM M., Mechanical Engineer, Sheldon Co., New York

SMITH, EDWARD J., Foundry Engineer, Ingersoll Rand Co., Painted Post

SPICER, ELMER D., Factory Manager and Chief Engineer, Moore Steam Turbine Corp., Wellsville

THOMSEN, RAYMOND L., Manager of Marine Dept., The Griscom Russell Co., New York

Ohio

BOUGHTON, JAMES A., Chief Engineer Power House No. 2, Goodyear Tire & Rubber Co., Akron

CONSTAM, ALYN F., Construction Engineer, The B. F. Goodrich Co., Akron

CECIL, WILLIAM D., Resident Material Inspector, Baltimore & Ohio R. R., Cincinnati

MACLEAN, ARCHIE A., Engineer of Tests, Ordnance Dept., U. S. A., Standard Parts Co., American B. B. Plant, Cleveland

Oregon

BETHARDS, F. EARL, Efficiency Department, Willamette Iron & Steel Wks., Portland

Pennsylvania

EADES, HERBERT S., Assistant to Mechanical Engineer, American Bridge Co., Ambridge

RAPPAPORT, ARTHUR, Engineering Draftsman, John Lang Paper Co., Philadelphia

Wisconsin

ROBERTS, EARL H., Chief Mechanical Engineer, John Obenberger Forge Co., West Allis

Canada

JARRED, ARTHUR, Superintendent, Smithy, Massey, Harris Co., Ltd., Toronto

FOR CONSIDERATION AS JUNIOR

Connecticut

HOMANN, FREDERICK A., Ensign, Technical Duties, U. S. N. R. F. Dept., Public Works, Naval District Base, State Pier, New London

District of Columbia

BURDICK, THEODORE A., Sergeant 1st Class 437th Engineers, General Engineer Depot, U. S. A., Washington

FERNALD, ERNEST M. Laboratory Assistant Navy Yard, Washington

NOLAN, JAMES B., Warrant Machinist U. S. N., Bureau of Navigation, Washington

Illinois

CARMICHAEL, VICTOR V., Assistant to Superintendent of Power, Aluminum Ore. Co., E. St. Louis

KERR, VOLNEY A., Engineer, Draftsman and Designer, American Well Works, Aurora

SNAPP, HOWARD M., Jr., U. S. Army, A. S. S. C., Science and Research Div., Joliet

TYMESON, CHARLES P., 1st Lieut. Ordnance R. C., U. S. Army, Rock Island Arsenal

Indiana

CORNELL, DANA R., Assistant General Foreman, Heat Treating Dept., Standard Forgings Co., Indiana Harbor

McCRADY, HARRY E., Tool Designer and Checker, Nordyke & Marmon Co., Air Plane Eng. Dept., Indianapolis

Massachusetts

HOPKINS, ETHAN C., Superintendent, Wade Machine Co., Boston

RITCHIE, A. T., Draftsman, Simplex Electric Heating Co., Cambridge

Michigan

ALBINSON, HAROLD A., Machine Designer, Michigan Copper & Brass Co., Detroit

McKENNY, CHARLES A., Sergeant Mechanic, Co. C., 313 Field Signal Battalion, Ypsilanti

Missouri

BALCH, WILLIAM S., Secretary and General Manager, Southwestern Appraisal Co., Kansas City

WEISSBACH, EDWARD A., Mechanical Engineer, Mallinckrodt Chemical Works, St. Louis

New Jersey
- COE, FRANK C., Superintendent and General Manager, C. T. Coe Co., Newark
- NATHAN, WALTER S., Student U. S. N. Steam Engineering School, Hoboken
- SKOOG, R. W., Draftsman, U. S. Navy Dept., N. Y. Shipbuilding Corp., Camden

New York
- BERNNER, MILTON ST. J., Elmhurst
- BEYER, EDMOND P. W., Designer, Gifford-Wood Co., Hudson
- BUCHANAN, EDWARD E., JR., Heat Treatment, Curtiss Aeroplane & Motor Corp., Hammondsport
- CARLISLE, CHARLES A., JR., with Savage Arms Corp., Utica
- RIBEIRO, JOSE DE ASSIS, Calculator, American Locomotive Co., Schenectady
- SIMS, LEWIS R., 1st Lieutenant, Ordnance R. C., Repair Shop Attach., 29th Div., Camp Mills, Mineola
- SMITH, WILLIAM A., Assistant to Educational Director, The Texas Co., New York
- STARLING, H. STANLEY, Assistant Material Inspector, Surveyor at Large, Bureau Veritas, New York
- WALSH, HARRY W., Master Engineer, U. S. Army Engineers, New York
- WALTON-CRANFORD, WILBERT, Erecting Engineer, Shipley Construction & Supply Co., Brooklyn

Ohio
- GWIAZDOWSKI, A. P., Associate Professor of Mechanical Engineering, Toledo University, Toledo
- LEATHERS, H. M., Sales Engineer, Cutler-Hammer Mfg. Co., Cleveland

Oklahoma
- BROOK, CLIFFORD E., Assistant Supt., Gas Pipe Line Dept., Empire Gas & Pipe Line Co., Bartlesville

Pennsylvania
- BODKIN, HARRY G., Tool Designer, Midvale Steel & Ordnance Co., Philadelphia
- CANTER, MAURICE J., Production Engineer, Midvale Steel Co., Philadelphia
- LEVIN, JACOB, Marine Draftsman, American International Shipbuilding Corp., Hog Island
- SIPLEY, LOUIS W., Rate Estimator, Midvale Steel & Ord. Co., Philadelphia
- SLICER, HARRY T., Assistant to Superintendent, Tyler Tube & Pipe Co., Washington
- STINSON, JOHN A., Production Engineer, Midvale Steel & Ordnance Co., Philadelphia

Texas
- SCOTT, FLOYD L., Engineer, Hughes Tool Co., Houston

Virginia
- DOHERTY, CHARLES H., Jr., Assistant Testing Engineer, E. I. du Pont de Nemours & Co., Hopewell

Cuba
- MURRAY, HAROLD B., Engineer, Sales Department, United States & Cuban Allied Works Eng. Corp., Havana

APPLICATIONS FOR CHANGE OF GRADING

PROMOTION FROM ASSOCIATE

Alabama
- CAINE, WILLIAM P., Steam Engineer, Ensley Wks., Tennessee Coal, Iron & R. R. Co., Ensley

Illinois
- WILSON, JOSEPH B., Commercial Engineer, Westinghouse Electric & Mfg. Co., Chicago

PROMOTION FROM ASSOCIATE-MEMBER

Massachusetts
- OLSON, MARTIN L., Instructor (Junior Master), Hyde Park High School, Boston

Ohio
- HUNTER, SAMUEL R., Superintendent of Production, American Rolling Mill Co., Middletown

Washington
- HAYS, LEWIS T., Tramway Engineer, U. S. Steel Products Co., Pacific Coast Dept., Seattle

PROMOTION FROM JUNIOR

Colorado
- BISSELL, ALBERT W., Assistant Superintendent, Wire Mill, Colorado Fuel & Iron Co., Pueblo

Illinois
- WACHS, THEODORE, Engineer, The E. H. Wachs Co., Chicago

Michigan
- LANNING, JOHN G., Assistant to Vice-Pres., Detroit Lubricator Co., Detroit

Pennsylvania
- BRAYTON, HAROLD M., Artillery Ammunition Designer, Frankford Arsenal, Philadelphia
- GRAF, JOHN C., Material Agent, Southwark Foundry & Mch. Co., Philadelphia
- ROSENCRANTS, FAY H., Purchasing Assistant, Emergency Fleet Corp., Philadelphia

Wisconsin
- ALLISON, LAWRENCE M., Chief Engineer, Lawson Aircraft Co., Green Bay

REINSTATEMENT AND PROMOTION FROM JUNIOR

Georgia
- McKEE, JOHN F., Engineer and Draftsman, General Fire Extinguisher Co., Atlanta

New York
- PENDLETON, FRANK E., Chief Engineer, New York Steam Co., New York

Ohio
- HORTON, WILLIAM M., Jr., General Superintendent, The Adams-Bagnall Elec. Co., Cleveland

Pennsylvania
- MORRISON, EGBERT R., Estimating Engineer, Union Spring & Mfg. Co., Sharon

South Carolina
- BARKLEY, MATTHEW B., Vice-President, Cameron & Barkley, Charleston

Wisconsin
- KEOGH, JERE K., Erecting Engineer, Allis-Chalmers Mfg. Co., Milwaukee

SUMMARY

New applications	253
Applications for change of grading:	
Promotion from Associate	1
Promotion from Associate-Member	3
Promotion from Junior	7
Reinstatement and Promotion from Junior	5
Total	269

EMPLOYMENT BULLETIN

THE SECRETARY considers it a special obligation and pleasant duty to make the office of the Society the medium for assisting members to secure positions, by putting them in touch with special opportunities for which their training and experience qualify them, and for helping any one desiring engineering services. The Society acts only as a clearing house in these matters.

GOVERNMENT POSITIONS

Stamps should be inclosed for transmittal of applications to advertisers; non-members should accompany applications with a letter of reference or introduction from a member; such reference letter will be filed with the Society records.

Members applying in person for Government positions at such places as Navy Yards should invariably make appointments before hand by letter, telephone or telegraph, and arrange to have passes or the equivalents so that they can gain entrance. In this way they will avoid disappointment.

YOUNG MEN wanted for the Department of Military Aeronautics. Should have mechanical training and, if possible, be thoroughly grounded in electrical work. May be of draft age and will go as enlisted men, then assigned to Training School for Radio Mechanics and after instruction will be sent overseas. They will be inducted at once.

TECHNICAL MAN or one with several years' experience to act as assistant engineer of tests. Salary, $4 a day. 2625.

TECHNICAL MEN for the Navy with considerable engineering experience in large power plants, preferably married. Men who have been superintendents of repair plants desired. Not over 35 years of age. 2629.

MECHANICAL ENGINEERS especially experienced in machine-shop practice to act as chief inspectors for the Ordnance Department on shell machinery and automatic screw-machine work. 2633 A.

EXPERIENCED MEN also wanted on steel and forging work. 2633 B.

Men for above to be over draft age. Salaries for satisfactory men with considerable training from $2400 to $3000 per annum.

MECHANICAL ENGINEERS, experienced in ship construction to act as assistants. Salary, $2400 per annum. 2637

TECHNICAL MAN capable of making reports for technical journal. One with editorial experience necessary. Knowledge of wood desirable although not absolutely necessary. Maximum salary, $3500. 2640.

ASSISTANT in charge of research and development. Man to bring to stage of commercial production parts made of sheet metal, fabrics, rubber and die casting. Applicants must have personality to secure coöperation of manufacturers in development work along above lines. Salary, $3600 per annum. 2642.

PRODUCTION ENGINEER as superintendent of plant, or one who has had an execu-

tive position in manufacturing concern. Knowledge of rubber desirable but not essential. Man occupying this position would probably be commissioned. 2644.

CIVILIAN POSITIONS

MASTER MECHANIC, young, energetic, good tool designer and familiar with precision work and production methods. Man who has had experience with automatic and with precision grinding. Location Connecticut. 0445-H.

MECHANICAL LABORATORY ASSISTANTS AND DRAFTSMEN required for important war work in development of parts for sheet metal, fabric and rubber. Graduates from manual training schools with one or two years' shop experience or one or two years in an engineering school desirable. Enclose photograph, stage age, give references, position in draft and willingness to enlist or be inducted in the army for work of this nature. 0459-H.

SPLENDID OPPORTUNITY in an old-established business for practical man with combination of mechanical and business ability who understands sheet-metal and light-screw machine work; one who can also develop sheet-metal specialties to be marketed so as to afford volume production to the factory. Location New York. 0460-H.

ASSISTANT CHIEF ENGINEER to act as chief engineer during temporary absence of the latter. Work is in nature of quantity-production war work of the highest importance; in factory employing 2600, and large number of draftsmen; commands excellent salary. Location Brooklyn, N. Y. 0461-H.

ASSISTANT PROFESSOR OF EXPERIMENTAL ENGINEERING in an Eastern University; to have charge of classes for juniors and seniors in the steam laboratory and materials testing department and to give a course in kinematics to sophomores. Salary about $1500, depending upon previous experience. 0462-H.

TECHNICAL GRADUATE, mechanical engineer, preferably with one or two years' experienee for power-plant lay-out and steam work. Salary $25 a week to start. Location New York State. 0463-H.

MECHANICAL ENGINEER with experience in design, testing and general engineering work in connection with small and medium steam turbines and their applications. Reduction-gear experience also desirable. Must have good business and executive ability and be able to handle a variety of work in connection with steam turbines and turbine-driven machines. Give full details of training, experience, salary expected and photograph. Location Connecticut. 0464-H.

DRAFTSMAN, power-plant equipment. Salary, $125. Location New York. 0466-H.

DRAFTSMAN on industrial and chemical plants. Salary, $150. 0467-H.

MECHANICAL ENGINEER with machine shop experience for position similar to master mechanic. Salary $50 to start. Location Brooklyn. 0468-H.

PROFESSOR OF MECHANICAL ENGINEERING in charge of department; should be technical graduate with both teaching and practical experience. Send full statement of training and experience, references and a late photograph. Salary $2400 for ten months. Location Idaho. 0471-H.

PROFESSOR OF ELECTRICAL ENGINEERING during period of war. Technical graduate preferably with teaching and practical experience. Send full statement of training and experience, references and a late photograph. Salary $2400 for ten months. Location Idaho. 0472-H.

INSTRUCTOR IN APPLIED SCIENCE LABORATORY, INSTRUCTOR IN ELEMENTARY APPLIED ELECRICITY AND MECHANICS for technical school in Greater New York. Preference given to men with mechanical or electrical technical training, with practical and teaching experience. Position permanent. Give full personal and experience data and photograph. State salary expected. 0473-H.

TECHNICAL TRAINED MECHANICAL ENGINEER, experienced in power-plant design, testing and operation. Location Connecticut. 0474-H.

MECHANICAL ENGINEER AND DESIGNER with extensive experience in design and construction of shipbuilding cranes, derricks, drag-line excavators and similar work. High-grade man wanted to take charge. Location Pennsylvania. 0475-H.

INSTRUCTOR in mechanics, mechanical drawing, mathematics, etc., for railroad-shop apprentices. Preferably a college graduate with some knowledge of railroad equipment and shop machinery. Salary $200. Location Texas. 0476-H.

INDUSTRIAL ENGINEERING PRODUCTION PROBLEMS. Opportunity for a man qualified by education to undertake work of this nature in large steel-castings plant. Preference given to man who has served apprenticeship in railroad shops. Location Ohio. 0477-H.

EXPERIENCED TOOL AND FIXTURE DESIGNER, with experience in the design of large machine tools. Essential industry. Location Central Ohio. 0478-H.

TIME-STUDY ENGINEER with shop-practice experience, draft exempt; time-study experience on automatic machinery desirable. Must have personality, diplomacy and tactfulness. Young man if possible. Salary $40 per week. Location New Jersey. 0479-H.

DRAFTSMAN with experience in the design of small engines. High-grade man. Salary $175 to $225. Location Pennsylvania. 0481-H.

DRAFTSMAN with experience on boiler design. High-grade man. Salary $175 to $225. Location Pennsylvania. 0482-H.

DRAFTSMAN with experience on locomotive-crane design. High-grade man. Salary $175 to $225. Location Pennsylvania. 0483-H.

DRAFTSMAN with experience on the design of steel towboats and barges. High-grade man. Salary $175 to $225. Location Pennsylvania. 0484-H.

DESIGNING DRAFTSMAN, acquainted with designing heavy machinery such as brass and copper rolling mills, hydraulic-press work, etc. Good designer and not an ordinary draftsman. Will make any reasonable inducement to the right man. Location Connecticut. 0485-H.

SALESMAN for special machinery. With technical training and also accustomed to meeting the engineering staffs of large organizations. Location Ohio. 0488-H.

YOUNG ORGANIZATION ENGINEERS, possessing both analytical and executive ability for time and motion-study work to standardize operations; large rubber plant. Large and expanding field for able men. Location Ohio. 0489-H.

PRODUCTION ENGINEER in newly organized planning department of large ice-making machinery plant. Location New Jersey. 0490-H.

MECHANICAL ENGINEER with sufficient experience to handle any design work in connection with the standardization of apparatus or its modification to meet specific requirements. Man with practical shop experience and technical training preferred. Will be subordinatae to engineer in charge of design and will have supervision over several assistants. Maximum initial salary $2400 a year, depending on the applicant's qualifications, etc. Location Brooklyn, N. Y. 0491-H.

ASSISTANT for checking all drawings against standards; accurate in work. Man with previous experience in this capacity preferred. Shop experience and technical training valuable assets but not required. Maximum initial salary about $35 per week. Location Brooklyn, N. Y. 0492-H.

SALESMAN, familiar with the steam-specialty business of the New York District. Position has every prospect of permanency and advancement. 0495-H.

SEVERAL FIRST-CLASS DRAFTSMEN with broad engineering experience wanted immediately. Good future for right man. Location Ohio. 0496-H.

THREE ENGINEERS, experienced in substituting mechanical equipment for hand labor. Must be familiar with all kinds of conveying equipment. Good future for right men. Location Ohio. 0497-H.

ASSISTANT MECHANICAL ENGINEER, familiar with general machinery in machine-shop and mill engineering. Must be competent to lay out and direct installation of new machinery, direct repairs and alterations on present equipment. Concern manufacturing mechanical rubber goods and employing about 2000. Technical graduate preferred. Salary $1500 to $2000, depending on man. Location Massachusetts. 0498-H.

MECHANICAL ENGINEER for production of airplanes; out of draft age or in Class 4. Salary $175. Location New York. 0499-H.

ASSISTANT PROFESSOR IN MECHANICAL ENGINEERING. Location Pennsylvania. Salary $1800. 0500-H.

ASSISTANT MECHANICAL ENGINEER with practical and theoretical experience and training in tool engineering; familiar with methods of manufacture for small, interchangeable parts. War work. Splendid opportunity for young man who can think and possesses unusual initiative. Location Brooklyn, N. Y. 0501-H.

MECHANICAL ENGINEERS AND DRAFTSMEN for designing machinery wanted by large and long-established company, located near New York City. 0502-H.

TURBINE DESIGNER of experience, capable of taking complete charge of design and construction of turbines and reduction gears, wanted by large and long established company, located near New York City. 0503-H.

TRAINED MECHANICAL ENGINEER with inventive ability to develop apparatus under the direction of chief engineer. Must have thorough grounding in theory of physics and mechanics. Only capable men of genuine ability will be considered. Give full details of training and experience. Location New York City. 0504-H.

YOUNG MAN WITH TECHNICAL EDUCATION and preferably some subsequent experience, for a steam-turbine manufacturer

mainly engaged in war work. State experience, draft classification, salary expected. Location Connecticut. 0505 H.

PRODUCTION ENGINEER, familiar with up-to-date production methods, particularly munitions production, heavy steel castings, etc. Salary about $6000 to $7000 a year. 0506 H.

INDUSTRIAL STATISTICIAN for Government work. High-grade man with salary in proportion to past records of results obtained. Man of draft age considered and if appointed would possibly be inducted into the Service. 0507 H.

MASTER MECHANIC to take charge of boilers, pumps, machinery and motors. Location New York. 0510 H.

MEN WITH TECHNICAL TRAINING or experience wanted for testing and efficiency work in power plants and substations of large electric-railway system. Good pay for men of adequate qualifications in the field of electric or steam-plant equipment. Give status with respect to draft. Location Brooklyn. 0511-G.

DRAFTSMEN, DESIGNERS, experienced in calculating and automatic machinery, typewriters, etc. Permanent positions to competent men. Location New York City. 0512 G.

PLANT ENGINEER of extensive and exceptional experience in plant engineering work, maintenance department, familiar with entire plant equipment, tools, jigs, die work, building construction, plant layout. Man of about 35 to 40 years of age. Location Philadelphia. 0514-G.

TEACHER for production work in connection with our coöperative courses in engineering; a man with actual experience in production and sufficiently broad experience to cover rather wide field. Salary $2400 or $3000 for three months' service. Location Ohio. 0515 G.

MEN AVAILABLE

Only members of the Society are listed in the published notices in this section. Copy for notices should be on hand by the 12th of the month, and the form of notice should be such that the initial words indicate the classification. Notices are not repeated in consecutive issues.

MECHANICAL ENGINEER, age 32, associate member, now employed as chief engineer of a plant making sugar, evaporating and heavy machinery. Experience of eight years in designing, estimating, purchasing and practical manufacture incidental to this class of machinery. H-207.

PRODUCTION OR WORKS MANAGER with specific training in all branches of shop, time-study and piece-rate efficiency and system, cost and general accounting, production and works management in metal stampings and fittings, tubing, general machine-shop and foundry-forging and die work, engine and general assembly. Available at short notice. Salary approximately $10,000. H-208.

EXECUTIVE OR PRODUCTION ENGINEER. Graduate mechanical engineer, 35 years of age, with 12 years' experience as an executive and in scientific management installations desires connection with manufacturing concern offering an attractive future as reward for hard work and results. At present employed. H-209.

PRODUCTION AND ENGINEERING EXECUTIVE with wide experience in the manufacture of interchangeable parts. Available September 15. Married, aged 30. In class IV of the draft. H-210.

MECHANICAL ENGINEER of executive ability, at present holding position but having little work to do; prefers to be busy. American, past draft age, married, technical education and 15 years' experience in industrial and power-plant work. H-211.

MECHANICAL AND MARINE ENGINEER, member, desires position of high responsibility, having upward of 18 years' experience in designing and operating large power plants and large ocean-going vessels. Will prove an expert on combustion and thermodynamics of either plant or ship. Will go where wanted. H-212.

FACTORY MANAGER OR ASSISTANT FACTORY MANAGER, with 30 years' practical experience and wide knowledge of mechanics in general. Twelve years in last position. Can furnish best of references. Well-informed on gas-engine work and also Liberty motor, with fair knowledge of heat-treating alloy steels. Readily adaptable to shop conditions. H-213.

WORKS MANAGER OR SUPERINTENDENT for manufacture of interchangeable parts. Experienced with large organizations and modern methods of operation. Graduate engineer with practical training in design, installation, operation and business administration. H-214.

MECHANICAL ENGINEER, college graduate, exempted from draft, experienced in sugar machinery and steam-power plant throughout Hayti, Santo Domingo, and Porto Rico, will consider a proposition to go to Cuba or Honolulu for the coming crop. H-200.

MASTER MECHANIC OR MAINTENANCE ENGINEER, member, now employed. Thorough technical and practical experience covering the construction, maintenance and operation of industrial works, steam- and water-power plants. Steam and fuel economy a specialty. Available about September 1. H-201.

MECHANICAL ENGINEER, member, thoroughly experienced in general mechanical and structural engineering; now in charge of engineering work on contracts aggregating twenty million dollars. Good organizer, executive ability, exemplary habits. Thirty-nine years of age. Will consider engineering sales proposition. Middle West preferred. Salary $5,000. H-202.

MECHANICAL OR WORKS ENGINEER, age 31, married, technical graduate, eight years' experience in design, construction and maintenance of paper mills and metal-manufacturing plants. Good organizer and executive. H-203.

SUPERINTENDENT OR MECHANICAL ENGINEER for cement plant, glasswork, porcelain or chemical works. Technical graduate, 39 years of age, married, 14 years' experience, able to handle tactfully executives and men; familiar with design, erecting and operating of crushers, dryers, kilns, furnaces, lehrs and grinding and labor-saving machinery. Can introduce methods of chemical control of raw material and finished product. Employed, but desires responsible position in a northern state. H-204.

SALES ENGINEER of high-grade experience desires a position as sales manager, sales engineer or plant manager; energetic salesman. Has travelled extensively and is well acquainted with machine and automobile manufacturers. Graduate mechanical engineer and good executive. H-205.

JUNIOR ENGINEER desires engineering or executive work with company situated in New York City. Mechanical engineering graduate of Worcester Polytechnic Institute, experienced in office executive work, good correspondent, and clear, rapid thinker, able to adjust himself quickly to new conditions. Is at present holding a civil service position in appraisal-engineering work. Married, exempt from draft, 25 years old and a junior member of the A.S.M.E. and S.A.E. H-206.

SALESMAN OR PURCHASING AGENT well versed in modern sales methods and systems, accustomed to meeting principals of large organizations, and estimating requirements to meet conditions. Has travelled extensively, thoroughly competent to complete contracts. Open for engagements after August 1. H-209.

MECHANICAL ELECTRICAL ENGINEER. 12 years' broad experience, technical training. Tactful executive, strong on coöperation, standardization and resource. Age 32, married. Specialty is design, development and production of small electrical equipment and other accessories with investigation of field for demand and requirements. Fully acquainted with modern factory methods and drawing office management, tool room and die work and finish processes. H-215.

ASSISTANT TO CONSULTING ENGINEER. Junior member, 1913 technical graduate, five years' practical experience in operating, testing and drafting in both electrical and mechanical engineering, four years with one concern, one year of power-plant drafting and heating and ventilating. Age 29, married, in Class IV, employed at present. Wishes a responsible position on the Pacific Coast. Salary, $150 per month. H-216.

FACTORY EXECUTIVE, experienced efficiency and mechanical engineer, in foundry practice, cotton and woolen textile machinery, machine tools, jigs and fixtures, oil mill, hydraulic, transmissions and wood-working machinery, is open for stable proposition offering adequate salary and ample authority. 35 years old. H-217.

CHIEF ENGINEER OR MASTER MECHANIC with thorough technical and practical experience covering construction, operation and upkeep of steel plant, specialty metallurgical work, heating and melting furnaces. H-218.

COMBUSTION ENGINEER, a graduate mechanical engineer, with 13 years' experience in the combustion of anthracite and bituminous coal, hand and stoker fired. Well trained in fuel-research work, sampling and the analysis of fuel. Capable of taking charge of the complete problems of a company consuming a large tonnage. H-219.

WORKS MANAGER, associate member, successful executive, experienced in design, purchase of materials and manufacture of general steel-plate work and allied lines, at present in complete charge of works employing 200 men, desires connection with a firm offering greater opportunities. H-220.

GENERAL MANAGER OR ASSISTANT TO PRESIDENT of a manufacturing company, desired by a resourceful and successful executive mechanical engineer in factory layouts, equipment and management. Complete record on request. H-221.

ENGINEERING SURVEY

A Review of Engineering Progress and Attainment in Mechanical Engineering and Related Fields, Including a Digest of Current Technical Periodicals and Selected Titles of Engineering Articles

News of Other Societies

American Institute of Electrical Engineers

THE thirty-fourth annual convention of the American Institute of Electrical Engineers was held in Atlantic City, June 26 to 28. On Wednesday morning, the opening day, President E. W. Rice, Jr., delivered the annual address, taking as his subject, A Review of Electrical Engineering Progress. He called special attention to the work of engineers in connection with the war, and to the continued efforts which will be needed to carry on the processes of reconstruction after the war. After the close of his address he introduced President-Elect Prof. C. A. Adams, who responded briefly, touching upon the period of reconstruction which is bound to take place at the close of the war, and suggesting the possible need of altering or extending the scope of the activities of the Institute to the service which it can render to the nation and the world.

An important feature of the convention was the conference of Institute officers and delegates of sections and branches each convention day at luncheon, from 12.30 to 2.30 p. m. About fifty officers and delegates of sections met at these conferences.

On Wednesday afternoon, at the first technical session, the papers read dealt with various phases of transmission problems. The Thursday morning session was devoted to several papers on the general subject of protective devices. The papers were as follows: Lightning Arrester Spark Gaps—Their Relation to the Problem of Protecting Against Impulse Voltages, by C. T. Allcutt, of the Westinghouse Electric & Mfg. Co.; The Oxide Film Lightning Arrester, by C. P. Steinmetz, of the General Electric Co.; The Oxide Film Lightning Arrester, by Crosby Field, Ordnance Department, U. S. A.; and Design of Transpositions for Parallel Telephone and Power Circuits, by H. S. Osborne, of the American Telephone & Telegraph Co. Charles E. Stuart of the Power and Light Division of the United States Fuel Administration also outlined the plans which have been formulated by the Government to take care of the question of fuel supply and fuel requirements in order to conserve fuel necessary for the essential industries and for heating purposes.

On Thursday evening a highly interesting war session was held, opened by an address on Engineers and the War, by General William M. Black, Chief of Engineers of the United States Army. General Black gave a most vivid description of the work of the engineers in France, and exhibited several reels of moving pictures showing not only much of their detailed routine work, but also the enormous engineering construction works which have been erected at some of the French ports of debarkation. The balance of the session was devoted to papers on Electric Power for Nitrogen Fixation, by E. Kilburn Scott, Consulting Engineer, of London, and America's Power Supply, by C. P. Steinmetz.

Technical sessions were held Friday morning and afternoon, at which papers on miscellaneous subjects were presented in the field of electrical engineering. One of these of general interest to the engineer was on The Automatic Hydroelectric Plant, by J. M. Drabelle, of the Iowa Railway & Light Co., Cedar Rapids, Ia., and L. B. Bonnett, of the General Electric Co., Schenectady, N. Y.

American Society of Heating and Ventilating Engineers

The semi-annual meeting of the American Society of Heating and Ventilating Engineers was held at Buffalo, June 26-28. The rules for limiting the supply of coal to domestic consumers next winter were advanced to their final stages, and will now be submitted to the Bureau of Mines and to the Fuel Administration. Further progress was made in the society's plans to raise funds for the maintenance of a research bureau. Prof. J. E. Emswiler, of Ann Arbor, Mich., presented details of the methods used at the University of Michigan for testing radiators by electrical means, using an electric heater to generate the steam consumed by the radiator and determining the heat required by measurement of the energy consumed in the heater. Thomas Chester, engineer for the American Blower Company, reviewed the development of mine ventilation in this country. The amount of air used to ventilate a coal mine is usually from two to three times the weight of the coal mined, and the required volume is computed by allowing 150 to 200 cu. ft. per min. per man and 500 cu. ft. per min. per animal. He stated that from 10 to 30 per cent more coal can be mined in a thoroughly ventilated mine.

A session on drying was opened with a paper by W. A. Perry, who pointed out that the big problem of the Food Administration is not that of prices, but the distribution of the available food supply. H. C. Gore, chemist with the Department of Agriculture, described the recent progress made in the drying of vegetables, and referred to some of the principal advantages derived from this process: in the case of tomatoes the saving of freight amounts to 99 per cent; there is also an enormous saving of space. The department has developed a type of drier known as the *general purpose* dryer. Nathan Ovitz, of the J. P. Devine Co., spoke on the possibilities of the vacuum process in drying vegetables and fruits. While the initial cost of the apparatus is higher, the operating cost is low, and all danger of burning the product is eliminated. W. L. Fleisher explained his idea of using the heating and ventilating equipments in public-school buildings throughout the country for the drying of foodstuffs.

The afternoon session on Thursday was convened at the Buffalo Canoe Club, Abino Bay, where dinner was served later. In the first paper, Reasons for Failures of Heating Systems, J. D. Hoffman enumerated the conditions of poor building construction met by heating engineers and the restrictions placed on their work by the owners of houses who insist upon uneconomical installations of piping systems. In the paper next following, A Campaign for Fuel Economy in House Heating, C. W. Baker, recommended warm-air furnace heating, and urged the addition of an auxiliary cold-air duct by which the air supply to the furnace may be taken from inside the house, instead of from outdoors, during very cold or windy weather. Konrad Meier discussed Economy in Heating, basing his ob-

servations on his experience in Switzerland, where he is located. War regulations provide in that country that rooms should not be heated over 60.8 deg. fahr., and the heating of halls and stairways is stopped altogether. He favored intermittent heating by steam, and suggested the wider use of coke as a fuel in place of anthracite. In the final paper on Reforms in the Design of Hot-Air Heating Plants Needed to Compete with Other Systems, C. W. Baker presented the reasons why, by the use of intelligent methods in the design of a hot-air furnace plant, it can be made not merely the equal, but the superior, of either steam or hot-water heating for all buildings of moderate size.

At the closing professional session, on Friday morning, W. M. Franklin's notes on Spontaneous Combustion gave an exhaustive treatment of the principles of combustion, and indicated the two principal methods of preventing spontaneous combustion: either by enclosing the susceptible material in airtight, fireproof cans, or by spreading it in a thin layer freely exposed to the air. A Bulletin of the Bureau of Mines containing Notes on Spontaneous Combustion of Coal was read before the convention. The heating of the base hospital at Camp Dodge was also described in a paper by P. M. O'Connell. (Based on the report in *The Heating and Ventilating Magazine*, July 1918, pp. 27-42)

American Boiler Manufacturers' Association

The thirtieth annual convention of the American Boiler Manufacturers' Association was held on June 17 and 18 at Philadelphia, with M. H. Broderick, president of the association, in the chair. The association and guests were welcomed to Philadelphia on behalf of the mayor and citizens by Dr. E. J. Cattell, city statistician. Following Dr. Cattell's address, William H. Burr, president of the National Founders' Association, discussed informally the present industrial conditions and their relation to war work. D. M. Metcalf, chief inspector of steam boilers, Toronto, Ontario, described industrial conditions in Canada, especially as relating to shell making, shipbuilding and aeroplane building. Dr. D. S. Jacobus, of the Babcock and Wilcox Company, Mem.Am.Soc.M.E. Boiler Code Committee, treated at length the question of boiler-furnace design.

The work of the American Uniform Boiler Law Society in promoting the adoption of the A.S.M.E. Boiler Code was outlined by Charles E. Gorton, chairman of the American Uniform Boiler Law Society.

C. O. Meyer, deputy inspector of the State of Ohio, presented a communication from his department, pointing out that the A.S.M.E. Code does not include vertical-flue boilers and track locomotive boilers, and that as a consequence it had been necessary to make special rules for the former and use the rules of the Interstate Commerce Commission for the latter. He intimated that if such features were not covered by the Boiler Code Committee, Ohio might find it necessary to return to its own rules that were in force before the adoption of the A.S.M.E. Code, and he suggested that the chairman of the American Uniform Boiler Law Society should be a man who is neither a member of the A.S.M.E. Code Committee nor a boiler manufacturer.

A letter from the United States Board of Supervising Inspectors pointed out that their own inspection rules had been in use for sixty years, had met all conditions, were efficient and safe, and for those reasons the board declined to adopt the A.S.M.E. Code instead.

Charles M. Schwab, Director-General of the United States Shipping Board Emergency Fleet Corporation, declared that the situation regarding marine engines and boilers was critical; he said 80 or 90 hulls were already in the water awaiting power equipment. To meet the emergency, all manufacturers of boilers, engines and other ship equipment and accessories are being urged to increase their capacity as much as possible and make extensions wherever needed, with Government funds, which will be available for this purpose.

W. C. Connelly, of the D. Connelly Boiler Company, Cleveland, Ohio, was elected president for the coming year. (*The Boiler Maker*, vol. 17, no. 7, July 1918, pp. 190-197)

American Society for Testing Materials

The American Society for Testing Materials held its twenty-first annual meeting at Atlantic City, N. J., June 25 to 28. It was evident that there is an increased interest in specifications due to the great expansion in this field for war purposes.

The sulphur and phosphorus question in steel specifications was the only one that caused any difference of opinion, but a satisfactory solution was arrived at by the adoption of the following amending clause:

> In view of the abnormal difficulty in obtaining materials in war time, the rejection limits for sulphur in all steels and for phosphorus in acid steels shall be raised 0.01 per cent above the values given in the specifications. This shall be effective during the war and until otherwise ordered by the society.

This clause is to be printed under the title of each specification containing chemical requirements *except* those for boiler and firebox steel and those for boiler rivets. Further, as regards sulphur the note shall not apply to the specifications for carbon-steel car and tender axles.

Urgent war conditions led to preparing the single new specification, for cast-steel anchor chain. A threatened shortage in wrought chain led to active study in several iron works of the possibilities of cast chain, and highly successful results were obtained. The steel committee made tests of the new material and drafted specifications to govern its acceptance, which were accepted by the society as tentative. The steel for chain use, according to these specifications, is to be made in the electric furnace and produced in dry-sand molds or cores.

R. J. Wig, chief engineer, concrete ship division, Emergency Fleet Corporation, delivered an address on the concrete ship. He reviewed the progress of this industry and indicated that its permanency was assured. An interesting statement was that if the wooden ship is taken as 100, the relative weights of the concrete and steel ships are respectively 90 and 75. He felt assured that a cement has been developed recently whereby a lighter ship can be constructed, probably bringing down the ratio from 90 to 77 or 80 as compared with the steel ship at 75.

Dr. Henry M. Howe introduced a topical discussion on industrial research, and emphasized the vital importance of this subject to the nation's present and future welfare.

During the meeting the sad news was received of the death of the distinguished secretary of the society, Dr. Edgar Marburg, an account of whose life is given elsewhere in this number.

American Concrete Institute

The annual meeting of the American Concrete Institute, which was postponed from its regular time in February because of rail congestion, was held on June 27 to 29, at Atlantic City, N. J., simultaneously with the meeting of the American Society for Testing Materials.

Advantage was taken of this concurrence in providing for

joint meeting of the two societies, at which papers dealing with concrete were presented alternately by members of the two bodies.

One of the sessions was devoted to the subject of concrete ships and was illustrated by a number of moving pictures, showing among other things some of the operations in one of the United States Government concrete ship yards. The leading paper of this session was entitled Principles of Design of Concrete Ships, by R. J. Wig, chief engineer of the department of concrete ships, and S. C. Hollister, engineer of design. It was an excellent exposition of the details required in the design of ships, particularly of concrete ships, and outlined the study that the concrete ship department has made on the subject.

Another session was devoted entirely to the subject of concrete houses, and consisted of the presentation by the different members of the Committee on Industrial Concrete Housing of various papers taking up the several divisions of the housing problem. Lieut. K. H. Talbot gave full and valuable information on the different kinds of forms, methods of placing concrete and methods of finishing.

Papers on concrete tests were read at other sessions. J. L. Pearson, of the United States Bureau of Standards, gave in some detail the present status of the stucco tests being conducted by the Bureau.

The papers on design and construction included a complete analysis of a reinforced-concrete chimney by J. C. Mingle, a discussion of the stresses in eccentrically loaded reinforced columns by L. J. Mensch, and an analysis of the treatment of concrete surfaces by J. J. Earley, Washington, D. C.

Several important reports from different committees were submitted to the convention, as well as papers on the details of certain concrete structures.

Prof. W. K. Hatt, Purdue University, Lafayette, Ind., was reëlected president for the ensuing year. (From report in *Engineering News-Record*, July 4, 1918)

National Electric Light Association

The thirty-fourth annual meeting of the National Electric Light Association was held at Atlantic City, N. J., June 13-14.

President John W. Lieb, general manager and vice-president, New York Edison Co., in his address to the Association, pleaded for the continuation of teamplay in the electrical industries, in which he included street railways, telephone, telegraph, light, power and the manufacturing enterprises. He regarded the "linking up" of systems to further fuel economy as the most important problem now confronting the industry.

Samuel Insull, president, Commonwealth Edison Co., Chicago, suggested that relief from the burdens of high cost of conducting the industry could be had by applying for rate increases to the public-utility commissions. He urged that central stations drop extravagances of a capital character and of an operating nature.

P. B. Noyes, Director Conservation Division of the United States Fuel Administration, pointed out the work the administration was doing. America must mine 220 million tons of coal in excess of that ever before mined in one year, and the draft has taken away 35,000 coal miners. He stated that it was impracticable completely to cut off fuel to non-war industries. One ton of coal meant keeping at least fifty people at work. The Administration expects the utilities to do much of their own policing in respect to the economical use of fuel.

Dr. S. S. Wheeler made an address on training the blind to do work in the electrical industry. They are now successfully winding coils of stators and armatures at the same piecework rate paid sighted persons.

Charles E. Stuart, Chief of Power and Light Division, United States Fuel Administration, in his paper on War Conservation of Power and Light detailed the manner in which the Power and Light Division will carry out the general plans laid out for the conservation of light and power by the Bureau of Conservation of the United States Fuel Administration. Isolated plants will be eliminated. Shop committees appointed by the management of manufacturing and industrial establishments will have charge of all details in the operation of their plants that would in any way contribute to economy in fuel. Interconnection of the power systems of the country will permit the utilization of considerable excess waterpower which is at present available. In coöperation with the Joint Commission on Refrigeration, the Power and Light Division is planning to introduce a number of proved economies in the operation of ice and refrigerating plants.

W. W. Nichols, of the Allis-Chalmers Co., read a paper on The Development of Water Power as a War Measure. The 1,058,000 hp. of hydroelectric machinery built and installed in 1917 represented a saving of 8,500,000 tons of coal. Ten per cent of the estimated coal shortage of this year would be met if the industry could repeat that performance.

W. F. Wells, vice-president and general manager of the Edison Electric Illuminating Co., Brooklyn, N. Y., was elected president of the association. (Based on the report given in *Power*, June 25, 1918)

Society for the Promotion of Engineering Education

The twenty-sixth annual meeting of the Society for the Promotion of Engineering Education was held at Northwestern University, Evanston, Ill., June 26 to 29, with an attendance of 125 representing 40 institutions. The subject for discussion was Engineering Education and the War.

The War Department was represented by Drs. J. R. Angell, C. R. Mann and S. P. Capen. Dr. Angell spoke at length on the Committee on Education and Dr. Mann presented the final report of the Joint Committee on Engineering Education which was organized at the Cleveland meeting in 1907.

One of the most important subjects discussed was the question of attendance at engineering schools next year. Announcement was made of the modification of the Selective Service Regulations as follows:

> Under such regulations as the Secretary of War may prescribe, a registrant who is regularly enrolled in a school approved by the War Department Committee on Education and Special Training, and is pursuing full-time courses leading to a bachelor or higher degree in medicine, engineering, physics, chemistry, and other technical subjects essential to the prosecution of the war, or who is an indispensable teacher in such courses, or who is engaged in the training of Army personnel, may enlist in the Enlisted Reserve Corps, and thereafter on presentation by the registrant to his local board of his certificate of enlistment, such certificate shall be filed with his questionnaire, and the registrant shall be placed in Class 5 on the ground that he is in the military service of the United States.

Dr. Capen read a paper on the Relation of the Bureau to the War and to Engineering Schools. The report of the standing committees occupied practically one day. The Committee on Mathematics recommended that the society, through its executive officers, request the coöperation of the Mathematical Association of America toward the appointment of a joint committee for consideration of the entire question of teaching of mathematics.

The joint session of the Western Society of Engineers, the Chicago Section, A. S. M. E., the Chicago Section, A. I. E. E., and the S. P. E. E. on Thursday night, was a success in every way. A. S. Baldwin, chief engineer, Illinois Central Railroad, presided.

The society celebrated its 25th anniversary at this meeting. The following men were present who were at the organization of the society at the World's Fair in 1893: G. C. Anthony, Ira O. Baker, L. M. Hoskins, William T. Magruder, and S. N. Williams. They were called upon for addresses at the get-together meeting in the gymnasium on Wednesday night.

The institutional delegates sent the following telegram to the Secretary of War:

> The institutional delegates present at the convention of the Society for the Promotion of Engineering Education express their hearty appreciation of the cordial relations which have existed between the engineering schools and the Committee on Education and Special Training of the War Department and offer their sincere coöperation in support of plans for the Student Army Training Corps.

The presidential address, Essentials in Engineering Education, was read by Vice-President John F. Hayford in the absence of President Milo S. Ketchum.

Committee on Development of the American Society of Civil Engineers

The spirit of the times for high ideals and greater service as now evidenced in all walks of life and business is reflected in resolutions adopted by the Board of Direction of the American Society of Civil Engineers, on June 18, 1918. The same spirit was shown in the discussion on the objects of an engineering society as the result of Mr. Cooke's paper on The Public Interest as the Bed Rock of Professional Practice, at our Spring Meeting at Worcester; and it is further attested in the principles enunciated by the Engineers' Club of Dayton, to which reference is made in another column of this issue. The significance of this spirit is indicated in the preamble preceding the resolutions relating to the American Society of Civil Engineers, the text of which follows:

> The development and application of the sciences in recent decades have caused profound changes in the social and industrial relationships of all peoples.
>
> The engineer has been a leader in this progress.
>
> Sociological and economic conditions are in a state of flux and are leading to new alignments of the elements of society.
>
> These new conditions are affecting deeply the profession of engineering in its services to society, in its varied relationships to communities and nations, and in its internal organization.
>
> A broad survey of the functions and purposes of the American Society of Civil Engineers is needed in order that an intelligent and effective readjustment may be accomplished so that the Society may take its proper place in the larger sphere of influence and usefulness now opening to the profession.
>
> Such a survey and readjustment can be accomplished successfully only with the aid of the membership throughout the country.
>
> Any steps toward changes in organization must lead to a revision of the Constitution of the Society, which has not been materially modified for many years, during which the Society has grown rapidly and has established 22 Local Associations of Members.
>
> The Constitution should be revised only after securing the views of the membership of the Society as to what its purposes and activities should be and as to the instrumentalities through which these purposes and activities should be carried out.
>
> Any changes in organization must take into account all the conditions above indicated, and also the relationship of the American Society of Civil Engineers to other engineering organizations and to the public.
>
> Therefore:
>
> *Resolved*, That a committee be created to report on the purposes, field of work, scope of activity and usefulness, organization, and methods of work of the American Society of Civil Engineers, and to make recommendations concerning these matters; the committee to consist of one member chosen by each Local Association of Members, and seven members at large appointed by the President.
>
> *Resolved*, That the President be instructed to select from this committee an executive committee of not less than five nor more than nine members and to appoint the chairman of this executive committee, who shall also be the chairman of the general committee.
>
> *Resolved*, That the President be instructed to prepare a precept for the general guidance of this committee.
>
> *Resolved*, That this committee be requested to present to the Board of Direction a preliminary report, not later than November 1, 1918, so that it may be printed and distributed to the membership in advance of the Annual Meeting in January 1919, at which meeting it will be presented for discussion.

Chicago Technical Societies Organize for War Work

Representing an effort to coöperate effectively and vigorously for war work, an important joint war committee has been formed by representatives of technical societies centered in Chicago. The movement was started by the military committee of the Western Society of Engineers, and at the invitation of that committee several meetings have been held at the Chicago Engineers' Club. As a result, the "War Committee, Technical Societies of Chicago," to quote the official name, was organized June 4, 1918.

The purpose of this organization is "to enable the technical societies of the Chicago zone to call into play the efforts of the members of the various societies herein represented as occasion may arise and to coördinate their activities in the most effectual manner to help win the war." It is not proposed to attempt any novel "stunts," but rather to place at the disposal of the United States Government and other authorized agencies the combined strength and resources of the Chicago technical societies for war work as need may arise.

The following member societies are coöperating in the new war committee:

Western Society of Engineers
Structural Engineers' Association of Illinois
Society of Industrial Engineers
Illinois Society of Engineers
Illinois Society of Architects
The American Railway Engineering Association
The Swedish Engineers' Society of Chicago
Illinois Chapter, American Institute of Architects
Chicago Section, American Society of Mechanical Engineers
Chicago Section, American Chemical Society
Chicago Section, American Institute of Mining Engineers
Mid-West Section, Society of Automotive Engineers
Illinois Association of American Society of Civil Engineers
Chicago Section, American Society of Heating and Ventilating Engineers
Chicago Section, American Society of Refrigerating Engineers
Chicago Section, Steel Treating Research Society
Chicago Section, Illuminating Engineering Society
Chicago Chapter, American Association of Engineers.

Officers of the war committee have been elected as follows: Chairman, F. K. Copeland; vice-chairman, W. L. Abbott; secretary, Edgar S. Nethercut; treasurer, William A. Fox. The executive committee consists of F. K. Copeland, W. L. Abbott, William Hoskins, C. A. Keller, Charles E. Lord, C. F. Loweth, Isham Randolph and Richard E. Schmidt. The address of the secretary of the war committee is 1735 Monadnock Block, Chicago. (*Official Bulletin*, June 22, 1918, p. 22)

War Work of Federal Board for Vocational Education

Since coming into existence one year ago the Federal Board for Vocational Education has organized its work in every state of the Union, and has rendered substantial assistance to the war-making branches of the Government through training men for special duties.

Under supervision of the board, war-emergency training classes for conscripted men have been organized in secondary schools and a series of war-emergency training courses has been prepared, not only for training under direct supervision of the board but in classes organized by the War Department among enlisted men and for classes conducted on a commercial basis under private civilian control.

Emergency war-training bulletins prepared by the Federal Board include announcements of training courses in shipbuilding for shipyard workers; mechanical and technical training for conscripted men (Air Division, United States Signal Corps); training for motor-truck drivers and chauffeurs; for machine-shop occupations, blacksmithing, sheet-metal working, and pipe fitting; for electricians, telephone repair men, linemen, and cable splicers; for gas-engine, motor-car, and motorcycle repair men; for oxy-acetylene welders; and for airplane mechanics, engine repair men, woodworkers, riggers and sheet-metal workers.

The preparation of these courses and the organization of training classes have been undertaken at the request of and in coöperation with the Signal Corps and the Quartermaster Corps in the War Department and the United States Shipping Board.

In June 1918, 12,000 men had been trained through the Federal Board and state authorities for vocational education and turned over to services—6000 in mechanical lines, 5000 in radio work for the Army, Navy and mercantile marine, and 1000 in clerical occupations for Quartermaster Corps work. It is estimated that an additional 3000 men have been trained by private agencies through impetus given to the work by the Federal Board, and that, when the complete reports for May are in, the number in training will be shown to be at least 7500. On June 13 the May reports showed 165 radio classes operated in 38 states and 172 mechanical classes in 49 communities distributed over 14 states. Contracts now in force provide for the training of 100,000 men during the current year. (*Official Bulletin*, July 17, 1918, p. 19)

Military Instruction Planned for College Students

In order to provide military instruction for the college students of the country during the present emergency, a comprehensive plan will be put in effect by the War Department, beginning with the next college year, in September 1918, in connection with institutions of collegiate grade. The details remain to be worked out, but in general the plan will be as follows:

Military instruction under officers and non-commissioned officers of the Army will be provided in every institution of college grade which enrolls for the instruction 100 or more able-bodied students over the age of eighteen. The necessary military equipment will, so far as possible, be provided by the Government. There will be created a military training unit in each institution. Enlistment will be purely voluntary, but all students over the age of eighteen will be encouraged to enlist. The enlistment will constitute the student a member of the Army of the United States, liable to active duty at the call of the President. It will, however, be the policy of the Government not to call the members of the training units to active duty until they have reached the age of twenty-one, unless urgent military necessity compels an earlier call. Students under eighteen and, therefore, not legally eligible for enlistment, will be encouraged to enroll in the training units. Provision will be made for coördinating the Reserve Officers' Training Corps system, which exists in about one-third of the collegiate institutions, with this broader plan.

This new policy aims to accomplish a twofold object: first, to develop as a great military asset the large body of young men in the colleges; and second, to prevent unnecessary and wasteful depletion of the colleges through indiscriminate volunteering, by offering to the students a definite and immediate military status. Those who do not graduate this spring should be urged to continue their education and take advantage of this opportunity to serve the nation.

Training camps to fit men to act as assistant instructors in the new Students' Training Corps are now being held at Plattsburg, N. Y., Fort Sheridan, Ill., and Presidio, Cal. Courses at these camps will end on September 16.

The character of the training given in the Students' Army Training Corps will depend on the kind of unit organized in the particular institution. The standard time to be allotted to military work will be ten hours per week during the college year supplemented by six weeks of intensive training in a summer camp. The ten hours a week will not include the hours of outdoor work in drill. The summer camps will be an important feature of the system. These will be active for six weeks, and there will be an intensive and rigid course of instruction. The plan provides approximately 650 hours of military work per annum.

Salvage of Waste Material Made Profitable in England

Consul Augustus E. Ingram, at Bradford, reports:

The National Salvage Council is now urging all local authorities to recover for utilization waste and dormant materials hitherto regarded as "refuse." A definite national use has been found for many of these articles, and by well-organized collections and proper treatment not only have national resources been conserved, but a reduction has been effected in the tonnage required for the importation of new raw material.

Conferences with municipal authorities have been held in various cities. In certain salvage operations, such as retinning old cans, large authorities could put down a plant that neighboring small authorities or townships could utilize. (The Director of National Salvage is about to issue particulars as to the best method for dealing with this material, so as to reclaim not only the steel, but also the tin and solder.)

The advice given at the beginning of the war to "burn all refuse" is now obsolete. For instance, waste paper, if properly utilized, saves a great deal of shipping. At present only one-third of the paper is returned for trade use, although 365 trades are absolutely dependent on paper. Some authorities are paying a bonus to their employees for bringing in waste paper from the refuse. In Shipley, 80 tons of waste paper were collected in 1917, and that, including rags, realized £641 ($3119). In Bradford last year 75 tons of paper were collected from various public departments in the city, and realized £430 ($2093). The pulping mills now established in the country are a valuable new industry.

A pamphlet has recently been issued to local authorities by

the National Salvage Council offering many suggestions on the collection and utilization of waste and dormant materials. Among other things it states that organic refuse is needed for the extraction of glycerine and for feeding pigs. Grease traps to save the grease from dish washing at hotels, etc., are suggested. All available bone material should be saved; at present only about half such available material is recovered. Fish waste should have the oil extracted and a meat food suitable for feeding animals and poultry made from the residue; at Liverpool a plant has been installed for this purpose, and the fats obtained find a ready sale at £80 ($389.32) per ton, while the meal is retailed at about £21 ($101.20) per ton.

The municipal destructor works at Bradford is doing excellent waste-reclamation work. Ashpit refuse, after the old cans and metal are sorted out, is utilized as fuel for operating the reclaiming machinery. The clinker from the furnace is ground into a coarse grit and sold for use in braking tramcars and fine ashes are utilized in the manufacture of disinfectant powder. Animal refuse is subjected to steam heat and disintegrated, yielding finally tallow, bone meal, and meat meal. (*Official Bulletin*, June 25, 1918, p. 16)

British Thermal Gas Unit Proposed as U. S. Standard

The Fuel Administration issues the following:

The proposed order of the United States Fuel Administration, making a universal British-thermal-unit standard of 528 in the manufacture of gas in the United States, was discussed at a conference held in the office of Mark L. Requa, director of the oil division of the Fuel Administration. Representatives of the public-utilities commissions of New York, Illinois, Pennsylvania, Maryland, New Jersey, Wisconsin, New Hampshire and Massachusetts were present, together with representatives of the War Department, Council of National Defense, and the war-service committees of the gas-making industry.

Mr. Requa explained that the purpose of the proposed order was to conserve oil; that the standard as adopted in the proposed order was the same standard as that now in effect in the State of Massachusetts; and that this standard was for all practical purposes the standard adopted by the French Government after an investigation extending over a period of years. The public-utilities commissioners present expressed themselves as being entirely willing to coöperate in the Fuel Administration's effort to conserve oil. Several of them requested the privilege of presenting suggestions in writing, which they thought would tend to make the proposed order more definite.

When the question of the price at which gas was to be furnished the public under the new standard came up for discussion, Mr. Requa said the public-utilities commissions of the various states should settle the matter for themselves—that the Fuel's Administration's principal interest was in reducing oil requirements to the minimum.

The proposed order would supersede all previous standards for candlepower and British-thermal-unit value in artificial gas. A British thermal unit is the amount of heat required to raise 1 pound of water 1 degree in temperature. (*Official Bulletin*, June 26, 1918 (p. 11).

Conference on Metal-Working Machinery

The War Industries Board announced today that the methods for increasing the output of plate-working machinery to meet the unusual demands, principally of the Navy and the Emergency Fleet Corporation, were discussed at a meeting of such tool builders with representatives of the War Industries Board, army and navy engineers, the Emergency Fleet Corporation and some of its sub-contractors. Probably 95 per cent of the manufacturers of punching and shearing machinery, bending rolls, plate planers, spacing tables, etc., were represented.

Suggestions for increasing the output included: more intensive manufacturing by eliminating the usual large variety of tools and concentrating on the production of a limited variety, and the distribution of contracts to concerns that have no urgent war contracts but which, with the aid of patterns, drawings and the coöperation of regular manufacturers, could produce standard equipment. It is hoped in this way to advance the general war program.

To carry out the suggestions adopted by the meeting a committee of manufacturers was appointed to work in conjunction with G. E. Merryweather, chief of the machine-tool section of the War Industries Board. This committee includes H. J. Bailey, of Hilles & Jones, Wilmington, Del., as chairman; W. R. Beatty, of the Beatty Machine & Manufacturing Co., Hammond, Ind.; W. H. Harman, of the Southwark Machine Co., Philadelphia; Walter D. Sayle, of the Cleveland Punch & Shear Works, Cleveland, Ohio; Fred C. Avery, of the Long & Allstater Co., Hamilton, Ohio. (*Journal of Commerce*, July 9, 1918, p. 3)

Lehigh University to Give Degree in Three Years

In order to meet the needs of the present war situation, Lehigh University will substitute, as a war measure, three-year courses in place of four-year as heretofore. By this means the student will gain one whole year of time in his life and save the cost of living expenses for one year without his being subjected to any serious additional strain in his work. By substituting three terms a year in place of two terms, and by shortening the summer vacation to one month, the University will be able to give the student the same course in three years that is now given in four.

Under the four-year system of two terms yearly of 17 weeks each, 34 weeks in a year, gave in the four years a total of 136 weeks, of which two weeks yearly, or eight weeks in the four years, were devoted to examinations, leaving 128 weeks for instruction. Without lessening the thoroughness of the different engineering and arts courses by introducing three terms of 14 weeks each, devoted entirely to instruction, 42 for the year, or 126 for the course, the work can be given in three years. This change involves the elimination of a little over two weeks yearly now given to final examination periods. Examinations will be taken care of by tests throughout the term. The proposed plan will allow one vacation of one week at Christmas and one of one week in the spring, with eight weeks in the summer, three or four weeks of which will be devoted to the required summer schools in practical work of the technical courses, leaving the men from four to five weeks' free time for rest and vacation—certainly an ample provision in this time of war strain, and perhaps at any time.

"Carry On" is the title of a new publication on the subject of the reconstruction of disabled soldiers and sailors. The magazine is a monthly message from General Gorgas, Surgeon-General of the U. S. Army, and published for him by the American Red Cross. It may be obtained without charge by addressing the Surgeon-General, U. S. Army, Attention Editor *Carry On*, Washington, D. C.

REVIEW OF ENGINEERING PERIODICALS

SUBJECTS OF THIS MONTH'S ABSTRACTS

For Articles on Subjects Relating to the War, see Aeronautics, Engineering Materials, Machine Tools, Munitions, Varia

Aeronautics

The A. E. G. Bombing Biplane. Description, with illustrations, of one of the large German bombing planes. It is stated that judging from contemporary British standards of design the A.E.G. is, according to the official report, decidedly clumsy not only in detail work but also in appearance, while its performance is poor. Steel is used in construction to a very large extent while wood is introduced very sparingly and plywood is almost entirely absent. It is also quite inferior to the German Friedrichshafen machine as regards the useful load it can carry although the power plant is the same.

The following features of construction are of interest. The framework, possibly because it is made entirely of steel tubing, is formed as one unit from tip to tail. The cross and upright tubes of the framework are attached to the main booms by direct welding without the use of sockets, and single and double lugs are welded into the corners for the attachment of the bracing wires.

The method of carrying the engines is peculiar, the chief feature being the absence of any direct tie between the engine and the outer plane. In fact, the engines are supported entirely from the main spars of the lower wings with ties reaching out to the main booms of the fuselage. Each engine is supported from the front main spar by two pairs of V-struts meeting at a point and fixed to the spar by means of a ball-and-cup joint. A single pair of V-struts supports the engine from the rear spar, the connection with which is also made by means of ball-and-cup joint.

The one propeller which has been recovered has a diameter of about 10 ft. 4 in. and a pitch of 59.3 in. It is built up of ten laminæ, of which the first and tenth are of walnut, the second, third, fourth, sixth and ninth of mahogany, and the fifth, seventh and eighth of a different kind of mahogany, probably African. The thickness of the laminæ varies in a peculiar manner; the first is 0.73 in. thick, the second to the sixth are 0.80 in., the seventh and eighth 0.40 in., the ninth 0.80 in. and the tenth 0.83 in. thick. The official report surmises the enemy is either short of timber or has some highly scientific reason for varying the thickness, concerning which we have no knowledge. (*The Engineer,* vol. 125, no. 3258, June 7, 1918, pp. 484-486, 14 figs.)

Air-Propeller Performance and Design by the Specific-Speed Method, M. C. Stuart. The purpose of the paper is to develop and show a new method of treatment of the performance and design of geometrically similar air propellers. The method described is an adaptation and extension of methods which have been successfully applied to hydraulic turbines, centrifugal fans and centrifugal pumps; in particular, by the author in a paper on Centrifugal Fan Calculations by the Specific-Speed Method (*Journal of the American Society of Naval Engineers,* August 1916).

When the more usual type of propellers is applied to a machine the requirements of power and forward velocity of the machine are known and the rotational speed and diameter of the propeller are expressed in terms of power and forward velocity and the direct method of treatment is thus obtained.

The writer defines the specific speed N_s of a propeller operating at any given efficiency as the speed of a geometrically similar propeller which is of such a diameter D_s as to produce unit power at a unit velocity and with the same efficiency. Conversely, the specific diameter D_s of any propeller operating at a given efficiency is the diameter of a geometrically similar propeller which, when running at a speed N_s, will produce unit power at unit velocity and with the same efficiency.

The specific tip speed v_s of a propeller operating at any given efficiency may be defined as the tip speed of a geometrically similar propeller required to produce unit forward velocity at the same efficiency.

An interesting feature of the Specific-Speed method is the fact that the use of slip and slip function is not necessary.

The specific speed, specific diameter and specific tip speed of any type of air propeller, operating at any given efficiency, are defined as the speed, diameter and tip speed, respectively, of a geometrically similar propeller which will develop 100 useful (thrust) horsepower when the forward velocity is 100 m.p.h. Formulæ for these three specific units are derived from the laws of similitude as applying to propeller performance. From test data of any propeller of the type computations are made of the values of the specific units at various efficiencies; and the specific units and efficiencies are plotted in the form of curves, which, in connection with the formulæ, cover completely the design and performance of all propellers which are geometrically similar to the propeller tested.

It is believed that the presentation of the performance of propellers and the solution of problems by the Specific-Speed method may prove to be much simpler than the present methods which involve the use of coefficients and functions for the following reasons:

a The coefficients or functions are merely abstract numbers without any tangible significance, while the specific units used

in the Specific Speed method may be thought of as speeds and diameters for unit requirements of performance, and the actual speeds and diameters for any requirements of performance are simply proportional to the specific units.

b All problems in the performance or design of a group of geometrically similar propellers may be solved by the use of a single curve and the simple formulæ for the specific units.

c The characteristics of various types of propellers may be compared upon coordinates which show directly the value of the propellers in meeting any desired requirements of performance. (*Journal of the American Society of Naval Engineers*, vol. 30, no. 2, May 1918, pp. 315-333, 5 figs.)

THE AUSTRIAN BERG SINGLE-SEATER FIGHTER. The machine is of the single-seater fighter type, in which the pilot and top plane are so placed in relation to each other that the wing obstructs the view to a very small extent only. This has been accomplished mainly by making the body very deep and placing the pilot fairly high inside the body, the extra depth of the body being secured by deepening the turtle back which forms a very much greater proportion of the overall depth than is the case in most machines. The turtle back is different from the majority in that it does not, except in the front, cover the whole width of the flat top of the body, but comes to a point just in front on the vertical fin.

The pilot's seat is extremely comfortable and is provided with arm rests, enabling the pilot to rest one arm while working the control lever with the other.

The controls are mainly of the usual type, but, in connection with the lateral controls, the wing flaps are fitted with cranks recessed in slots in the planes; and there is a somewhat unusual arrangement whereby the *positive* cable is taken to the front arm of the crank, so that it is the *return* cable which pulls the wing flaps down. The reason for this may be found in the warped wing flap, which may conceivably have its outer tip tilted upwards to such an extent that the effect of moving the flaps is between a force acting downward on the flap moved upward before the flap on the opposite side which has been moved down simultaneously, receives an upward force.

Aerodynamically, the wings present an interesting feature. The upper surface of the wing section has a most decided return sweep beginning behind the rear spar and being of such a magnitude as to present a considerable area of concave surface.

The tail planes are built of steel tubing throughout and the fixed tail plane is of interest because of the fact that although it is built up of single steel tubes, the section is made cambered by bending the single tubes forming the ribs. Both upper and lower surfaces, therefore, have the same camber. The incidence of the tail plane is adjustable, but not during flight. (*Flight*, no. 491 (no. 21, vol. 10), May 23, 1918, pp. 555-557, 1 fig.)

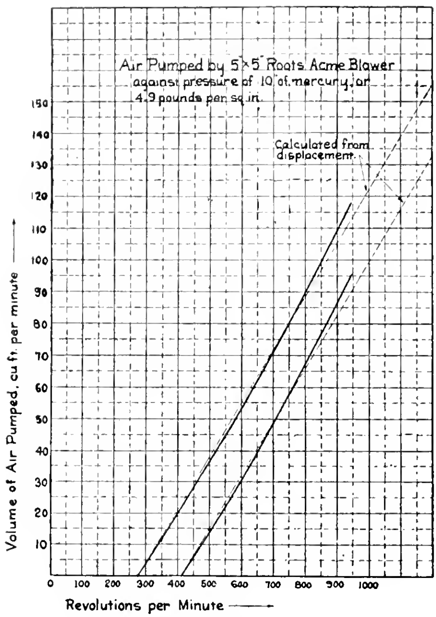


FIG. 1 RELATION BETWEEN QUANTITY OF AIR DELIVERED AND SPEED OF BLOWER

Air Machinery

TESTS ON ROTARY BLOWERS AND EXHAUSTERS. Investigation of the effect of pressure drop due to friction in the intake pipe and of actual and probable delivery with varying speeds.

Tests on rotary exhausters are seldom performed, partly because their discharge is pulsating and therefore nozzles or orifices cannot be used to measure the flow directly, and also because the rotary exhauster is in itself a meter of the displacement type, its speed being the measure of the quantity of gas delivered.

Usually the probable delivery is found by multiplying the difference between the slip speed and the actual speed by the displacement of the exhauster per revolution.

There is a belief, however, that other factors enter into the rate of delivery, and, among other things, that the pressure drop due to friction in the intake pipe reduces the delivery and counteracts the increase in efficiency due to the higher ratio of actual speed to slip speed.

In order to clear up these points Prof. W. Trinks (Mem. Am.Soc. M.E.) undertook a test at the Carnegie Institute of Technology on the delivery of a Roots rotary blower. The results of this test are shown in Fig. 1, which indicates the relation between the quantity of the air delivered and the speed of the blower.

In order to get a larger slip the head plates were removed from the blower and more red lead was put into the joint. The right-hand curve was obtained from this test; the character of both curves being exactly the same, however.

The length and shape of the inlet pipe were varied and the location of the pressure gage on the outlet was changed, but none of these changes had any appreciable influence on the shape of the characteristic curves.

From these curves it appears that the actual delivery falls below the probable delivery at lower speeds and rises above it at higher speeds, which is probably due to vibrations of the air column. As regards these vibrations, it is stated that they have a phase lag against the impressed vibration of the blower, which may explain why attempts to furnish an engine torque of the blower have not been successful.

Vibrations occur in the discharge pipe as well as in the intake and increase with the speed, but only up to the point where they become sound waves. Above this speed the pitch of the sound, that is, the frequency of vibration increases, but the amplitude, that is, loudness, remains constant, the maxi-

mum depending upon the ratio of outlet-pipe size to fluctuation of displacement. The smaller the outlet pipe for a given blower the worse the vibration becomes. (*The Blast Furnace and Steel Plant*, vol. 6, no. 7, July 1918, pp. 298-299, 3 figs., *e*)

Engineering Materials

Rubber Substitutes, Andrew H. King. Technical discussion of the factors and limitations to be considered in studying rubber substitutes. The writer believes that there is, as yet, no real substitute for rubber and states that oil substitutes are not in great demand in this country, because of the extensive use of reclaimed rubber and mineral rubber. He discusses the use of substitutes based on certain pitches, greases and waxes and briefly mentions the matter of glue substitutes. (*Metallurgical and Chemical Engineering*, vol. 18, no. 12, June 15, 1918, pp. 630-636, 1 fig., 7 tables)

Uses of Zirconia as a Refractory. Abstract of a paper recently presented by J. A. Audley before the refractory section of the Ceramic Society (British).

The paper covers such matters as properties and composition of zirconia, its technical applications and as a lining for industrial furnaces especially, and the use of zirconia in the manufacture of ferrozirconium to be ultimately used for the production of zirconium steels. It was stated that these steels are particularly hard and it is affirmed that 1-in. armor plate of zirconium steel is equal to 3-in. armor plate of the best German steels. The matter of the manufacture of crucibles of zirconia was also discussed. (*The Iron Age*, vol. 102, no. 2, July 11, 1918, pp. 72-73)

The Effect of Annealing on the Electrical Resistance of Hardened Carbon Steels, I. P. Parkhurst. Paper read at the metallurgical symposium of the American Chemical Society in Boston, September 1917, in which the writer comes to the following conclusions:

The total change in resistance increases with the carbon content of the steel. The change is very rapid at the beginning of the annealing and becomes slower as the resistance decreases. However, there was no indication in any case that the change was complete at the end of the test.

Since the resistance of a steel changes with the hardness, the curves are a fair indication of the varying rates at which hardened steels are softened by annealing at a constant temperature. The larger part of the change is completed within a few minutes, but the change is not entirely complete in 113 hours. (*The Journal of Industrial and Engineering Chemistry*, vol. 10, no. 7, July 1, 1918, pp. 515-518, 3 figs.)

Influence of Small Quantities of Some Metallic Elements on the Mechanical Properties of Brass, E. Millington. Description and data of experiments carried out to determine the effects of certain metallic elements on the mechanical properties of brass castings, the metallic elements investigated being tin, iron, manganese and aluminum. The addition of the first three elements to the copper-zinc alloy has been usually limited to 2 per cent, while manganese was carried to 2.81 per cent. In some respects the ternary alloys proved to have mechanical properties quite dissimilar from those of the original binary alloy. (*Journal of the Society of Chemical Industry*, vol. 37, no. 10, May 31, 1918, pp. 149 T-155 T, 3 figs., 3 charts, 2 plates)

Specifications for Aircraft Steels. Abstract of an address of Albert Ladd Colby at the last annual convention of the American Society for Testing Materials. Mr. Colby attended the Anglo-American and the International Aircraft Conferences, held in February and March, as the society's delegate. He stated that specifications were formally adopted and issued in April 1918 in the form of a pamphlet under the auspices of the British Engineering Standards Association, and gave some details of these standards. (*The Iron Age*, vol. 102, no. 2, July 11, 1918, pp. 70-71)

Tests Give New Information on Concrete Behavior. Abstracts of some of the papers presented at the joint meeting of the American Society of Testing Materials and American Concrete Institute.

Capt. L. N. Edwards, U. S. E. R., advanced the theory that the strength of cement mortars and consequently of concretes is dependent upon the quantity of cement in relation to the surface areas of the aggregates, consistency and physical qualities being equal. In other words, since the strength of mortar is primarily dependent upon the character of the bond existing between the individual particles of the sand aggregate, the optimum quantity of the cementing material depends upon the total surface area of the sand.

In fact, Captain Edwards stated that diagrams could readily be made showing the relation between granularmetric analyses of sands and their surface areas. To do this, actual counting of particles would have to be made at the beginning, but with these diagrams the proper quantity of cement for any given sand could readily be taken off.

P. J. Freeman, of the Pittsburgh Testing Laboratory, described the first year's results of tests of the five-year period of tests on the value of blast-furnace slag for a coarse aggregate in concrete.

In a paper entitled Fire Tests for Concrete Columns and based on tests made at the Pittsburgh Laboratories of the U. S. Bureau of Standards, Walter A. Hull, of the Bureau, indicates that the results so far obtained show beyond doubt that the design of a reinforced-concrete column, that is, the amount and disposition of the steel, is not nearly as important a factor in fire resistance as is the nature of the aggregate. It was further found that gravel-concrete columns showed a marked tendency in the concrete to break up early in the fire test.

Prof. D. A. Abrams, of the Lewis Institute, Chicago, showed through a series of elaborate tests that little additional strength can be attained by mixing concrete over one minute.

The same author presented a paper on the effect of age and storage on concrete strength. Data of many long-time tests taken from available literature showed a progressive increase in the compressive strength up to one, or in some cases, two years, with often a slight falling off beyond that period. When plotted to logarithmic curves, however, these showed a characteristic straight-line curve reducible to a formula with two constants, dependent on material, manufacture and storage.

To avoid certain difficulties with the standard Deval rattler when used for abrasive tests of road materials, Prof. H. H. Schofield, of Purdue University, has devised a modified rattler which is claimed to give a greater range of results. (*Engineering News-Record*, vol. 81, no. 1, July 4, 1918, pp. 48-49)

Internal-Combustion Engineering (See also Railroad Engineering)

Effect of Circulating-Water Temperature on the Lubricating Oil. Data of tests recently made by the Texas Company for the purpose of determining the effect of the temperature of the water in the circulating system on the condition of the lubricating oil.

The motor used was a Buda-type H. U. which employs a forced-feed oiling system at an oil pressure of 30 lb., the oil reservoir holding eight quarts.

The first test was made with the entire radiator front blocked by a sheet of cardboard and the radiator filled with hot water. The second test was made by removing the cardboard and filling the radiator at the start with cold water. During the two tests the atmospheric temperature was quite low. A medium-bodied motor oil was used for both tests.

The prevailing idea as to the relation between the temperature of the motor and the character of the lubricating oil has always been that a hot motor thinned the oil down rapidly and that a heavier oil was required than for a colder motor. It appears, however, that when lower-grade gasolines and kerosenes are used and partially vaporized fuel passes into the cylinder, the liquid portions or heavy ends condense on the cylinder walls and tend to wash the lubricating oil off the cylinder walls. The test made with the circulating-water temperature of 180 deg. fahr. showed a reduction of viscosity of the oil of only 26.3 per cent, while similar tests made with a circulating-water temperature of 102 deg. fahr. indicated a reduction of viscosity of the remaining oil 48.3 per cent.

In the opinion of the author these tests show the bad effect on the lubricating oil of unvaporized fuel in the cylinder, and also show that even if complete vaporization is not secured through the carburetor the fuel loss may be reduced by the use of higher circulating-water temperatures. (*Lubrication*, vol. 5, no. 8, June 1918, pp. 11-14, 1 fig., *e*)

Machine Parts

ELASTIC COUPLING OF PRIME MOVERS AND GENERATORS, O. Ohnesorge (*Zeits. Vereines Deutsch. Ing.* 62, pp. 77-78, Feb. 16, 1918). In a previous article [Abs. 703 (1916)] the author pointed out that the oscillations of generating plant are set up not only by irregular driving moment, but also by the presence of elasticity in the coupling between the prime mover and generator. On this account the provision of elastic couplings to hinder any hunting of the units may exaggerate the trouble that is to be counteracted unless certain specific conditions are fulfilled. It is necessary that the coupling employed should have a definite elastic constant, but the proposal that all such couplings that are obtainable on the market should be classified according to this feature is hardly practicable. As a matter of fact, the couplings that are obtainable have in general far too low a power of storing energy. The present article describes with illustrations the main features of the design of an elastic coupling with adjustable elasticity and having the property of causing the forces to act on a comparatively large volume of the working fluid that provides the elasticity, a defect of most commercial couplings lying in the fact that there is not room within the coupling to bring sufficient working fluid into action. In the design shown the coupling consists of two parts connected together by pistons working in cylinders containing oil kept under pressure by connection with an air receiver to which the cylinders are joined by an oil-filled pipe passing through a hollow shaft. The elastic forces are able to be adjusted, even during running, by means of the pressure and volume of the air-receiver. (*Science Abstracts*, Section B—Electrical Engineering, vol. 21, pt. 5, (no. 245), May 31, 1918)

MAXIMUM POWER AND SPEED OF BELT PULLEYS AND GEAR WHEELS, W. Kummer (*Schweiz. Bauzeit.*, 30, no. 5, 1917; *Elektrot. u. Maschinenbau*, 35, p. 629, Dec. 30, 1917). The author investigates maximum practicable values for power and speed in belt pulleys and gear wheels, basing his results upon the maximum peripheral force, P kg., transmitted. In belt drives P depends upon the tensile strength of the belt referred to the maximum peripheral force which can be transmitted. Using quadruple Ideal leather, total thickness 16 mm., with large pulleys, favorable transmission ratio, and high belt speed, a force of p = 55-56 kg. per cm. of belt width can be utilized continuously. If the belt width = b cm. $P = pb$. Let $q = b/D$, where D = diam. in cm. of the smaller pulley, then the moment M in kg-cm. on this pulley $= D^2qp/2$. Introducing the revolutions per second n, and an experimental factor K (in cm./sec.^{2}), we have $D^2 = K^2/n^4$, hence $K^2/n^4 = 2M/qp$. Since the horsepower $L = 2\pi nM/7500$, we have $Ln^3 = \pi qpK^2/7500$. Taking the highest values which can be realized in practice without going to extremes, we have $p \sim 50$ kg./cm.; $q \sim 0.75$; and $K \sim 8000$ cm./sec.^{2}, which yields $Ln^3 = 1{,}000{,}000$ approximately. This equation is plotted in the original. In gear drives, the force P operative at the periphery is $P = kb^2/\psi$ where b = width of gear wheel in cm., k = experimentally determined coefficient of bending strength of the teeth of kg./cm.^{2}, and ψ = ratio of wheel breadth to tooth pitch. By introducing the ratio $q = b/D$, the turning moment M in kg.-cm., is $M = D^3q^2k/2\psi$. Again, by introducing the revolutions per second (n), the constant K, and the horsepower L, we obtain the equation $Ln^5 = (\pi q^2kK^3)/(7500\psi)$, as expressing the relation between maximum power and speed for the smaller gear wheel. This expression appears also in the general form Ln^5 = constant, as the general relation between power and speed in standard electrical machinery. According to American practice in ship driving, suitable values for the constant in the above equation are: $(k/\psi) \sim 60/30 \sim 2$ kg./cm.^{2}; $q \sim 4.0$; $K \sim 53{,}000$ cm./sec.^{2}. Then $Ln^5 \sim 2 \times 10^{12}$.

The curves plotted between L and n for belts and gears from the above formulæ represent the virtual limits of present-day practice (say up to 5000 hp. for belts and 12,500 hp. for gears), assuming the same general construction in each type of drive from various horsepowers. Though these curves will change as practice advances, the general formulæ Ln^3 = constant and Ln^5 = constant will hold good for belts and gears respectively, so long as the appropriate factors are used in determining the constant term. (*Science Abstracts*, Section B—Electrical Engineering, vol. 21, pt. 5 (no. 245), May 31, 1918)

Machine Shop

SYMPOSIUM ON DROP FORGING. The fifth annual convention of the American Drop Forge Association was held in Buffalo, June 19 to 21, and in connection with this meeting was held the third annual meeting of the Drop Forge Supply Association. Numerous technical matters were discussed.

H. D. Savage presented a paper on Powdered Fuel for Drop-Forge Furnaces. He stated that powdered coal as now commercially developed is a practical, reliable and economical fuel for forge work. While it is not applicable to all existing plants, in those plants where it can be applied it may produce a fuel economy of 30 to 60 per cent over oil or coal burned by other methods, will increase production and greatly minimize the human element in the regulation of combustion. At the same time the author stated that he did not think the use of powdered coal was worked out very successfully in small shops because of the large expense involved in the installation. He also said that the American Locomotive Company is now using powdered-coal furnaces at its Schenectady plant and is equipping its whole forge shop with them. These furnaces are

being provided with stacks and forced draft to exhaust the ashes, and dust that formerly escaped into the shop is now kept in the furnaces and carried up the stack.

B. K. Read presented an interesting paper on Fuel Analysis of the Drop-Forge Plant. In it he pointed out the fact that a vast majority of manufacturers are still burning their fuel under conditions not conducive to the greatest possible economy. This applies not only to the case of coal, but to oil burning as well. He cited a case of one company where the following arrangement is used:

The company has an oil storage capacity of 120,000 gal., approximately a month's supply, in seven storage tanks. The oil house is connected with the steam-drop-hammer shop by a concrete tunnel in which are located the steam and oil lines. A duplicate system of motor-driven circulating oil pumps is located in the steam-hammer house, distributing the oil around the building in the steam-pipe tunnel, then to the board-hammer shop, and then overflowing back to the oil house. A pressure of about 20 to 30 lb. is maintained. From this circulating oil line risers are taken up to the various furnaces. A natural-gas line parallels the oil system so that either fuel may be used. Supplementing the oil-line system is a test oil line. A 300-gal. test tank is located in the oil house and a circulating oil line extends around the shop with a plug tee at each furnace. This enables any one furnace to be tested independently of the main oil supply. A test gas meter is provided for use in making tests when both gas and oil are used. Along with the oil and gas system is the air-pressure system. Air is delivered by a centrifugal compressor at 16 oz. pressure to five mains and then to each furnace.

The furnaces are built to withstand shocks and vibrations, and are completely encased in a steel box lined with firebrick. No induced air is allowed to enter the furnace. The slag opening is normally closed, and the only escape of the products of combustion is over the hearth. Above and in front of the hearth is a perforated air pipe deflecting the gases upward. In the upward path of the waste gases is placed a cast-iron pot or preheater through which the pressure air passes over baffles and is heated before it mixes with the oil and gas. Four sizes of furnaces are used and a spare one of each size is provided.

Tests carried out in this plant have shown a very material economy in fuel, due to the improved method of operation. Thus it was found that the furnaces were burning about as much oil during meal hours and the time between shifts as when there was steel in them. As a result, two men were assigned to watch the furnaces and shut them off during these periods. The air pressure is also a factor in furnace economy requiring an investigation of the air line.

George W. Pressell presented a paper on the relation between the highest quenching speed and maximum hardness. He stated that for hardening purposes an oil should be selected which will give a uniform quenching speed, will not produce gaseous vapors at low temperature, and will not oxidize or thicken with repeated use. The quenching speed of an oil depends on its refrigerating properties and also on its fluidity or viscosity.

He stated that exhaustive tests were made with an animal hydrocarbon oil which is a distillation of wool grease (no further data as to this oil appeared to have been presented) claimed to be an oil possessing a smaller percentage of residue and solid matter in suspension than any other oil known.

The average quenching speed for distilled wool-grease oil was 102 sec. The total variation in time of quenching in temperature of the bath ranging from 82 to 249 deg. was 9 sec., while cottonseed oil under the same conditions showed a quenching speed varying from 104 to 119 sec.

The ideal quenching medium for forgings would be a water-soluble material, which, when mixed with water, would give a quenching speed through the critical range equivalent to that of water, and from the critical range to the atmospheric temperature equivalent to that of oil. Mixtures of water and oil proved to be unsuccessful, however.

George C. Stebbins discussed the Care and Maintenance of Piston Rods. It is at present regarded necessary to use the highest grades of steel in piston rods, and the author found that his greatest trouble was caused by breakages of piston rings.

Referring to the maintenance of hammers, he recommended the use of a central oiling system, and explained a system of this type that he has installed in his plant. A steel tank is located near the steam line, a pipe running from this line into the oil tank to secure the proper pressure. The oil is carried in a line from the pressure tank, from which it is fed to the hammer. A $\frac{1}{2}$-in. line carries it to an ordinary sight-feed lubricator, and there is a $\frac{3}{8}$-in. line above the lubricator, which taps into the throttle. The system is so arranged that the oil supply for any hammer can be shut off. He said that in his plant many of the piston rods that are used had heads riveted on instead of using the solid rod, and he found this type of rods satisfactory. (Abstract made through *The Iron Age*, vol. 101, no. 26, June 27, 1918, pp. 1650-1654, *dp*)

Manufacture of Cast-Steel Chains. Chester K. Brooks. Description of the work of the National Malleable Castings Company in the experimental development of cast-steel chains.

The first problem was the working out of suitable foundry methods for producing chain links in sand molds and uniting them into continuous lengths of chains.

Because of the vital importance of sand castings in a product of this character all of the links are produced in dry-sand molds. The method of application of gates and risers required some study, but it is said that excellent results were obtained both in pouring through the stud and through the side of the link.

The article describes in some detail the methods of testing the product by both dynamic and static tests. The results of these tests are given in the form of tables.

The second part of the paper is devoted to a discussion of the design and manufacture of the M. C. B. coupler.

The limitations of the M. C. B. contour have imposed certain fixed dimensions upon the size of the hub of the knuckle, its weakest point, and have barred any substantial increase in section. At the same time the stress to which this hub is subjected is enormous. It was believed that the use of a material of high ductility would be capable of withstanding these severe shock stresses, as it was supposed a very ductile material would by its elongation absorb some of the shock and so save itself from rupture. The difficulty with this is that the major part of this elongation is available only after the elastic limit of the material has been passed.

Two possible solutions for this problem have been offered: one, a change in the contour of the knuckle, approved some years ago by the M. C. B. Association; and the other, the development of a new steel.

The author states that the experience gained in the manufacture of the coupler knuckle has been extensively utilized for development of the cast-iron chain. In this connection he believes that the standard M. C. B. drop-testing machine presents the most readily available machine for testing cast-steel chain links. (Paper read before the American Society for

Testing Materials, June 25-28, 1918, abstracted through *The Iron Trade Review*, vol. 63, no. 1, July 4, 1918, pp. 29-32, 19 figs., *gd*)

EFFECT OF MASS ON HEAT TREATMENT, E. F. Law. The usual method of experimental work on heat treatment of metals involved using test pieces of comparatively small size. Unfortunately, however, the heat treatment of large masses of steel presents many difficulties not met in the case of small masses. As a result some of the troubles in commercial heat treatment are due not to the lack of knowledge of the underlying phenomena, but to not always correct practical application of that knowledge.

The present investigation had for its purpose the obtaining of information which would enable one to understand the changes which actually take place in a considerable mass of steel during the stages of each treatment.

In this case the experimental cubes were 18 in. on a side, weighing 14.5 cwt.

These cubes, supported on knife edges, were heated in a gas-fired "treatment" furnace in which the flame did not come in contact with the cube. The cube was gradually raised to the temperature of 1650 deg. fahr.

The curves in Fig. 2 show the heating of these cubes. One of the most noticeable features about these curves is the rapidity with which the heat penetrates to the center of the cube. At 130 min. from the time of charging the center and half-way are almost at the same temperature, but at this point the absorption of heat due to the Ac change causes greater lag at the center than elsewhere and the two temperatures do not approach one another again till the lapse of another 70 min.

After being in the furnace for about $4\frac{1}{2}$ hours the cube is withdrawn and cooled one way or another. For air cooling it is placed on knife edges; for oil cooling it is plunged in the usual way in mineral oil having a specific gravity of 0.897.

The comparative cooling curves are given in Fig. 4. The rate of cooling with oil seems to have been surprisingly rapid in this test, due evidently to the fact that a very large volume of oil as compared with that of the metal was used.

A third cube was placed on knife edges and cooled by spraying water at a pressure of 10 lb. per sq. in. on the upper and lower surfaces.

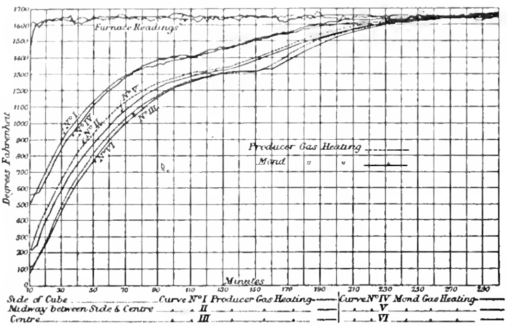


FIG. 2 HEATING CURVES OF STEEL CUBES 18 IN. ON THE SIDE

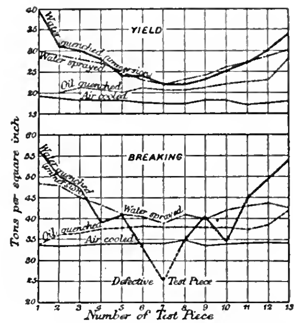


FIG. 3 DATA OF MECHANICAL TESTS OF SAMPLES FROM CUBES COOLED IN VARIOUS WAYS

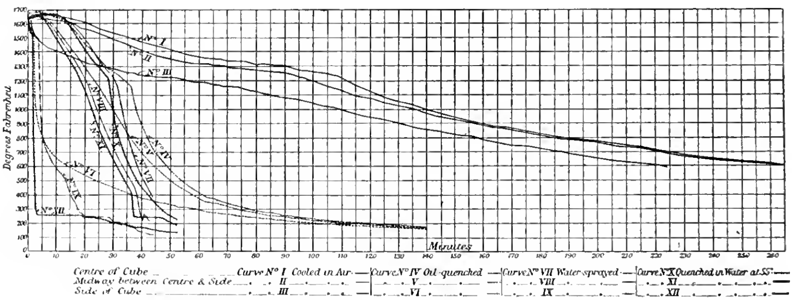


FIG. 4 COOLING CURVES OF 18-IN. STEEL CUBES IN AIR, OIL AND WATER

It is of interest to compare the oil and water curves. With oil—even in the center of the cube cooling takes place rapidly; but the evolution of heat at the Ar point is very noticeable. In the half-way curve, however, there is not the slightest indication of any recalescence. If it occurs (and presumably it does) it appears to be so evenly balanced by the conduction of heat to the outside that no change in the direction of the curve is noticeable. In fact, if the half-way curve were considered by itself it might be supposed that the steel possessed no critical point at all.

The curves VII, VIII and IX secured with water are in some respects similar to the curves with oil. The center curve again shows an evolution of heat and is not unlike the oil-hardening curve, although the rate of cooling through the lower ranges of temperature is more rapid. On the other hand, the half-way curve is totally different to that obtained by oil quenching. There is no sign of recalescence in the upper ranges, and the temperature falls evenly until about 450 deg. fahr. (232 deg. cent.), when there is a sudden acceleration in the rate of cool-

ing, followed by an abrupt halt at about 250 deg. fahr. (120 deg. cent). Somewhat similar features are shown in the curve representing the cooling of the outside of the cube.

The important difference between the two methods of cooling is to be found in the almost sudden slowing up of the cooling in oil shown in the lower ranges of temperature as compared with the cooling in water. Both in oil and water cooling, however, there is a period during which the metal in the center of the cube is cooling down more rapidly than the metal midway between the center and the surface.

A mechanical and photomicroscopical investigation of the metal was also carried out. The results of the mechanical tests are plotted in Fig. 3.

As might have been expected, the 13 results from the air-cooled cube gave practically identical results. In the case of the oil-quenched cube the breaking stress and yield are both raised, while the elongation is lowered, to almost the same extent in every test, the curves approaching a straight line. In other words, the effect of oil quenching is as apparent in the center of the cube as on the outside. In contrast to the results obtained by oil quenching, those obtained by water quenching show a very decided variation from surface to center of the cube; and this is most marked in the case of the cube plunged in cold water. The effect of the quenching is uneven, and the tests suffer from the lack of what might almost be described as "automatic tempering," which occurs in the lower ranges of temperature during oil quenching.

Sections were cut from the test pieces and examined microscopically. The photographs obtained show the characteristic appearance of magnifications of 100 diameters. The entire series are pearlitic, as might have been expected from the mechanical tests, and under higher magnifications they all, with one exception, show well-developed laminated pearlite. The exception is to be found in the surface of the cube quenched by plunging in water. In this case very little free ferrite is to be seen, and it is evident that the transformation has been very nearly arrested. This is confirmed by the fact that the surface of the cube was the only part which presented the slightest difficulty in machining.

The abrupt halt in the neighborhood of 250 deg. fahr. (120 deg. cent.) shown in the curves obtained from the water-cooled samples was totally unexpected and too striking to be passed over without notice. The writer does not claim to give an explanation of this fact, but points out that experiments repeated on 18-in. and 12-in. cubes showed that it occurred with remarkable regularity and was not affected by reasonable variation in mass. (Paper read before the Iron and Steel Institute, May 3, 1918, abstracted through *Engineering*, vol. 105, no. 2736, June 7, 1918, pp. 647-650, 2 figs., eA)

Steels for Gears and Their Treatment, Geo. A. Richardson. The writer divides all gears into two classes:

a Gears which are primarily used merely for the purpose of changing speeds, and

b Gears which are primarily used for the purpose of conveying power and must withstand the severe service conditions which are necessary.

In the first case, the cheapest material consistent with convenience is the best; in the second, the best material is the cheapest.

When the gears are to be used to convey power it becomes necessary to consider:

a Whether resistance to wear is the most important requirement, or

b Whether the resistance which the gear will offer to shock or sudden and excessive loads is of importance.

When resistance to wear is the most important consideration, the oil-hardened gear will, in the opinion of the author, give better service than case-hardened material. This opinion is rather contrary to the generally accepted view, and is based on the consideration that case-hardened material has an excessively brittle surface, and lacks the strength and toughness necessary to withstand the impact of shocks or heavy and excessive loads.

It was formerly believed that superior results could be obtained in gear trains by using varying grades of materials in the different gears, the idea being that those gears which tended to wear out fastest should be made of harder or better material. The latest information shows that when gears are operating under the same service conditions no advantage is secured by using gears of varying hardness.

As regards material, cast iron is the best material where it can be used, but all heavy gears for high, severe service have to be made of cast steel of either the straight-carbon or alloy types. While such gears can be cast in varying sizes for quantity production, drop forgings are preferable because they are cheaper to make, more uniform and stand up better in service.

For especially severe service, large-size gears have been manufactured with great success by using a nickel-chrome composition and air-hardening. In alloy steels for gears there are two general classifications to consider: case-hardening and oil-hardening. In some cases the choice between the two classes is determined by certain definite considerations. In many other applications, either class may be used. Plain carbon steel is used quite extensively in the case-hardened form, but not for the more severe kinds of service, because the core is very low in tensile strength.

An important point to bear in mind in connection with alloy-steel gears is that the lower the quenching temperature that can be used to get an effective hardness, the better the result. The higher nickels can be successfully hardened at the lower temperature. Chrome-nickel steels require a somewhat higher hardening temperature which decreases as the nickel content increases. Chrome vanadium requires the highest quench of all. For case-hardening it is not well to go above 0.20 per cent carbon in any of the alloys.

The alloy steels will stand a forging temperature of as high as 2200 deg. fahr., but they must be finished at a low temperature, the finishing temperature being the more important the higher the grade of steel.

The writer discusses in detail the case-hardening of high-grade steels.

As regards oil-hardening alloy steels, the writer states that the more sensitive of them, such as nickel-chrome compositions, absolutely require a double treatment. The first requirement is a preliminary treatment which may be a quench or an anneal to break down the crystallization set up during forging and bring the steel to a uniform cell size, though not a thorough grain refinement. In addition, it has been found desirable in the case of some alloys to give them a quench from the forging temperature in order to improve the condition of the steel. The forgings are taken directly from the forge and dipped into oil or water. They become black, but not cold and are then buried in ashes. The final treatment should be given at the lowest temperature that can be used and still give hardness.

As regards the relative merits of case-hardening and oil-hardening compositions, the writer states that, as a general

rule, the oil hardened gear can be counted on for more steady and uniform wear. Oil-hardened gears give a lower scleroscope hardness than case-hardened gears, but this is not a criterion of wearing quality, as the toughness of the material always enters in. (Paper presented at the Annual Meeting of the American Drop Forge Association, June 20, 1918, abstracted through *The Iron Age*, vol. 101, no. 26, June 27, 1918, pp. 668-670, 2 figs., *gp*)

Machine Tools

AUTOMATIC SPACING AND PUNCHING MACHINE FOR STRUCTURAL WORK, S. A. Hand. Description of a new machine which automatically spaces and punches variable structural members in both web and flange in one passage through the machine, and in any lengths and widths up to the maximum delivered by the rolling mills. All motions are electrically controlled from a central keyboard in about the same manner as musical instruments are played. (*American Machinist*, vol. 49, no. 1, July 4, 1918, pp. 1-8, 11 figs.)

HIGH-CUTTING-SPEED PLANER. The Powell Machine Company of Worcester, Mass., has developed a metal-planing machine claimed to give high cutting speed. This latter is secured by providing for accelerated platen travel after the cutting action is begun.

High speeds are difficult to secure in a planer because of the following factors: (1) the shock caused by the reversal of the platen at the return of the back stroke, and (2) the impact of the tool striking the work at high speed.

In the Powell planer automatic means are used to allow the tool to enter the cut at a low speed and to increase this speed thereafter.

On the usual driving shaft there are provided a pair of tight and loose pulleys for a return speed of 120 ft. per min., and a pair of tight and loose pulleys for a cutting speed of 60 ft. per min., in addition to which the planer is equipped with a second driving pulley and connections which increase the speed of the driving shaft to 180 ft. per min.

As the table reverses to take the cutting stroke the cutting speed is shifted to the tight pulley, which is provided with a ratchet. The tool now enters into the cutting stroke. After the platen has moved a predetermined distance a dog attached to the platen shifts a belt to the secondary high-speed pulley. This increases the speed of the driving shaft, which unlocks the ratchet pulley. By an arrangement of dogs placed at predetermined positions it is claimed that the cutting speed may be increased or retarded without perceptible shock or strain to moving parts during the cutting stroke. At the end of the stroke the final dog shifts the belts back to the loose pulley and the return is shifted to the tight pulleys. This causes the platen to return at normal speeed. (*The Iron Trade Review*, vol. 63, no. 1, July 4, 1918, pp. 22-23, 1 fig., *d*)

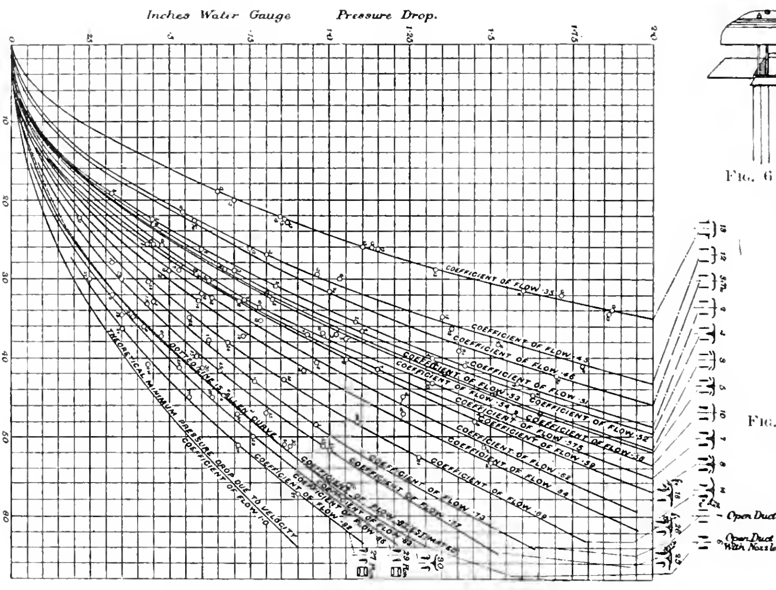


FIG. 5 TEST RESULTS WITH VARIOUS INTAKES: SHAFT OF SQUARE SECTION

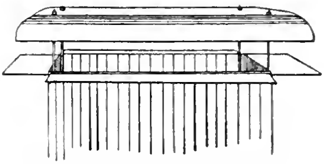


FIG. 6 OLD-TYPE COWL WITH FOUL-WEATHER FLAPS

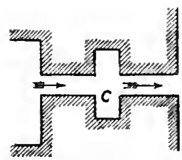


FIG. 7 DIAGRAM OF ELASTIC FLUID CONDUIT WITH INTERPOSED CHAMBER

MILLING-MACHINE VISE AS A SPECIAL MILLING FIXTURE, Hugo F. Pusep. A practical discussion for the purpose of showing how the milling-machine vise may be made serviceable in place of the more expensive special fixtures. The writer called attention to the fact that, under the present conditions, production may be held up for considerable periods, because of the difficulty of supplying the machine shop with the necessary special equipment. The article is of a strictly practical nature. (*American Machinist*, vol. 48, no. 26, June 27, 1918, pp. 1101-1103, 6 figs.)

Marine Engineering

AIR SUPPLY TO BOILER ROOMS, Richard W. Allen. The writer discusses the subject of air supply to boiler rooms where closed stokeholds are employed, a matter of particular impor-

tance where oil fuel is used, as this necessitates high air pressures being maintained in the boiler rooms.

The writer gives formulæ for determining the air pressure required to produce a certain speed, and points out that within the range of speeds and pressures actually employed on board ship, the speed varies as the square root of the pressure difference, or for an exit nozzle consisting of a short cylindrical pipe with ends not rounded off an air pressure of 1 in. water gage would produce approximately a speed of 54 ft. per sec. (assuming a coefficient of flow of 0.8).

As regards the velocity of air in the air shafts, the speeds recommended are from 20 to 25 ft. per sec. The pressure required to produce this velocity is relatively small, 0.13 in. to 0.20 in. water gage, but increases in the ratio of the square of the velocity.

Tests recently made on four different classes of ships indicate that the air trunks are sometimes constructed so that they necessitate very high speeds with resultant excessive power losses. It must be remembered that to obtain a speed of air a pressure difference has first to be set up. The pressure energy is converted into velocity energy, the greater part of which is lost so that very little of it is converted back to pressure. Hence, the higher the air speed the greater the loss.

Enlargements and Restrictions in the Air Passages.—Tests taken for steam have shown that when a chamber, such as *C* in Fig. 7, is interposed in a pipe run, even if it be of no

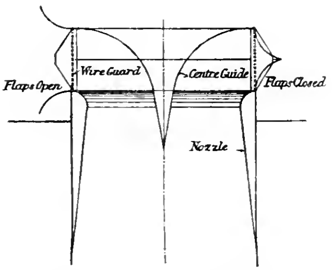


Fig. 8 New-type Cowl with Foul-Weather Flaps, with Center Guide and Nozzle

great length in the direction of the axis of the pipe run is sufficient to destroy completely the speed of the fluid approaching the chamber through the first portion of the pipe, and makes it necessary to have a further pressure drop expended in order to produce the speed afresh in the outgoing pipe.

Such sudden enlargement often presents itself where the air shaft leading from the top deck down to the fan compartment emerges into the fan compartment. There are also many points in the air passage where restrictions in area are frequent and the writer enumerates the chief causes which produce such restrictions.

As regards intakes, the writer calls attention to experiments made to establish the relative efficiency of their different types. The essential requirement in designing a betetr intake was to produce a guide which would perform the protective duty, but at the same time induce the flow of air into the shaft, especially when partly closed against the water.

The results of these tests are shown in Fig. 5, where data are given of the tests with the old-type cowl shown in Fig. 6 and the new type with central guide and nozzle shown in Fig. 8.

It is stated that the new design has an efficiency of 83 per cent against 35 per cent for the old design. In the new design the guides are of stream-line section and pivoted to the top of the air intake shaft so that they can be opened any desired amount. The other two recent innovations, namely, the center guide and nozzle, shown in Fig. 8, are embodied in the deck entry, the center guide in the form of a deflector or inverted pyramid attached beneath the cowl top, and the nozzle providing the *vena contracta* flow at the end of the entrance to the intake shaft.

In explanation of the manner in which the center guide and nozzle contribute to prevent loss of pressure, it has been proved that where these contrivances are not provided the whole of the space which they occupy is filled with eddy cur-

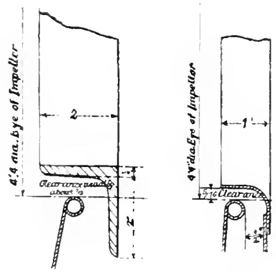


Fig. 9 To the left—Fan Inlet Ring of Incorrect Design; to the right Fan Inlet Ring of Improved Design

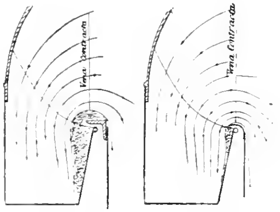


Fig. 10 Air Streams through Rings in Fig. 9

rents, which are continuously absorbing energy. The reason for the formation of the eddies is partly that the direction of the air is changed on entering the shaft and owing to its velocity sweeps round the corners, and partly owing to the law of *vena contracta* for the flow of all fluids, either liquid or gaseous, at entrance or exit of duct. The center guide and nozzle conform to the correct line of flow to prevent the formation of any eddies. Another improvement to which importance is attached is fitting the diaphragms, places athwart-ships, subdividing the air intake shaft. When a ship is traveling at a high speed there is a tendency for the air to rush past the intake without being drawn in, and for the air which does enter to bank up in the after side of the intake shaft, with a consequent tendency to starve the forward fans. By fitting diaphragms, the tendency to unequal air supply fore and aft will be efficiently counteracted, and all the fans will receive their due share of air.

Inlet Rings. In many cases where the fan has failed to deliver its desired output, it has been found on examination to be due to inlet rings badly fitted to the fan eye, or to the inlet ring being of unsuitable shape. The inlet ring should be satisfactory as regards: (1) correct clearance, (2) angle of entry,

and (3) the avoidance of sharp corners. An inlet ring of recommended design with correct clearances is shown at B in Fig. 9, while an incorrectly designed ring with the sharp corner is shown at A of the same figure.

Fig. 10 shows how the design of the ring affects the shape of the air stream. At A, corresponding to ring shown at A, Fig. 9, the effective area of the fan eye is reduced, the velocity of entry increased, and consequently the momentum of the air in the direction parallel to the axis of the fan. Fig. 10 at B shows how the *vena contracta* is increased in area and the velocity of entry reduced. Further, with the lower momentum and elimination of the outer eddies, the radius of change of direction of the air becomes smaller.

Some interesting tests are reported on steam consumption of the fan installation, which show that the increase in the steam consumption is about 20 per cent due to 1 in. vacuum on the inlet. On the other hand, it was found that the performance of a fan may be considerably improved both in output and efficiency through correct design of the fan casing and of discharge of the air from the fan case. Thus, in comparative tests with the fan first in a concentric casing and next in a volute casing, it was found that the improvement due to the volute amounted to 30 per cent in output and 9 per cent in efficiency. Still better results were obtained in another test.

The subject of deflectors on fan casings and of direction of rotation of the fan is discussed in considerable detail on the basis of an interesting e perimental investigation. (Paper read at the Spring Meeting of the Institution of Naval Architects, March 22, 1918, abstracted through *Engineering*, vol. 105, no. 2737, June 14, 1918, pp. 662-665, 18 figs, *ep*A.)

Mechanics

CHARTS FOR THE DESIGN OF HELICAL SPRINGS, M. M. Brayton. The purpose of the article is to bring spring formulæ to the practical man in such a way that he may be able to use them without going through a lengthy calculation on the slide rule or by hand. For this purpose the writer offers several simple graphical solutions.

Helical springs are usually made from wire of circular cross-section and may be designed for either tension or compression. The formulæ apply equally well in either case. In the design of these springs several factors have to be considered, namely, diameter of wire, outside diameter or mean radius of coil, maximum safe axial load, number of coils per inch, maximum safe shearing stress of the steel and the de 'ection of the spring under a given load.

The following formula expresses the general relation:

$$W = \frac{\pi S d^3}{8(D - d)}$$

where W = total safe load on spring in pounds
d = diameter of wire in inches
D = outside diameter of coil in inches
S = maximum fiber stress in pounds per square inch, taken at 60,000.

The writer gives a chart enabling one to find W by merely drawing two lines perpendicular to each other.

Since it is sometimes convenient to have the same formula expressed in terms of the mean radius of the coil rather than the outside diameter, the writer gives another chart based on the formula

$$W = \frac{\pi S d^3}{16 R}$$

where the same notation is used as above. Another chart is given to solve graphically the formula for the deflection of a spring under a given load.

The charts are not suitable for reproduction, but appear to be quite simple and convenient for use. (*American Machinist*, vol. 48, no. 24, June 13, 1918, pp. 1007-1011, 3 figs., *p*)

ON TWO-DIMENSIONAL FLUID MOTION, WITH FREE STREAM LINES, PAST AN OBSTACLE OF CURVED OUTLINE, J. G. Leathem (*Roy. Irish Acad.*, Proc. 34, pp. 11-39, March 1918). The author commences by giving in chronological order a list of papers to which he refers on the subject of two-dimensional flow of infinite liquid, with free stream lines, past a fixed obstacle of curvilinear outline. [For the author's previous paper on Two-Dimensional Fields of Flow, with Logarithmic Singularities and Free Boundaries, see Abs. 644 (1916).] In these researches there have been three distinct objectives: (1) A mathematical formulation, in terms of somewhat general functions, for any motion bounded partly by fixed and partly by free boundaries. (2) The exact or approximate adaptation of such a general formula to the case of an obstacle of arbitrarily assigned outline. (3) The choice of such forms of obstacle as shall correspond to liquid motions that can be precisely specified.

The exact adaptation of a general formulation to the case of an assigned obstacle seems bound to depend upon difficult functional equations, upon whose solution further progress must wait. The primary objective of a comprehensive formulation remains of fundamental importance, since such may well be the only possible point of departure for further progress in general theory, and the present paper offers a general formulation in terms of conformal curve factors—functions whose properties the author has discussed in previous papers. The method leads to expressions in terms of a definite integral involving a single arbitrary function of a real variable, and it is believed that in this form the properties of the relation between the fundamental variables are exhibited as simple as possible. From this formulation as starting point it has proved feasible to make a certain advance in knowledge, for there are obtained formulæ which specify the most forward points at which free stream lines can break away from an obstacle with smoothly curved sides. Attention is called to a probable connection between the positions of these points and the resistance which the obstacle offers to the stream when there are no free stream lines but the "wake" is in rotational motion; and a principle is deduced which may have important bearing on the problem of designing cylinders of small resistance—as, for example, struts for aeroplanes. The various sections of the paper respectively deal with: Notation and formulation; general formulæ; demonstration of generality; determination of points of departure of free stream lines from a curved obstacle; influence of the shape of the obstacle upon the divergence of the free stream lines, and the resistance to relative flow. The subject is treated mathematically throughout. (*Science Abstracts*, Section A—Physics, vol. 21, pt. 5 (no. 245), May 31, 1918)

Railroad Engineering

WELDING TRUCK SIDE FRAMES, BOLSTERS AND ARCH BARS. Report of a special committee made to the Master Car Builders' Association at its meeting in Chicago, June 1918.

The tests were made at the Bettendorf Company's plant, Bettendorf, Iowa, and at the plant of the American Steel Foundries Company at Alliance, Ohio. At Bettendorf a 1500-ton hydraulic press was used, and at Alliance a Riehlé testing

machine of 1,000,000 lb. capacity was used in making the tests.

The following data show the nature of the work performed. The frame shown in Fig. 11 had a crack $3\frac{3}{4}$ in. long, yet under tests did not show signs of opening until a load of 195,000 lb. was applied, and opened $\frac{1}{8}$ in. under a load of 230,000 lb. The frame used in Test No. 8, Book A, with a crack $1\frac{1}{2}$ in long, took a load of 332,000 lb. before the fracture occurred. Any methods employed in welding or preventing cracks of this character from extending would permit the frame to remain in service with safety, as it is only in isolated cases that frames ever failed without giving sufficient warning that by ordinary inspection replacement or repair could be made to prevent accident or derailment. In many cases they have been kept in service until the crack commenced to open or extend into the

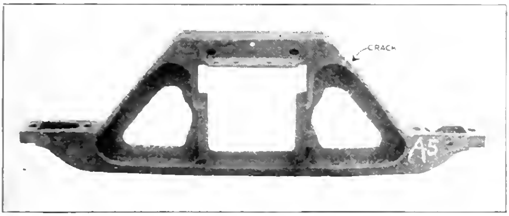


Fig. 11 Side Frame Before Welding

welding under load, as internal strain is liable to be set up through welding, which can be avoided by preheating. It is good shop practice to preheat cast steel and pressed-form bolsters and side frames.

The following summary and conclusions were presented by the committee in connection with one series of tests:

Of the 23 tests as per data herewith, there were 10 castings in which the original fracture had consisted of a complete break of the entire tension member, the fracture extending well into the web, with the exception ot test No. 19, the tension member of which was broken in from both sides, but not quite wholly fractured. (See photograph 1391.)

Of these 10 castings, the tension member of which was entirely fractured, only three broke in the weld under test. (See test No. 11, casting F-8; test No. 17, casting F-1; and test No. 20, casting F-3.)

If, in view of the data herewith submitted, it is desired to weld tension members that are almost wholly broken, with the fracture showing porosity, the welded portion should be built up to a considerable extent tor 2 in. or 3 in. over the surface to compensate for what may have been a weak point.

As a conclusion, it may be said that the tests clearly indicate that properly made welds are satisfactory.

In view of these tests and experiments, it is considered important that in making such welds consideration should be given to the tensile strength of the welding material as com-

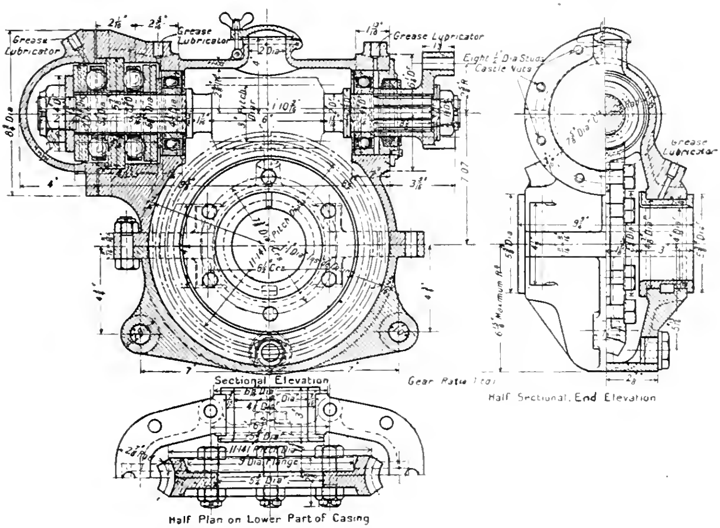


Fig. 12 Worm Drive of Bagnall Locomotive

vertical section before removal and without anxiety on the part of mechanical officers responsible for their performance.

A number of the castings tested were welded where broken entirely across the tension member, yet the welds were sufficiently strong so that under test the casting broke at some location other than the weld. Therefore the proper welding of side frames and bolsters would be permitted, the limit to prohibit welding to be when the strength of the weld would not equal that of the joining sections.

The committee also made certain recommendations as to the manner of carrying out the welding operation. Among other things, it states that great care should be exercised to prevent

pared with the tensile strength of the casting welded. If Norway iron or other welding metals of low tensile strength are used, the welds should be built up an amount sufficient to compensate for the total strength of section to be welded.

The Association by formal actions recognized as good practice and sanctioned the extension of autogenous welding to all parts of car equipment. (Abstracted through *Railway Age*, vol. 64, no. 25, June 21, 1918, pp. 1493-1496, 6 figs., *ep*)

Small Locomotives of Special Types. Description of the 40-hp. internal-combustion locomotive built by W. G. Bagnall, Ltd., Stafford, England.

The [illegible] is of [illegible] type, with cylinders 4[illegible] by 5 [illegible] and is [illegible] gasoline and run on kerosene.

The arrangement of [illegible] worm wheel is shown in Fig. 12. The thrust of the worm is taken up by ball bearings which are of the Hoffman type.

The cooling water, which is circulated on the thermosiphon system, is contained in a cylindrical tank arranged in precisely the same position as is the boiler in an ordinary steam locomotive. The tank, which is built up of two rings, 2 ft. 2⅝ in. and 2 ft. 3 in. internal diameter and 5 ft. long, has internally dished ends which serve as tube plates. There are in all 56 1¼-in. outside-diameter tubes, which are swelled to 1⅜ in. diameter at the front ends. They are of steel and No. 16 W. G. The internal faces of the tube plates are 4 ft. 8 in. apart. The cooling effect is obtained by the passage of the air through the tubes, no mechanical arrangement for forcing the air through the latter being found necessary. The capacity of the water tank is 113 gal. The exhaust pipe from the engine is taken up the chimney, which serves as a silencer. A branch from the exhaust pipe is taken to a whistle which is operated

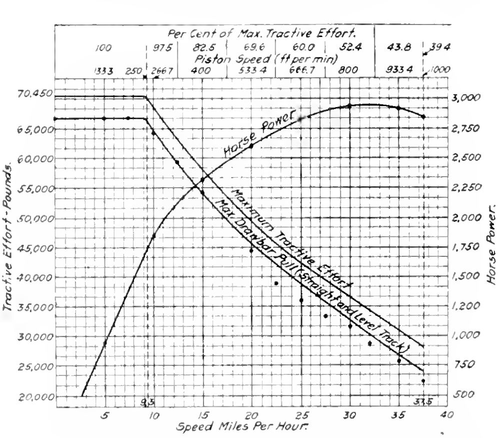


FIG. 13 TEST RESULTS SECURED WITH 2-10-2-TYPE LOCOMOTIVE ON THE UNION PACIFIC ON HEAVY GRADES

by cord from the cab. The arrangement of all the control levers in the cab follows closely steam-locomotive practice and appears to be excellent in every way.

In the same article is described a fireless locomotive built by a British concern. It is claimed to be the smallest fireless locomotive, from the point of view of weight, which has ever been constructed. In working order it weighs only 3½ tons. The engine is carried on four wheels, but only one exhaust is driven. The outer casing is of canvas soaked in boiled oil and painted; the cab is of wood and the buffers are of special shape and material, the plungers being of lignum-vitæ backed up by Spencer springs. (*Engineering*, vol. 125, no. 3256, May 24, 1918, pp. 442-443, and 448, 7 figs., *d*.)

TESTS WITH 2-10-2 LOCOMOTIVE ON THE UNION PACIFIC. Data of tests made with one of 27 engines built last year by the Baldwin Locomotive Works. The new engines were designed to be used over a reconstructed section on the Union Pacific between Ogden, Utah, and Evanston, Wyo. They were designed primarily to move the same tonnage eastbound over the new line with a ruling grade of 1.14 per cent compensated for curvature that the Mikado locomotives handle over the lines with 0.83 per cent grades. It was also desired to eliminate helper service on this district which has several difficult grades.

In tests the 2-10-2-type locomotives handled 1800 tons eastbound over this division (some of the grades are still 63 ft. per mile, uncompensated for curvature) at an average running speed of 15 m.p.h. with the coal consumption of 358.4 lb. per thousand gross ton-miles.

The curves in Fig. 13 show the tractive effort and drawbar pull developed and the horsepower. A maximum of 2940 hp. was developed at a speed of 30 m.p.h., which is at the rate of 1 hp. for every 121.6 lb. weight of the locomotive in working order, an unusually good performance.

The article describes in some detail the construction of this type of locomotives, and gives the principal dimensions and ratios of the locomotives. (*Railway Age*, vol. 64, no. 26, June 28, 1918, pp. 1572-1574, 5 figs., *ed*)

Refrigeration

COLD ACCUMULATORS AND THEIR APPLICATION, Ernest S. H. Baars. The article discusses the purposes of temperature hold-over tanks used in the refrigerating industry and describes a new hold-over tank which uses a weak calcium chloride solution in frozen state. The physical phenomena involved are discussed.

The term "cold accumulator" sounds paradoxical, because technically speaking it is not possible to accumulate cold. What is actually meant is a surplus refrigerating capacity stored up for use later on. The apparatus may also be called a "hold-over tank," because it keeps the room cold during the short period while the refrigerating plant is shut down. Such hold-over tanks are used principally in connection with small refrigerating plants which are not operated continuously. They are also desirable for automatically controlled refrigerating plants to prevent excessively frequent starting and stopping of the compressor and wearing out of the control apparatus.

Hold-over tanks may be divided into three types. The first

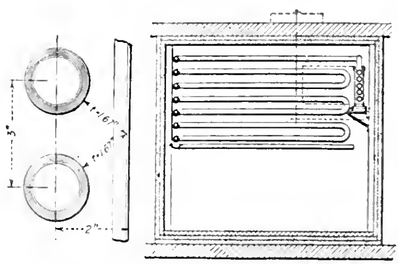


FIG. 14 HOLD-OVER TANK (TO THE LEFT, SPACING OF COILS; TO THE RIGHT, SECTION OF TANK)

is the brine tank. The second is a tank with the requisite amount of evaporating coils and a highly concentrated solution of chloride of calcium brine. While the machine is running the brine is cooled down to about 20 deg. fahr., and during the remainder of the way, when the machine is shut down, the heat that enters the room through the walls is absorbed by the cold brine in the tank, until the latter reaches a temperature when the refrigerating machine must be started again.

Several years ago the writer designed a third type, the working of which is based on a different principle. Instead of using a strong solution of calcium chloride, he uses a weak

solution and freezes it. For the successful operation of the hold-over tanks with frozen brine, tanks must have a special shape. Because of the fact that when a solution is frozen very slowly the water in it is frozen out and the salt crystals fall to the bottom of the vessel, it is essential that no brine be located too far from the evaporating pipe. By this means the salt crystals are kept in the ice and are ready to go in solution with the water as soon as the temperature rises.

Another feature is the flexibility of the walls of the tanks where corrugated sheets are used, thus preventing bursting through the expansion of the ice. Fig. 14 gives an idea of the construction of the tank.

The writer discusses in some detail the molecular movement of liquids as affecting the freezing point of solutions. (Paper read before the Engineers' Society of Milwaukee, abstracted through *Power*, vol. 48, no. 1, July 2, 1918, pp. 31-33, 2 figs. *d*)

Steam Engineering

Effect of Feedwater Temperature and Rate of Injection Upon Steam Flow, Frank G. Philo. The writer shows that under any given condition the actual output of the boiler expressed in B.t.u. absorbed per unit of time is constant, regardless of the rate of feeding and the temperature at which boiler feedwater is injected. At the same time boiler output expressed in pounds of steam per unit of time varies widely with changing feedwater temperature and rate of feedwater injection.

The normal condition is considered to exist when the feedwater is fed into the boiler at the same rate at which the boiler is steaming, while any rate of feedwater injection above or below normal will increase or decrease the rate of boiler steaming and the amount of water in the boiler.

As regards feed temperature, it is stated that when it is the same as the temperature of the water in the boiler, feedwater injection does not affect the rate of steaming, but when the feedwater is higher in temperature than the water in the boiler an increase in steam flow occurs upon feeding water into the boiler.

The following formulæ and chart (Fig. 15) have been developed to show the magnitude of the above described effects.

H = total heat above feedwater temperature of 1 lb. of steam

L = latent heat of 1 lb. of steam under given conditions plus B.t.u. for superheating 1 lb. of steam (if superheated)

h = heat of feedwater from feed temperature to boiler temperature

R_s = rate of steaming

R_w = rate of feedwater injection

1 With feedwater shut off entirely, $R_s = \frac{H}{L} = 1 + \frac{h}{L}$.

2 The rate of feedwater injection that would decrease steam flow to the rate of R_s would be $R_w = 1 + \frac{L - R_s L}{h}$

3 The rate of feedwater injection that would cause steam flow to cease would be $R_w = 1 + \frac{L}{h}$. (R_s = zero)

4 Under any given condition the sum of the heat absorbed by the feedwater and the heat used in boiling the water equals the total heat, or H absorbed by the boiler. As a formula this would be written $R_s L + R_w h = H$.

For examples of the foregoing take the conditions of 100 lb. gage, saturated steam, and 60 deg. fahr. feedwater temperature. Then $H = 1189 - (60 - 32) = 1161$ B.t.u.; $L = 880$ B.t.u.; and $h = 281$ B.t.u.

1 $R_s = \frac{H}{L} = \frac{1161}{880} = 1.32$, the rate of steaming with no feed.

2 Let R_s = 50 per cent, then $R_w = 1 + \frac{L - R_s L}{h} = 1 + \frac{880 - (0.5 \times 880)}{281} = 2.57$, the rate of feed required to reduce the rate of steam flow to 50 per cent of normal.

3 $R_w = 1 + \frac{L}{h} = 1 + \frac{880}{281} = 4.13$, the rate of feed required to stop steam flow.

Variable feedwater injection with the steady load is inimical to uniform steam pressure, but with loads that have a periodic fluctation, as in rolling mills, properly handled variable feedwater injection aids in the maintenance of the steam pressure.

The above discussion emphasizes the necessity of giving closer attention to the matter of correct boiler feeding. (*Power*, vol. 47, no. 26, June 25, 1918, pp. 915-916, 1 fig., *pt*)

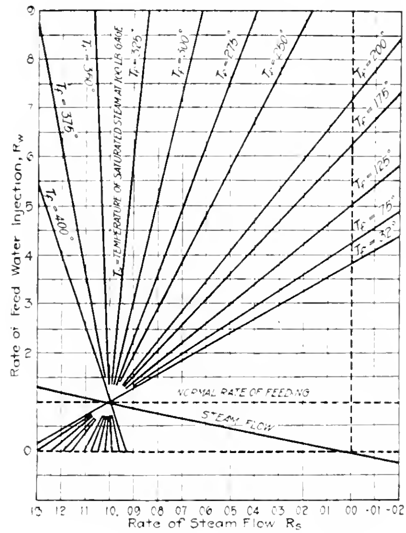


Fig. 15 Effect of Feedwater Injection on Steam Flow

Boiler-House Operation with Reference to Various Fuels, Knust (*Elek. Werk.* 6, 1916; *Elektrot. u. Maschinenbau*, 35, p. 47, Jan. 28, 1917, Abstract). It is economically preferable to distill hard coal rather than use it directly under boilers. All bituminous coals should be subjected to distillation. The author investigates the possibilities of substitutional fuels for boilers. For any given fuel there is direct dependance between the temperature of combustion, the quantity of air for combustion, the CO_2 content, and the temperature of the flue gases. The higher the CO_2 content and the lower the temperature of flue gases the more favorable the utilization of the fuel. The author gives formulæ for the initial temperature T, and by comparing this with the measured value, t, the loss of fuel may be determined at once. If $T = 2000$ deg. cent. and $t = 300$ deg. cent., the gross efficiency η of the firing is $(2000 - 300)/2000$, i.e., 85 per cent; for $T = 2000$ deg. and $t = 200$ deg., $\eta = 90$ per cent.

The author gives a table comparing gross efficiency, initial temperature, air surplus, and air and flue-gas quantities for a specified coal and various CO_2 contents. Formulæ are given for the air theoretically required for combustion and for the

vol[illegible] the [illegible]. A daily consumption of 10,000 kg. of coal when the CO_2 content is 12 per cent and the flue-gas temperature 200 deg. cent. corresponds to 33,400 kg. per diem when the CO_2 content is 4 per cent and the flue-gas temperature 400 deg. cent; the great saving under the former conditions is obvious. A table is given showing for the principal fuels, the calorific value, evaporation factor, maximum CO_2 content, initial temperatures and overall efficiencies. Charts for four of the most important of these fuels show the efficiency as a function of the CO_2 content and the flue-gas temperature.

A mixture of one part of coke to two of hard coal yields no difficulties in working; and a mixture of one coke to three of brown-coal briquets is also satisfactory. Thoroughly good mixing is the principal requirement. If coke be used alone, the grate, air supply, and stoking arrangements must all be modified. Using brown-coal briquets instead of hard coal adds about 60 per cent to the grate and 14 per cent to the smoke-

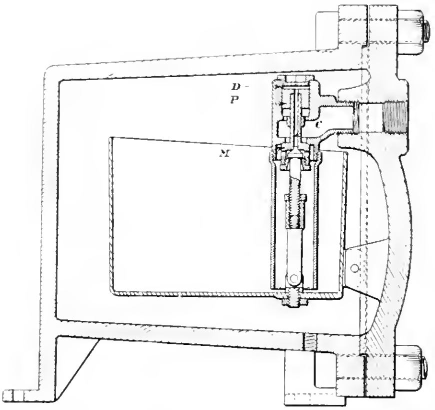


FIG. 16 BUCKET-TYPE STEAM TRAP WITH DOUBLE VALVE SYSTEM

stack duty. A formula is given expressing the cash value of substitutional fuels in terms of heating value. (*Science Abstracts*, Section B—Electrical Engineering, vol. 21, pt. 5 (no. 245), May 31, 1918)

STEAM TRAPS IN NAVAL SERVICE, F. G. Hechler. Description of the various classes of steam traps, with particular reference to their use in naval service.

As regards the capacity of steam traps, the author points out that while it is customary to designate steam traps according to the size of the inlet and outlet pipe connections, this method is not exact. Traps of the same nominal size often have widely different capacities. For instance, with the $1\frac{1}{4}$-in. traps tested at the Naval Engineering Experiment Station, the minimum capacity for any trap at 250 lb. steam pressure was found to be 2300 lb. of water per hour, while the maximum was 26,300 lb., or more than eleven times as much. This latter trap had a compound valve arrangement similar to that of Fig. 16. A capacity rating of a steam trap is of no value unless the pressure at which it was made is also given.

In order to secure satisfactory capacity results from steam traps it is desirable that they should be provided with interchangeable valves and valve seats adapted to various pressures. Also all valves should operate satisfactorily up to pressures somewhat higher than their rated value, which means that a 30-lb. valve should operate up to, say, 40 or 45 lb. for a margin of safety. This also makes it possible to grind in the valves when they become warm and even to rim out the seat. Both these operations are apt to enlarge the seating area of the valve, with the consequent danger of the trap becoming inoperative at the higher pressures.

The valve shown in Fig. 16, which gave such a large water discharge in the test above referred to, is representative of a type exclusively used in the naval service. With this type either a single- or compound-discharge valve may be used, and the latter gives the trap a very large capacity. This trap has the inlet and outlet connections in the cover so that it can readily be dismantled, provided the body is not fastened to the floor. The counterbored-recess type of gasket flange is used, and the best results will be obtained by carefully fitting the male and female ends so that there is only a small clearance.

The desirable features of a satisfactory steam trap for use in the naval service are summarized by the writer as follows:

Strong, rugged construction with properly designed gasket joints which may be kept tight without difficulty.

Inlet and outlet connections in the body of the trap.

The outlet valve located above the bottom of the trap where it is not likely to become clogged.

An accessible inlet strainer.

Powerful valve-operating mechanism so that the outlet valve may be large enough to give the trap ample capacity.

Proper functioning when oscillated.

A gage glass or other device for easily determining whether the trap is operating properly. For this purpose a hand gear for opening the outlet valve is also often convenient.

To secure the best results with traps they should be installed on the ship with the axis fore and aft to minimize the effects of a heavy sea. They should always be connected to the lines with unions, and every trap should be bypassed. (*Journal of the American Society of Naval Engineers*, vol. 30, no. 2, May 1918, pp. 239-254, 8 figs., *dcp*)

Thermodynamics

DEPENDENCE OF THE THOMSON-JOULE EFFECT FOR AIR ON PRESSURE AND TEMPERATURE FOR PRESSURES UP TO 150 ATMOSPHERES AND TEMPERATURES FROM — 55 DEG. TO + 250 DEG. CENT., F. Noell (*Zeits. Vereines Deutsch. Ing.*, 62, pp. 49-54, Feb. 2, and pp. 63-67, Feb. 9, 1918). The temperature change which a gas experiences by expansion without doing external work, i. e., the Thomson and Joule effect, is a phenomenon first observed by Thomson and Joule but only for moderate pressures and a small temperate range. A systematic investigation has been commenced by E. Vogel at the Munich Polytechnic Institute and participated in by the authors, employing much wider limits. All previous work on the subject had been so arranged that passage from a given high pressure to that of the atmosphere was made by a reducing valve whose low-pressure side communicated with the atmosphere. In this way it was not possible to measure the cooling effect at various pressures, and so study its dependence upon pressure and temperature. The innovations to the method now described in the paper provided for the adjustment of pressure differences on both sides of the reducing valve. The apparatus is discussed at great length and diagrammatically illustrated; the temperature measurements were made by means of a platinum resistance thermometer. Following this comes a full description of the experimental procedure accompanied by nine tables of results, the data being obtained at — 34 deg., — 55.4 deg., — 0.6 deg., 49.2 deg., 99.3 deg., 149.7 deg., 199.3 deg. and 249.9 deg. cent., respectively. The interpretation of the results oc-

cupies the second communication to which seven curves are attached.

The experiments have firmly established the dependence upon pressure and temperature of the Thomson-Joule effect for air between the above temperature limits. The general result may be expressed by the formula:

$$\triangle = dT/dp = \frac{A_1 - A_2p}{T} + \frac{B_1 - B_2p}{T^2} + \frac{C_1 - C_2p}{T^3} + D_1 - D_2p$$

where $\triangle$ is the cooling for 1 atmospheric pressure change, T the absolute temperature of the gas at the high-pressure side, p the arithmetic mean of the pressures on the high and low sides, dp the pressure difference, dT the corresponding temperature difference, and A_1, A_2, B_1, B_2, C_1, C_2, D_1, D_2 constants. At all temperatures investigated a linear decline of the cooling effect by the above formula the temperature drop caused by the reducing valve can be calculated for higher initial pressures by integration and has been depicted graphically, whereby it is seen that the proportionality of the cooling with the pressure difference at low temperatures and high pressures is no longer so exact. The results of this investigation agree with those of others. By extrapolation, a portion of the inverse curve has been determined. From the observed cooling effect the specific heat of air, C_p, was calculated for the region of the experiments with confirmation of the values obtained by Scheel and Heuse and by Swann for one atmosphere. (*Science Abstracts*, Section A—Physics, vol. 21, pt. 5 (no. 245), May 31, 1918)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Survey.

Rehearsal of Demobilizing Plan in Britain

Plans for the demobilization of the British fighting forces and the furnishing of civil employment for the men as soon as possible after the war are being worked out by the Government. The system as explained in an official statement is essentially as follows:

First, the men will be provided with substantial refreshment. A brief "fall in" will be called and there is to be a handing in of equipment. All must be given up except the uniform which the soldier is wearing and his greatcoat, the latter to be returned after a month of furlough, to which each man is entitled. A man will be allowed to keep his soldier clothes, with the exception of the greatcoat.

At the receiving huts of the dispersal depot the soldier will be expected to "hand over" all his accouterments. In another department each soldier is given an advance, and at the same time he gets a document, made out to the principal post office of the district to which he is going, enabling him to receive in three equal installments, during the period of his 28 days' furlough, the remainder of the money owing to him either on deferred pay, service gratuities or from any other sources.

On his application the man is presented with an out-of-work insurance policy, which is valid for a year. It is in the form of a document which entitles the holder to receive a fixed sum for a definite period, when unemployed, from a post office. The rate and the period will be fixed "when the time comes."

Finally, the men are grouped into different huts, each of which is occupied by those who are destined for a certain locality, and when the locomotive drags the empty carriages into the railway station, the Tommies enter them and are rapidly carried away to their friends and relations. This is the never-ending procession which will go on morning, noon and night, month after month, when the happy era of peace arrives.

It may be surmised with every degree of certainty, that all men on getting to the dispersal station may not be quite as fit as would warrant them being sent on post haste. That has also been provided for. Medical men will be there, and those who are not quite up to the mark will be detained in the hospital ward until able to travel.

At a camp not far from London there has been a rehearsal of the methods to be adopted to "disperse" the men. Big as was the job to get men into the army, it will be a bigger job to get them out of it, but the country may be sure that everything that can be done will be done to enable the soldiers to reach their homes and get employment with the minimum of friction.

The scheme is far-reaching in its ramifications. It has been carefully thought out by the British authorities, who have not only had to consider the position at home but also how it will fit in with the convenience of our French and Italian allies, with the Dominions overseas, with transport facilities from Salonika, Mesopotamia, and Palestine and from other parts of the world. Ships and railways will obviously play an important part in this huge undertaking; and so far as France is concerned the wharf space at the quays across the Channel will be a desideratum of first importance. It is expected, in fact, to dominate the situation. How long it will take to demobilize our army of millions is a question to which even those occupied in the task are not prepared to give a definite reply.

Eighteen dispersal depots are to be established in England, Scotland and Wales. They will be chiefly in populous districts, from which the majority of the fighting men have been drawn.

When the armies have been got away, the distribution of the soldiers into civil employment is a feature of the demobilization which rests with the Ministry of Labor. Up to the point of dispersal the army authorities will have acted in conjunction with the Labor Ministry and the trade unions. Then to some extent they part company. The basis of the whole scheme is industrial reconstruction and not military convenience. The problem of the Ministry of Labor is to tell us who the men are who are required first, and we have devised a scheme by which any man having his job ready for him will be released early. Those who have no occupations to go to will naturally remain in the army a little longer than those who have. Many may desire to remain with the colors, and with those it may be necessary to garrison India and to take the place of men there who will be anxious to get home.

On the other hand, men in trade and industry will be released with the utmost speed, as well as men needed in the factories and in other occupations which it is urgent shall get into their stride as early as possible.

The work involved in keeping records of what is likely to be the after-the-war conditions of millions has been prodigious. This has been mainly the business of the Ministry of Labor. Communication has been kept with employers, and happily, with few exceptions, there is a fine spirit in existence among them to welcome back the men who have left home to face the dangers of the battlefields and the sea.

No doubt when the demobilization comes about there will be many rough edges in the scheme which will need making smooth, but that can only be done as the result of actual experience. The rehearsals have been very successful and, in the opinion of those best able to judge, give promise of an equally successful realization when the moment of disbandment has been reached. (*Journal of Commerce*, July 1, 1918, p. 2)

Under the title, The Deepest Well in the World and the Next Deepest in America, Dr. Israel C. White, state geologist of West Virginia (Morgantown, W. Va.) has described (1) a well 7386 ft. deep put down by the Hope Natural Gas Co., eight miles from Clarksburg, W. Va., and (2) a well 7248 ft. deep owned by the People's Natural Gas Co., and situated five miles from McDonald, Pa. The paper, which has been printed as an illustrated pamphlet of 22 pages, was presented by Dr. White before the National Gas Association of America last May. The second of the two wells described is said to be the third deepest well in the world. (*Engineering News-Record*, July 18, 1918.)

SELECTED TITLES OF ENGINEERING ARTICLES

AERONAUTICS

AIRPLANE PERFORMANCE DETERMINED BY ENGINE PERFORMANCE, G. B. Upton. The Sibley Journal of Engineering, vol. 32, no. 9, June 1918, pp. 137-142, 3 figs., 3 tables.

AERONAUTICAL PROBLEMS ELUCIDATED BY LESSONS FROM PARADOXICAL WINDWHEELS, Thomas O. Perry. The Michigan Technic, vol. 31, no. 2, May 1918, pp. 80-91, 9 figs.

IL PROBLEMA DEGLI IDROVOLANTI, A. Guidoni. Rivista Marittima, Anno 51, no. 3, March 1918, pp. 191-196, 9 figs. Brief discussion of hydro-aeroplane design.

LATERAL STABILITY OF AN AIRPLANE, Frederick Bedell. The Sibley Journal of Engineering, vol. 32, no. 10, July 1918, pp. 154-156, 11 figs.

THE NEW GIANT GERMAN AEROPLANE. The Engineer, vol. 125, no. 3259, June 14, 1918, p. 512.

WAR AIRPLANES OF TODAY, F. L. Faurote. Automotive Industries, vol. 39, no. 1, July 4, 1918, pp. 14-17, 12 figs. Descriptive paper presented before the summer meeting of the Society of Automotive Engineers in June 1918, at Dayton, Ohio.

THE ENGLISH S. E. V. A. SINGLE-SEATER FIGHTER. Aerial Age Weekly, vol. 7, no. 17, July 1918, pp. 822-825, 7 figs.

AIR MACHINERY

*TEST ON ROTARY BLOWERS AND EXHAUSTERS. The Blast Furnace and Steel Plant, vol. 6, no. 7, July 1918, pp. 298-299, 3 figs.

BLAST FURNACES

PRINCIPAL CHANGES IN BLAST FURNACE LINES, J. G. West, Jr. The Blast Furnace and Steel Plant, vol. 6, no. 7, July 1918, pp. 289-296, 26 figs.

BUILDING CONSTRUCTION

COST OF CONSTRUCTING AND MOVING PORTABLE CAMP BUILDINGS. Engineering & Contracting, vol. 49, no. 25, June 19, 1918, p. 614, 3 figs. Figures for special type of portable buildings, 18x54-ft. sleeping quarters, 18x54-ft. kitchen and dining room, 18x18-ft. commissary and 18x18-ft. office, designed by U. S. Office of Public Roads and Rural Engineering for housing 40 men.

HOW A CHAIN FACTORY WAS BUILT AND THEN OCCUPIED, Charles Lundberg. Iron Age, vol. 101, no. 25, June 20, 1918, pp. 1585-1590, 15 figs. Description of plant of Diamond Chain and Mfg. Co., Indianapolis.

CHAINS

*TESTS OF CAST STEEL ANCHOR CHAINS. The Marine Review, vol. 48, no. 7, July 1918, pp. 294-297, 15 figs., 3 tables.

*HOW CAST STEEL CHAINS ARE MADE, Chester K. Brooks, The Iron Trade Review, vol. 63, no. 1, July 4, 1918, pp. 29-32, 19 figs.

*ELECTRIC CAST-STEEL ANCHOR CHAIN, H. Jasper Cox. The Iron Age, vol. 102, no. 1, July 4, 1918, pp. 25-26.

*SOME EXPERIMENTS WITH CAST STEEL CHAIN, Chester K. Brooks. The Iron Age, vol. 102, no. 1, July 4, 1918, pp. 26-28, 3 figs., 1 table.

CONVENTIONS

CERAMIC CONFERENCE HELD IN PITTSBURGH. The Clay Worker, vol. 69, no. 6, June 1918, pp. 759 and 790.

IRON AND STEEL INSTITUTE, ANNUAL MEETING, MAY 2-3, 1918:
- Defects in Steel Ingots, J. N. Kilby.
- Non-Metallic Inclusions: Their Constitution and Occurrence in Steel, Andrew McCance.
- A Cause of Failure in Boiler Plates, Walter Rosenhain.
- Effect of Mass on Heat Treatment, E. F. Law.
- The Effect of Cold-Work on the Divorce of Pearlite, J. H. Whiteley.
- Effects of Cold-Working on the Elastic Properties of Steel, J. A. Van Den Broek.
- Iron, Carbon and Phosphorus, Dr. J. E. Stead.
- Presidential Address, Eugene Schneider.
- Committee No. 2—For Blast-Furnace Practice.
- Determination of Cobalt and Nickel in Cobalt Steel, W. R. Schoeffler and A. R. Powell.
- Damascene Steel, Col. N. Belaiew.
- Note on Inclusions in Steel and Ferrite Lines, Dr. J. E. Stead.
- Technical Aspects of Establishment of Heavy Steel Industry in India, with Results of Some Researches Connected Therewith, A. McWilliam.
- Blast-Furnace Bears, Dr. J. E. Stead.
- Copper Tuyeres for Blast-Furnaces, A. K. Reese.
- Fuel Economy in Blast-Furnaces, T. C. Hutchinson.
- Jurassic Ironstones of the United Kingdom Economically Considered, F. H. Hatch.
- Importance of Coke Hardness, G. D. Cockrane.

YEARLY MEETING OF THE AMERICAN CONCRETE INSTITUTE. Railway Age, vol. 65, no. 1, July 5, 1918, pp. 17-21, 4 figs.

ELECTRICAL APPLICATIONS

PROTECTING THE PANAMA LOCK VALVES AGAINST ELECTROLYSIS, R. H. Whitehead. Engineering News-Record, vol. 80, no. 26, June 27, 1918, pp. 1219-1221. Describes protective covering applied and wood separators.

ELECTRIC FURNACE FOR FORGING STEEL, Wirt S. Scott. Iron Age, vol. 101, no. 26, June 27, 1918, pp. 1676-1677. Experimental electric forging furnaces of the resistor type leading up to commercially successful units. Silicon carbide as a resistor. From a paper read before the Association of Iron and Steel Electrical Engineers.

POWER-STATION EARTH CONNECTIONS, P. H. Adams, Power, vol. 48, no. 2, July 4, 1918, pp. 40-42, 8 figs. Discussion of proper method of putting down earth connections for electrical equipment and the effect of corrosion in power-plant equipment when the proper attention is not given to maintaining the earth connection at a low resistance.

ENGINEERING MATERIALS

EFFECT OF PHOSPHORUS ON SOFT STEELS, J. S. Unger. Iron Age, vol. 101, no. 24, June 13, 1918, pp. 1538-1540, 3 figs. Results of experiments showing that in soft steels an increase in phosphorus of 0.01 per cent is equivalent to an increase in tensile strength of about 850 lb. per sq. in. From a paper read before the American Iron and Steel Institute, May 1918.

*STEELS FOR GEARS AND THEIR TREATMENT, Geo. A. Richardson. The Iron Age, vol. 101, no. 26, June 27, 1918, pp. 1668-1670, 2 figs.

CONCESSIONS MADE IN STEEL STANDARDS. The Iron Trade Review, vol. 63, no. 1, July 4, 1918, pp. 33-35.

A SUMMARY OF IRON AND STEEL PROCESSES. The Blast Furnace and Steel Plant, vol. 6, no. 7, July 1918, pp. 296-297.

PERMISSIBLE STRESSES IN STEEL, Ewart S. Andrews. The Engineering Review, vol. 31, no. 7, January 15, 1918, pp. 199-201, 4 figs.

MALLEABLE CAST IRON, Prof. T. Turner. The Journal of the West of Scotland Iron and Steel Institute, vol. 25, no. 6, March 1918, pp. 285-302, 17 figs.

FOUNDRY

WESTINGHOUSE PLANT AT SOUTH BETHLEHEM. The Iron Age, vol. 102, no. 1, July 4, 1918, pp. 22-24, 5 figs. A description of the interesting features of equipment of foundry and forging machine and erection shops.

FUELS AND FIRING

PITCH AS A FUEL FOR POWER GENERATION, John B. C. Kershaw. Power, vol. 47, no. 26, June 25, 1918, pp. 904-906. A summary of the most recent patents and experiments relating to the use of coal-tar pitch as a fuel for steam boilers and for internal-combustion engines.

ECONOMIC HANDLING OF ASHES, Reginald Trautschold. Industrial Management, vol. 56, no. 1, July 1918, pp. 17-20.

REPORT OF COMMITTEE ON FUEL ECONOMY AND SMOKE PREVENTION. Railway Age, vol. 64, no. 25, June 21, 1918, pp. 1516-1519, 1 fig.

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* Abstracted in the Engineering Survey in this issue.

FURNACES

BY-PRODUCT COKE OVEN PRESSURE REGULATION, Charles H. Smoot. The Blast Furnace and Steel Plant, vol. 6, no. 7, July 1918, pp. 306-310, 2 figs. First of a series of articles dealing with the subject by by-product coke-oven pressure regulation. The general theory of regulation is discussed.

HOISTING MACHINERY

A LARGE ELECTRIC CRANE, H. Y. Stukey. American Machinist, vol. 49, no. 2, July 11, pp. 71-72, 3 figs. Description of an electric traveling crane with total lifting capacity of 431 net tons.

FEDERAL SHIPS ERECTED BY DERRICK TRAVELERS BUILT FOR LONG SERVICE. Engineering News-Record, vol. 80, no. 24, June 13, 1918, pp. 1129-1132, 6 figs. Problem studied on basis of bridge-erection experience; derricks of pillar-crane type; low stresses and special bearings for reliability; gantry truck details from shop-traveler practice.

OPERATION AND MAINTENANCE OF ELEVATORS—GEARED TRACTION MACHINES, R. H. Whitehead. Power, vol. 47, no. 26, June 25, 1918, pp. 900-903, 8 figs. Construction and operation of three geared types of traction-elevator machines discussed.

INTERNAL-COMBUSTION ENGINEERING

TWO ESSENTIAL CONDITIONS FOR BURNING TAR-OIL IN DIESEL ENGINES, P. H. Smith. Page's Engineering Weekly, vol. 32, no. 716, May 31, 1918, pp. 256-257. Paper read before the Diesel Users' Association (British). The conditions of which the writer speaks are atomization and turbulence. The sleeve pulverizer system is discussed in particular.

SOME NOTES ON THE OPERATION OF GAS AND OIL ENGINES, PART 2, WATER COOLING, Jas. G. Walthew. Gas and Oil Power, vol. 13, no. 153, June 6, 1918, pp. 125-126, 2 figs, 1 chart.

DETAILS OF HIGH-SPEED INTERNAL COMBUSTION ENGINES, Harry R. Ricardo. Engineering, vol. 105, no. 2735, May 31, 1918, pp. 620-623, figs. 8-28. Continuation of paper read on April 30 before the Northeast Coast Institution of Engineers and Shipbuilders at Newcastle-upon-Tyne. Subjects discussed in this issue: volumetric efficiency of engine; design of pistons; a comparison of wear and tear on slow and high-speed engines. Profusely illustrated with drawings and curves.

***EFFECT OF CIRCULATING WATER TEMPERATURES ON THE LUBRICATING OIL USED IN INTERNAL-COMBUSTION ENGINES.** Lubrication, vol. 5, no. 8, June 1918, pp. 11-14, 1 fig.

TWO-STROKE ENGINES, George Funck. The Automobile Engineer, vol. 8, no. 115, June 1918, pp. 154-158, figs. 8-13. Second installment serial on theory and design of two-stroke-cycle engines.

THE POSSIBILITIES OF THE HVID ENGINE, E. B. Blakely. Gas Engine, vol. 20, no. 7, July 1918, pp. 341-347, 9 figs. Description of the four-cycle Hvid-type motor using kerosene and heavier oils with ignition by heat of compression, with results of tests made on a 5¾ x 9-in. engine. Paper read before the National Gas Engine Association, June 1918.

CONSERVATION OF MOTOR FUEL AS AFFECTED BY LUBRICATING OIL, S. F. Lentz. Gas Engine, vol. 20, no. 7, July 1918, pp. 327-333. Results of experiments showing change of physical state of oil during use in motors. Abstract of paper read before the National Gas Engine Association, June 1918.

THE SEMI-DIESEL OIL ENGINE, L. H. Morrison. Power, vol. 48, no. 2, July 9, 1918, pp. 47-49, 7 figs. Points out a difference between semi-Diesel and low-compression oil engines and discusses some types of the former.

LABOR

TRAINING SHIPYARD WORKERS BY EMERGENCY FLEET CORPORATION METHODS, R. V. Rickford. International Marine Engineering, vol. 23, no. 6, June 1918, pp. 325-328, 4 figs.

PIECE WORK SYSTEM IN RAILWAY SHOPS, W. J. McClennan. Railway Mechanical Engineer, vol. 92, no. 7, July 1918, pp. 411-416, 5 figs. A discussion of the organization of the methods for determining proper prices, and of the forms used.

THE LABOR PROBLEM OF A GREAT FRENCH SHELL FACTORY, Robert K. Tomlin, Jr. American Machinist, vol. 49, no. 1, July 4, 1918, pp. 22-24, 8 figs.

A SYSTEM OF LABOR COMPENSATION, M. K. Smogorjevsky. Railway Mechanical Engineer, vol. 92, no. 6, June 1918, pp. 325-329, 2 figs. A combination of the Taylor, piece-work and Prusso-Hessian methods developed in a Russian railway shop.

LOT COST SYSTEM IN MAKING WINCHESTER GUNS, W. E. Freeland. Iron Age, vol. 102, no. 1, July 4, 1918, pp. 8-10, 4 figs. Bonus payments to machine adjusters and instructors a feature of the production system; some of the cost forms used.

AMERICANIZATION A PROBLEM IN HUMAN ENGINEERING, Henry D. Hammond. Engineering News-Record, vol. 80, no. 24, June 13, 1918, pp. 1116-1119.

THE FUTURE OF THE APPRENTICE, C. C. Hermann. Machinery, vol. 24, no. 10, June 1918, p. 889. Results of present training methods and suggestions for an improved course.

LUBRICATION

THE LUBRICATION OF MACHINE SHOP EQUIPMENT. Lubrication, vol. 5, no. 8, June 1918, pp. 2 5. A general discussion of the subject presented by the Lubricating Engineering Association with the main purpose of showing how proper lubrication may help to eliminate noise and to prolong the life of machines and tools.

WASTE OIL TROUBLES, W. A. Taller. National Engineer, vol. 22, no. 7, July 1918, pp. 296-298, 1 fig.

MARINE ENGINEERING

WELDING SHIP'S PARTS TOGETHER, James G. Dudley. International Marine Engineering, vol. 23, no. 6, pp. 359-360, 4 figs. An account of the development of the electric welding of ships by the Emergency Fleet Corporation.

FERRO-CONCRETE SHIPS, T. J. Gueritte. International Marine Engineering, vol. 23, no. 6, pp. 329-334. Discussion of materials and systems of construction; plastered and molded ships; weight, cost and durability. Paper read before the North East Coast Institution of Engineers and Shipbuilders, Newcastle-upon-Tyne, March 1918.

GOVERNMENT DESIGNS AND BUILDS 3500-TON CONCRETE SHIPS. Engineering News-Record, vol. 81, no. 1, July 4, 1918, pp. 17-21, 7 figs. Shape and size of vessels under construction follow standard wooden ships of same tonnage. Usual concrete details adapted to sea-going ships.

DESIGN STEEL SHIPS FOR MAXIMUM EFFICIENCY OF BRIDGE-SHOP FABRICATION. Engineering News-Record, vol. 81, no. 1, July 4, 1918, pp. 5-12, 13 figs. Description of the fabricated-ship construction at the Hog Island plant and some of the features of construction.

MACHINE PARTS

INGENIOUS MECHANICAL MOVEMENTS, Franklin D. Jones. Machinery, vol. 24, no. 10, June 1918, pp. 902-908, 10 figs. Second of a series of articles on mechanism.

BEARINGS FOR MACHINE SHOP EQUIPMENT, Edward K. Hammond. Machinery, vol. 24, no. 11, July 1918, pp. 975-987, 21 figs. First of a series of articles. Deals with various forms of plain bearings which have demonstrated their ability to give satisfaction in service.

MACHINE SHOP

***DROP FORGING PROBLEMS DISCUSSED.** The Iron Age, vol. 101, no. 26, June 27, 1918, pp. 1650-1654.

GRINDING AND LAPPING THREADS, J. E. Lindgren. Machinery, vol. 24, no. 11, July 1918, pp. 1023-1024, 5 figs. Attachments, fixtures and laps used for producing accurate threads.

MANUFACTURING WRIGHT ROLLER BEARINGS. Machinery, vol. 24, no. 11, July 1918, pp. 1019-1021, 9 figs. Description of the processes involved in machining parts, heat-treating, assembling and inspecting.

OPERATING THE GRIDLEY AUTOMATIC TURRET LATHE—1, Douglas T. Hamilton. Machinery, vol. 24, no. 10, June 1918, pp. 926-931, 16 figs. Complete instructions for tooling, setting up, and operating. 2, July 1918, pp. 1016-1018, 4 figs. Examples of camming and setting tools.

Manufacturing Operations on Jewelry Settings, J. V. Hunter. American Machinist, vol. 49, no. 2, July 11, 1918, pp. 47-52, 13 figs.

Manufacturing the Curtiss Airplane Cylinder, II. The Water Jacket, G. A. Ranger. American Machinist, vol. 49, no. 2, July 11, 1918, pp. 62-65, 15 figs. Describes preparation of the Monel metal jacket and the brazing operations.

Work in a Texas Repair Shop, Frank A. Stanley. American Machinist, vol. 49, no. 2, July 11, 1918, pp. 53-56, 13 figs. Description of a varied line of work in the blacksmith shop and structural department of a large smelter; bending, forming and welding operations; some special tools.

Design and Construction of Work-Benches, Frank H. Mayoh. Machinery, vol. 24, no. 10, June 1918, pp. 880-886, 24 figs. Bench legs and tops; location of benches; portable work benches.

Metallic Electrode Arc Welds, O. S. Eschholz. Railway Mechanical Engineer, vol. 92, no. 7, July 1918, pp. 416-419, 7 figs. Suggestions for determining the quality of the joint; proper methods which will secure good results.

Fusion Welding Fallacies—1, S. W. Miller. Machinery, vol. 24, no. 11, July 1918, pp. 1014-1015, 5 figs. Some common beliefs and why they are unsound.

Arc Welding of Mild Steel, O. H. Eschholz. The Electric Journal, vol. 15, no. 7, July 1918, pp. 247-250, 13 figs.

*Effect of Mass on Heat Treatment, E. F. Law. Engineering, vol. 105, no. 2736, June 7, 1918, pp. 647-650, 17 figs.

Bluing Steel, W. B. Greenleaf. Machinery, vol. 24, no. 11, July 1918, pp. 997-998, 2 figs. Materials, arrangements and methods used on light sheet-steel work.

Heat Treatment of Axles, Dwight D. Miller. Railway Mechanical Engineer, vol. 92, no. 7, July 1918, pp. 419-421, 3 figs. The scientific heat treatment of locomotive and car axles made possible by use of electric furnace.

MACHINE TOOLS

A New Nut Making Machine. The Engineer, vol. 125, no. 3259, June 14, 1918, pp. 510-511, 3 figs.

*Designs High-Cutting Speed Planer. The Iron Trade Review, vol. 63, no. 1, July 4, 1918, pp. 22-23, 1 fig.

Intensive Production on Drilling Machines—1, Edward K. Hamilton. Machinery, vol. 24, no. 10, June 1918, pp. 914-921, 5 figs. Organization of the drilling department and use of special equipment on machine to adapt them for a wide range of work.
2, July 1918, pp. 1030-1034, 12 figs. Design of cutting tools and work-holding fixtures for handling turned lathe work on drilling machines.

The Inspection of Machine Tools, Ethan Viall. American Machinist, vol. 49, no. 1, July 4, 1918, pp. 13-17, 15 figs. Description of testing methods used in some well-known machine-tool-building shops.

War-Time Repairs in the Navy—III, General Repair Work, Frank Stanley. American Machinist, vol. 48, no. 26, June 27, 1918, pp. 1091-1094, 10 figs. The making of small and medium-sized parts. Overhauling machine tools for ships.

Results of Faulty Tool Designing, F. B. Jacobs. Machinery, vol. 24, no. 11, July 1918, pp. 1028-1029, 9 figs. Examples of tools and fixtures that did not work, with reasons for failures.

The Wilt Process of Twist Drill Manufacture, Franklin D. Jones. Machinery, vol. 24, no. 11, July 1918, pp. 1007-1013, 11 figs. A process in which all machining operations on twist drills, except grinding, are done automatically.

Supports for Milling Machine Arbors, Luther D. Burlingame. Machinery, vol. 24, no. 11, July 1918, pp. 992-996, 18 figs. Historical review showing early designs with the development of types now used.

MEASURING APPARATUS AND METHODS

Example of Precision Gage Making. Machinery, vol. 24, no. 10, June 1918, pp. 878-879, 5 figs. Methods of making and testing a gage requiring unusual accuracy.

Universal Milling Machine Dynamometer, R. Poliakoff. Machinery, vol. 24, no. 10, June 1918, p. 932, 4 figs. Describes a dynamometer designed for measuring the pressure that a milling-machine cutter exerts on the work and on the various parts of the milling machine through the work.

Indicator Gages Used in Gasoline-Engine Construction, C. C. Marsh. Machinery, vol. 24, no. 10, June 1918, pp. 910-913, 5 figs. Gages for inspecting cylinder depth, length, external diameter, cam lift, profile and eccentricity.

Contour- and Radius-Measuring Instrument. Machinery, vol. 24, no. 10, June 1918, pp. 898-899, 5 figs. Universal type of instrument for measuring irregular profiles, radius gages and contours that cannot be tested by ordinary measuring devices.

Distantiagraph, W. D. Farris. Proceedings of the U. S. Naval Institute, vol. 44, no. 181, March 1918, pp. 557-559, 3 figs. Describes an instrument designed to determine the actual distance a ship must pass over a light or point.

Gages and Thermometers, John E. Starr. Refrigerating World, vol. 53, no. 6, June 1918, pp. 11-12.

Viscosity Determinations in Absolute Units. Engineering, vol. 105, no. 2737, June 14, 1918, pp. 655.

MECHANICS

Non-Molecular Structure of Solids, Arthur H. Compton. Journal of The Franklin Institute, vol. 185, no. 6, June 1918, pp. 745-774, 15 figs.

Approximate Live-Load Stresses in Railway Bridges, H. R. White. Engineering News-Record, vol. 80, no. 24, June 13, 1918, pp. 1137-1138, 2 figs. Linear formula for floor-beam concentration giving shears and moments easily.

Designing Wall Beams in Concrete Flat-Slab Buildings, Albert M. Wolf. Engineering News-Record, vol. 80, no. 24, June 13, 1918, pp. 1124-1126, 3 figs.

Equivalent Uniform Loads for Concrete Beams, Albert J. Becker. Engineering & Contracting, vol. 49, no. 26, June 26, 1918, pp. 633-635, 3 figs. Method of calculating special beams with partial or non-uniform loads.

Formulas for Calculating Thickness and Reinforcement for Concrete Conduit, L. Robert de la Mahotiere. Engineering & Contracting, vol. 49, no. 24, June 12, 1918, pp. 591-593, 4 figs. A translation from Le Génie Civil. Based on assumption of empty conduit supporting a uniform load on upper half; thickness of conduit constant.

MILITARY ENGINEERING

Condotta e Osservazione del Tiro Terrestre, Giuseppe Fioravanzo. Rivista Marittima, Anno 51, no. 3, March 1918, pp. 173-190, 11 figs. An extensive mathematical article on land artillery fire.

MUNITIONS

Routing and Handling Shells, James Forrest. Machinery, vol. 24, no. 10, June 1918, pp. 922-925, 8 figs. General production methods and short cuts on larger shells.

The Manufacture of the Lewis Machine Gun, X. The Bolt and Feed Operating Stud—I, Frank A. Stanley. American Machinist, vol. 49, no. 1, July 4, 1918, pp. 25-29, 9 figs. Description of the machining operations.

Forging the U. S. 75-Millimeter Shell, Erik Oberg. Machinery, vol. 24, no. 10, June 1918, pp. 890-897, 20 figs. Fourth of a series of articles describing approved methods employed in the forging and machining of the U. S. 75-mm. shell.

By-Product Coke Industry in War Time, William H. Blauvelt. The Iron Age, vol. 101, no. 24, June 13, 1918, pp. 1544-1545. Importance of the by-product method in coal conservation; furnishing raw materials for high explosives; keystone products, bases of important industries. From paper read before the American Iron and Steel Institute, May 1918.

Sidelights on Winchester Gun Production, W. E. Freeland. The Iron Age, vol. 101, no. 24, June 13, 1918, pp. 1521-1526, 9 figs. Control of tools and gages; foremen held responsible for inspection; time-study methods and satisfactory results.

POWER-PLANT ENGINEERING

ESTIMATING POWER REQUIREMENTS OF A LOCALITY, Ludwig W. Schmidt. Power, vol. 48, no. 2, July 9, 1918, pp. 55-56.

PUMPS

A LOG BOOK FOR AN ELECTRICALLY DRIVEN PUMPING UNIT AT NEW BEDFORD, R. C. P. Coggeshall. Journal of the New England Water Works Association, vol. 32, no. 2, June 1918, pp. 173-179, 1 fig., 1 chart.

WATER-WORKS PUMP WITH HIGH EFFICIENCIES. Power, vol. 48, no. 1, July 2, 1918, p. 16, 1 fig. Results of efficiency tests of two 12-in. motor-driven centrifugal pumps.

RAILROAD ENGINEERING

STANDARDIZATION OF INDIAN RAILWAYS' LOCOMOTIVES, E. C. Poultney. Railway Age, vol. 64, no. 24, June 14, 1918, pp. 1425-1430, 9 figs., 3 tables.

*TESTS WITH 2-10-2 LOCOMOTIVE ON THE UNION PACIFIC. Railway Age, vol. 64, no. 26, June 28, 1918, pp. 1573-1574, 3 figs.

DESIGN AND MAINTENANCE OF LOCOMOTIVE BOILERS. Railway Age, vol. 64, no. 25, June 21, 1918, pp. 1522-1523.

SEMI-ELLIPTIC SPRINGS—MANUFACTURE AND REPAIR. Railway Age, vol. 64, no. 25, June 21, 1918, pp. 1528-1531, 10 figs.

*SMALL LOCOMOTIVES OF SPECIAL TYPES. The Engineer, vol. 125, no. 3239, June 14, 1918, pp. 507-510, figs. 19-26.

FEED WATER HEATERS, J. Snowden Bell. Railway Review, vol. 63, no. 1, July 6, 1918, pp. 14-16, 3 figs.

NORFOLK & WESTERN 267-TON MALLET LOCOMOTIVE, H. W. Reynolds. Railway Age, vol. 65, no. 2, July 12, 1918, pp. 59-63. Details of design of a 2-8-8-2 Mallet locomotive and tender built at the Norfolk & Western Shops, Roanoke, Va.

LOCAL STRESSES IN BOX BOLSTERS, L. E. Endsley. Railway Mechanical Engineer, vol. 92, no. 6, June 1918, pp. 343-348, 15 figs. Tests of loaded bolsters with Berry strain gage showing effect on strength of design details. Abstract of paper read before St. Louis Railway Club, May 1918.

THE RAILWAY SHOP TOOL ROOM, M. H. Williams. Railway Mechanical Engineer, vol. 92, no. 6, June 1918, pp. 335-340, 7 figs. The importance of the tool room and its equipment.

DRAFTING MODERN LOCOMOTIVES, H. W. Coddington. Railway Mechanical Engineer, vol. 92, no. 6, June 1918, pp. 331-333, 3 figs.; no. 7, July 1918, pp. 387-392, 10 figs. Improvements effected by a study of draft conditions on Norfolk & Western 4-8-2 type engines.

THE LIGHT RAILWAY ALONG THE BRITISH FRONT AT CLOSE RANGE, Robert K. Tomlin, Jr. Engineering News-Record, vol. 80, no. 25, June 20, 1918, pp. 1162-1169, 15 figs. Where and how lines are built; how maintained and how operated; what they have accomplished.

A WELL-ORGANIZED REPAIR SHOP. Railway Mechanical Engineer, vol. 92, no. 6, June 1918, pp 303-311, 15 figs. A study of methods followed in repairing locomotives on the New York Central at West Albany.

RECLAMATION ON THE SOUTHERN PACIFIC, Frank A. Stanley. Railway Mechanical Engineer, vol. 92, no. 7, July 1918, pp. 381-386, 12 figs. First installment. Describes the extensive salvage work done in the road's Sacramento shop.

DOINGS OF THE UNITED STATES RAILROAD ADMINISTRATION. Railway Age, vol. 65, no. 2, July 12, 1918, pp. 48-57. Action of freight classification, valuation, mileage, etc.

REFRIGERATION

*COLD ACCUMULATORS AND THEIR APPLICATION, Ernest S. H. Barrs. Power, vol. 48, no. 1, July 2, 1918, pp. 31-33, 2 figs.

STEEL FRAME REFRIGERATOR CARS, E. G. Goodwin. Railway Mechanical Engineer, vol. 92, no. 7, July 1918, pp. 401-405, 10 figs. Description of Norfolk & Western design with bunched insulation, insulated bulkheads and conduit floor racks.

STEAM ENGINEERING

INTERPRETING STEAM-TURBINE TEST CURVES, H. E. Brelsford. Power, vol. 47, no. 25, June 18, 1918, pp. 866-868, 5 figs. Brief description of standard turbine test curves and how they are derived and used in interpreting turbine characteristics.

*EFFECT OF FEED-WATER TEMPERATURE AND RATE OF INJECTION UPON STEAM FLOW, Frank G. Philo. Power, vol. 47, no. 26, June 25, 1918, pp. 915-916, 1 fig., 1 table.

IMPROVING PLANT CONDITIONS, A. W. Blom. Power, vol. 48, no. 1, July 2, 1918, pp. 11-12, 4 figs. How changes were made to prevent air from leaking past the end of chain-grate stokers. Description of a feed-water heater working on the jet-condenser principle.

REMODELING THE ST. LOUIS BADEN STATION, K. Toensfeldt. Power, vol. 47, no. 25, June 18, 1918, pp. 862-865, 4 figs. Remodeling a station of 3300 boiler horsepower at a total investment cost of \$177,500 for an estimated annual saving of \$11,797.

TABLE OF B.T.U.'S PER BOILER HORSEPOWER AT VARIOUS EFFICIENCIES, Charles H. Bromley. Power, vol. 48, no. 2, July 9, 1918, p. 46.

SOME CAUSES OF BOILER-TUBE FAILURES, R. Cederblom. Power, vol. 48, no. 2, July 9, 1918, pp. 43-46, 4 figs. Theory advanced that failure of tubes through blistering is due to steam formation in the tube preventing the water from sweeping the tube surface and keeping it cool. How to minimize the trouble; influence of baffling on steam generated per square foot of tube.

CAUSES OF VACUUM TROUBLE, L. F. Forseille. Power, vol. 47, no. 26, June 25, 1918, p. 909, 1 fig. An analysis of trouble experienced in the maintenance of a normal vacuum on a 10,000-kva. turbine unit equipped with a jet type of condenser.

MAIN AND AUXILIARY STEAM PIPING, Ralph W. Propert. The Journal of the American Society of Marine Draftsmen, vol. 5, no. 1, April 1918, pp. 9-11.

SOOT BLOWERS FOR HORIZONTAL WATER-TUBE BOILERS. Power, vol. 48, no. 1, July 2, 1918, pp. 2-7, 19 figs. An extensive discussion of the subject of soot blowers with special reference to the different types of mechanical blowers on the market and their application to the various boilers in use.

GASKETS FOR STEAM-PIPE LINES, Zeno Schultes. Power, vol. 48, no. 1, July 2, 1918, pp. 8-10, 4 figs. General discussion of the subject of packing for steam pipe lines. The author claims that flanged pipe joints are particularly apt to leak and explains it by the presence of rough flange faces, large bolt holes and holes spaced too far apart.

VARIA

AMERICAN CHEMISTS' DEFENSIVE MEASURES AGAINST GAS ATTACKS IN FRANCE, Robert K. Tomlin, Jr. Metallurgical and Chemical Engineering, vol. 18, no. 12, June 15, 1918, pp. 636-639, 3 figs.

HANDLING MATERIALS AT HOG ISLAND, H. Cole Estep. The Marine Review, vol. 48, no. 7, July 1918, pp. 277-279, 313, 4 figs.

EVOLUTIONARY BUSINESS PRINCIPLES, L. P. Alford. Industrial Management, vol. 56, no. 1, July 1918, pp. 8-9.

VESTIBULE SCHOOLS FOR THE UNSKILLED, H. E. Miles. Industrial Management, vol. 56, no. 1, July 1918, pp. 10-12.

BOXING MACHINERY TO PREVENT DAMAGE, Luther D. Burlingame. Industrial Management, vol. 56, no. 1, July 1918, pp. 27-33, 18 figs.

TANKS FOR WATER SUPPLY, Charles L. Hubbard, National Engineer, vol. 22, no. 7, July 1918, pp. 288-295, 18 figs., 1 table.

ARMY LEAD IN WASTE PREVENTION AND UTILIZATION. Engineering News-Record, vol. 81, no. 1, July 4, 1918, pp. 25-26, 1 table.

L'INDUSTRIE DU CHAPEAU DE PAILLE EN LORRAINE. Société Industrielle de l' Est, Bulletin no. 138, May 1918, pp. 4-12. The straw-hat industry in Lorraine.

YOUNGSTOWN SHEET AND TUBE TANDEM PLATE MILL. The Iron Age, vol. 101, no. 26, June 27, 1918, pp. 1660-1663, 6 figs. Description of continuous slab-heating furnaces and new type of plate turnovers. Capacity, 15,000 tons per month.

INTERMEDIATE RATE FINE-SAND WATER FILTER OPERATES UNDER VACUUM. Engineering News-Record, vol. 80, no. 26, June 27, 1918, pp. 1230-1232, 4 figs. Silty water after a 75-mile journey through

irrigating [illegible] is clarified without chemical treatment to the extent of 3 million gallons daily.

Engineering Education as Applied to Naval Architecture and Marine Engineering, H. A. Everett. International Marine Engineering, vol. 23, no. 6, June 1918, pp. 337-342. From an address before the Delaware River Branch of the American Society of Marine Draftsmen, Feb. 1918.

Training Engineer Officers for the Army at Camp Lee, Frank C. Wight. Engineering News-Record, vol. 81, no. 1, July 4, 1918, pp. 12-15, 10 figs.

Compulsory Cooperation of Central Station and Isolated Plant, S. R. Sague. Power, vol. 47, no. 25, June 18, 1918, pp. 870-872. Correspondence with city officials of Cleveland, O., the Fuel Administration and others concerning the advisability of enforced coöperation of public-service and privately owned plants, so as to avoid duplication of distribution systems and prevent waste of coal.

Early Attempts at Submarine Building, H. H. Manchester. American Machinist, vol. 48, no. 26, June 27, 1918, pp. 1081-1085, 10 figs. Attempts by former generations to devise submarine boats dating from 390-1800 A. D.

The Laws Guarding Machinery, Chesla C. Sherlock. American Machinist, vol. 49, no. 2, July 11, 1918, pp. 76-78.

The Lyons Fair. American Machinist, vol. 49, no. 2, July 11, 1918, pp. 68-70, 2 figs. Delayed correspondence dealing with the annual industrial exposition at Lyons, France.

War as a Test of Efficiency, Edward H. Hurley. American Machinist, vol. 49, no. 1, July 4, 1918, pp. 11-12.

Changes in American Machine-Tool Exports, L. W. Schmidt. American Machinist, vol. 49, no. 1, July 4, 1918, pp. 9-11. Changes in the industrial condition of our allies which must be taken into account in planning after-war business.

Factory Moving, L. J. Hengesbach. Machinery, vol. 24, no. 11, July 1918, pp. 999-1002, 5 figs. Methods of efficiently solving the problems arising when moving machinery into a new factory.

Training Women for the Drawing Room, Howard W. Dunbar and W. E. Freeland. The Iron Age, vol. 102, no. 1, July 4, 1918, pp. 1-5, 2 figs. Description of the successful teaching system employed by the Norton Grinding Co., and of the results secured.

LIBRARY NOTES AND BOOK REVIEWS

Articles of interest from the Library of the four Founder Societies, selected list of accessions during the month, and reviews of books of special importance prepared by members of the A.S.M.E. and others particularly qualified.

BOOK NOTES

American Lubricants. From the Standpoint of the Consumer. By L. B. Lockhart. The Chemical Publishing Co., Easton, Pa., 1918. Cloth, 6x9 in., 236 pp., 13 illus., 44 tables. $2.

The purpose of this book is to aid the user of lubricants in the intelligent selection of oils and greases by giving facts and figures of value and excluding all irrelevant matters.

American Railway Accounting. A Commentary by Henry C. Adams. Henry Holt & Co., New York, 1918. Cloth, 5x8 in., 465 pp. $3.

Discusses the standard system of railway accounts promulgated for and used by American railways and is intended to explain the accepted rules to students of accounting and practical accountants.

Automobile Construction and Repair. A Practical Guide to the Design, Construction, and Repair of Automobile Mechanisms. By Morris A. Hall. American Technical Society, Chicago, 1918. Flexible leather, 711 pp., 6x8 in., 568 illus., 4 pl., 4 tables. $2.50.

Intended for mechanics engaged in automobile construction and repair. Describes the construction of the standard types of transmission, clutches, valves, etc., and gives methods for repairing the troubles that occur in operation.

Train Operation. A Treatise on Train Rules, Train Orders, Change of Time Table, Automatic Block Signals, Interlocking, Examination Questions and Answers. By William Nichols. Le Grand Brown, Rochester, N. Y., 1916. Flexible leather, 340 pp., 55 pl., $2.50. (flexible cloth $2.)

An interpretation and amplification of the Rulings of the American Railway Association issued prior to November, 1915, and of the Standard Train Rules and other practices which have been found necessary in handling trains. Based on the author's experience as chairman of the Board of Examiners, Southern Pacific Co., but does not apply to any particular railroad.

The Fighting Engineers. The Minute Men of Our Industrial Army. By Francis A. Collins. The Century Co., New York, 1918. Cloth, 5x8 in., 220 pp., 31 pl. $1.30.

A popular account of the work of the American engineering regiments in France and America.

The Financing of Public Service Corporations. By Milton B. Ignatius. The Ronald Press Company, New York, 1918. Cloth, 6x9 in., 508 pp. $5.

This volume presents a comprehensive discussion of all the important aspects of public-service-corporation financing from the inception of the enterprise to the expenditure of the proceeds. Intended for corporation officials, public officers, bankers and brokers. Based on the work of the Public Service Commission of the Second District of New York.

Heating and Ventilation. By John R. Allen and J. H. Walker. First edition. McGraw-Hill Book Company, Inc., New York, 1918. Cloth, 6x9 in., 305 pp., 174 illus., 76 tables. $3.

Intended for use as a textbook in schools of engineering and architecture, and as a handbook by practising engineers.

Hiring the Worker. By Roy Willmarth Kelly. The Engineering Magazine Co., New York, 1918. Cloth, 6x9 in., 245 pp., 8 pl., 66 forms, 5 charts, 2 folded, 2 tables. $2.

A summary of the efforts of many firms to solve the problems of employment. Describes the theories and policies which have been tested, suggests the possibilities of employment management and attempts to point out the profitable avenues of advancement.

A History of Chemistry. By F. J. Moore. McGraw-Hill Book Co., Inc., New York, 1918. Cloth, 6x8 in., 292 pp., 6 illus., 12 pl., 37 por., 8 diag., 5 tables. $2.50.

This volume is based on a course of lectures given to the senior students of chemistry in the Massachusetts Institute of Technology and is intended to provide a concise account of those facts and influences which have made the science what it is today. Suitable for mature students.

An Introduction to the Chemistry of Plant Products. By Paul Haas and T. G. Hill. Second edition. Longmans, Green and Co., New York, 1917. Cloth, 6x9 in., 411 pp., 5 illus. $3.50.

This work is an attempt to provide botanists with an account of the chemical and biological significance of the more important substances occurring in plants. The present edition has been revised as a whole and the section on plant pigments has been rewritten.

Modern Inorganic Chemistry. By J. W. Mellor. New edition. Longmans, Green and Co., New York, 1917. Cloth, 6x8 in., 910 pp., 334 illus., 64 tables. $2.50.

A general course in chemistry intended to develop skill in observation and experiment, memory and knowledge of relevant facts, ability to reason and think in a logical, systematic way, to cultivate the imagination and to develop a critical and impartial judgment.

Modern Locomotive Valve and Valve Gears. By Charles L. McShane. Griffin & Winters, Chicago, 1918. Cloth, 5x8 in., 339 pp., 113 illus., 1 folded pl. $2.50.

A practical discussion of the principles, construction and operation of the valves and valve gears of modern locomotives. Written in simple, non-mathematical language.

Northwest Mines Handbook. A Reference Work of the Mining Industry of Idaho, Washington, British Columbia, Western Montana and Oregon. By Sidney Norman. Vol. 1. Published by author, Spokane, 1918. Cloth, 6x10 in., 366 pp. (advertising pages included), 28 illus., 9 por., 2 maps, 1 folded, 13 tables. $5.

Covers the mining enterprises which surround Spokane. Contains general descriptive articles on mining and geology of each state, statistics of production, gives lists of the mines and mining corporations, showing capital stock, property and development.

Over the Drawing Board. A Draftsmen's Hand Book. By Ben J. Lubschez. Journal of the American Institute of Architects, Washington, 1918. Cloth, 5x7 in., 131 pp., 22 illus., 9 pl. $2.

Contents: Introductory, Drafting Room, Equipment, Instruments, Mounting of Paper and Drawings, Tracing Paper and Tracing Cloth, Geometrical Short-cuts, Lettering, Titling, Numbering, Working Drawings, Indications, Lines, Sketches, Exhibition Drawings, Water Colors, Perspective, Filing of Drawings and Plates, Photography, the Reproductive Processes, Photo-Engraving, Etching, Wood Engraving, Lithography.

From his experience and observation, the author has selected convenient methods and short-cuts for draftsmen.

Popular Oil Geology. By Victor Ziegler. C. H. Merrifield, Golden, Col., 1918. Flexible cloth, 5x7 in., 149 pp., 62 illus., 1 pl. $2.50.

An exposition of the fundamental principles of oil geology, intended for men without technical training who are interested in the subject.

Regulation of Railways. Including a Discussion of Government Ownership Versus Government Control. By Samuel O. Dunn. D. Appleton and Co., New York, 1918. Cloth, 5x8 in., 354 pp., 5 tab. $1.75.

Contents: What is the Matter with Railway Regulation? Functions of Government in Relation to Railways, Commission versus Legislative Regulation, Federal versus State Regulation, Regulation of Rates, Valuation in Relation to Regulation of Rates and Securities, Regulation of Securities, Regulation of Railway Operation, Peaceful Settlement of Labor Disputes or Strikes? Government Regulation versus Government Ownership, Some Practical Phases of Government Ownership, The Failure of Government Ownership in Canada.

A general presentation of the methods that have been advocated and of the actual effects of rate regulation.

Rubber. Its Production, Chemistry and Synthesis in the Light of Recent Research. A Practical Handbook for the Use of Rubber Cultivators, Chemists, Economists and Others. By A. Dubosc and Dr. A. Luttringer. English Edition by Edward W. Lewis. J. B. Lippincott Co., Philadelphia, 1918. Cloth, 6x9 in., 383 pp., 51 tables. $6.50.

The authors have collected into a single volume all the scattered writings relating to the cultivation or the modern chemistry of rubber, with the addition of their own observations on these subjects. Much attention is given to the various proposed processes for the synthesis of rubber.

Scientific Management. A History and Criticism. By Horace Bookwalter Drury. Second edition, revised. Studies in History, Economics and Public Law; Edited by the Faculty of Political Science of Columbia University. Vol. 65, No. 2. Whole Number 157. Columbia University, New York, 1918. Paper, 6x10 in., 251 pp. $2.

A history of the origins and development of scientific management, with a critical review of its important aspects. Brief biographies of the leaders in the movement are given, and its relation to labor is discussed. The present edition has been largely extended and revised. The statements have been brought down to date, and the conclusions have been rewritten in a number of cases.

Strength of Materials. A Comprehensive Presentation of Scientific Methods of Locating and Determining Stresses and Calculating the Required Strength and Dimensions of Building Materials. By Edward R. Maurer. American Technical Society, Chicago, 1918. Cloth, 5x8 in., 126 pp., 2 pl., 7 tables. $1.

An elementary presentation of the subject, in which the use of higher mathematics has been avoided.

Standard Wiring for Electric Light and Power. As adopted by The Fire Underwriters of the United States, in Accordance with This Year's Edition of the National Electrical Code, with Explanations, Illustrations and Tables Necessary for Outside and Inside Wiring and Construction for All Systems, Together with a Special Section on House Wiring. By H. C. Cushing, Jr. H. J. Cushing, Jr., New York (copyright, 1918). Flexible cloth, 4x7 in., 360 pp. (advertising pages included), 4 illus., 21 diag., 37 tables.

This edition of the essential rules and requirements for safe and efficient wiring and construction for electric heat, light and power follows the plan adopted in former editions, but has been revised to meet present requirements.

A Text-Book of Inorganic Chemistry. Edited by J. Newton Friend. Vol. 5: Carbon and Its Allies, by R. M. Caven. J. B. Lippincott Co., Philadelphia, 1917. Cloth, 6x9 in., 468 pp., 15 illus., 70 tables, 1 folded, 1 chart.

Contents: Introductory, Carbon and its Compounds, Silicon and its Compounds, Titanium and its Compounds, Zirconium and its Compounds, Thorium and its Compounds, Germanium and its Compounds, Tin and its Compounds, Lead and its Compounds.

The aim of this series is to provide a comprehensive textbook of inorganic chemistry, sufficiently complete for ordinary purposes, and supplied with numerous references to the leading works and memoirs.

Tire Making and Merchandising. A Book of Facts Concerning Manufacturing Processes, Illustrating the Principal Tire Types, Rims and Non-Skid Treads, with Chapters on Rubber and Other Factors Governing Tire Costs, Present and Future Trend of the Market, Merchandising for Profit, Dividends from Service, Marketing Methods and Sales Campaigns, Tire Equipment of All Pleasure and Commercial Cars from 1913 to Present Date, and a Dealers' Dictionary of Terms. By F. R. Goodell. U. P. C. Book Company, New York, 1918. Flexible cloth, 5x8 in., 222 pp., 42 illus., 6 tables, maps, 7 diag. $2.

A compact summary of information on tire manufacture, marketing and merchandising, designed especially for those engaged in tire business.

Topography and Strategy in the War. By Douglas Wilson Johnson. Henry Holt and Co., New York, 1917. Cloth, 6x9 in., 211 pp., 33 pl., 18 maps. $1.75.

The author's objects have been to emphasize the effect played by land forms in plans of campaign and movements of armies in the great war, and to place before the reader a picture of each theater of war that will enable him to follow with intelligence the movements of the troops.

Wooden Shipbuilding. A Comprehensive Manual for Wooden Shipbuilders, to Which is Added a Masting and Rigging Guide. Compiled by W. J. Thompson. A. C. McClurg & Co., Chicago, 1918. Flexible cloth, 5x7 in., 202 pp., 2 tables. $2.50.

Contents: Wooden Ships, Masts and Rigging, Methods of Masting, Tables of Rigging. A book of pocket size, compiled from standard authorities. Chiefly intended as a glossary of the parts of ships and their rigging, with brief descriptions of the methods of construction, arranged in dictionary form.

Electric Furnaces in the Iron and Steel Industry. By W. Rodenhauser, J. Schoenawa and C. H. Vom Baur. Translated from the original by the latter and now completely rewritten. Second edition. John Wiley & Sons, Inc., New York, 1917. Cloth, 6x9 in., 429 pp., 134 illus., 2 pl., 24 tables. $3.75.

A review of the electrical furnaces used in iron smelting, and of the processes employed. The present edition contains minor revisions covering certain changes since 1913.

Tycos Mineral Oil Tables. Taylor Instrument Companies, Rochester, N. Y., 1918. First edition. Cloth, 4½x6½ in., 204 pp. $1.

A useful and handy collection of gravity and temperature tables for mineral oils—from determinations of the Bureau of Standards, together with other tables for general testing and refinery practice, including viscosity, water density, steam, ammonia and humidity tables, as well as tables for the conversion of weights and measures, and various physical and chemical tables. The book also contains instructions for testing oils.

Correction.—The price of A. N. Goldsmith's Radio Telephony is $2 instead of $1.25, as stated in the June issue.

ACCESSIONS TO THE LIBRARY

ALUMINUM. Its history, occurrence, properties, metallurgy and applications, including its alloys. Edition 2. By Joseph W. Richards. *Philadelphia, 1890.* Gift.

ALUMINUM AND ITS CONGENERS, including the rare earth metals. By H. F. V. Little. Vol. IV of Text-book of Inorganic Chemistry. *London, 1917.* Purchase.

CHEMISTRY OF PERMUTIT. *New York, 1917.* Gift of Arthur Worischek.

CITY OF NEW YORK. President of the Borough of Manhattan. Report of the Business and Transactions for the year ending Dec. 31, 1916. Gift of President of the Borough of Manhattan.

CONSTRUCTION DES AÉROPLANES. Résistance des Matériaux. By F. Orain. *Paris, n. d.* Purchase.

DYNAMICS OF MECHANICAL FLIGHT. Lectures delivered at the Imperial College of Science and Technology, March, 1910 and 1911. By Sir G. Greenhill. *London, 1912.* Purchase.

ENGINEERING SOCIETY OF CHINA. Proceedings. Vols. 15-16. *Shanghai, 1916-17.* Gift of Engineering Society of China.

THE ENGINEER'S YEAR-BOOK OF FORMULAE, RULES, TABLES, DATA AND MEMORANDA, 1918. Compiled and edited by H. R. Kempe. *London, 1918.* Purchase.

GOLD DEPOSITS OF THE RAND. By C. B. Horwood. *London, 1917.* Purchase.

GOLD INDUSTRY AND GOLD STANDARD. By Hennen Jennings. Gift of American Mining Congress.

HEALTH AND WAR. By Irving Fisher. (From *American Labor Legislation Review*, vol. 8, no. 1, 1918.) Gift of Irving Fisher.

MANUEL POUR L'ESSAI DES COMBUSTIBLES ET LE CONTROLE DES APPAREILS DE CHAUFFAGE. By F. Fischer. *Paris, 1902.*

THE MERRILL PROCESS OF INDUSTRIAL HEATING. *Fitchburg, Mass., n.d.* Gift of The G. M. Parks Co.

METAL MARKET YEAR-BOOK, "The Ironmonger," 1918. *London, 1918.* Purchase.

MODERN COKING PRACTICE. Vols. 1-2. Ed. 2. By J. E. Christopher. *London, 1917.* Purchase.

THE MOTOR, MARINE AND AIRCRAFT RED BOOK, 1917. Compiled by W. C. Bersey and A. Dorey. *London, 1917.* Purchase.

NATIONAL SOCIETY FOR VOCATIONAL EDUCATION. Problems of Administering the Federal Act for Vocational Education. (Bulletin No. 26.) *New York, 1918.* Gift of National Society for Vocational Education.

NATIONAL TEXTILE EXPOSITION (6th). Grand Central Palace, April 29-May 11, 1918. Gift of Textile Exhibitors Association.

NEW YORK STATE CHARITIES AID ASSOCIATION. Annual Report for the year ending Sept. 30, 1917. *New York, 1917.* Gift of Association.

NEW YORK STATE CONSERVATION COMMISSION. Annual Report, 5th, 1915. *Albany, 1917.* Gift of Conservation Commission.

NOMENCLATURE FOR AERONAUTICS. Report No. 15. National Advisory Committee for Aeronautics. *Washington, 1918.* Gift of National Advisory Committee for Aeronautics.

NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS. Transactions. Vol. XXXIII. *Newcastle-upon-Tyne, 1917.* Purchase.

NOVA SCOTIA. Department of Public Works and Mines. Annual Report of the Mines, 1917. *Halifax, 1918.* Purchase.

PENNSYLVANIA STATE BOARD OF CENSORS. Report for the year ending Nov. 30, 1917. *Harrisburg, 1917.* Purchase.

PORTLAND CEMENT ASSOCIATION. Catalog of books, periodicals and pamphlets in the library. *Chicago, 1918.* Gift of Association.

PRODUCTION OF ELLIPTIC INTERFERENCES IN RELATION TO INTERFEROMETRY. Parts I-II. By Carl Barus. *Washington, 1911-12.* Gift of Carnegie Institution of Washington.

RÉSISTANCE DES MATÉRIAUX. By Ch. De Mussan. *n. p. n. d.*

STEAM TABLES FOR CONDENSER WORK. Ed. 4. *Carteret, N. J., 1915.* Gift of Wheeler Condenser & Engineering Co.

STRUCTURAL SERVICE BOOK. Volume I. A revised reprint from the twelve issues for 1917 of the *Journal of the American Institute of Architects. Washington, 1918.* Gift of American Institute of Architects.

SURFACE WATER SUPPLY OF THE UNITED STATES, 1916. Part I—North Atlantic slope-drainage basins. (U. S. Geological Survey. Water Supply Paper No. 431); Part VII. Lower Mississippi River Basin. (U. S. Geological Survey. Water Supply Paper No. 437.) *Washington, 1918.* Purchase.

SOCIETY OF BRITISH GAS INDUSTRIES. Presidential address by Sir Robert Hadfield. April 18, 1918. Gift of Sir Robert Hadfield.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS. Transactions, 1917. Vol. 25. *New York, 1918.* Purchase.

SUBMARINES. A list of references in the New York Public Library. Compiled by Mary Ethel Jameson, with a foreword by Simon Lake. *New York, 1918.* Gift of New York Public Library.

TABULAR CLASSIFICATION OF IGNEOUS ROCKS. By Victor Ziegler. *n. d.* Gift of author.

TORPEDOES. A list of references to material in the New York Public Library. Compiled by William A. Ellis. *New York, 1917.* Gift of New York Public Library.

WHO'S WHO, 1918. *London-N. Y., 1918.* Purchase.

GIFT OF ILLUMINATING ENGINEERING SOCIETY.

A COLLECTION CONSISTING OF SEVENTY-EIGHT BOOKS, PAMPHLETS AND SOCIETY PUBLICATIONS.

GIFT OF RED CROSS INSTITUTE FOR CRIPPLED AND DISABLED MEN

DEVELOPMENT IN ENGLAND OF A STATE SYSTEM FOR THE CARE OF THE DISABLED SOLDIER. By John C. Faries.

ORGANIZATION, WORK AND METHOD OF THE RED CROSS INSTITUTE FOR CRIPPLED AND DISABLED MEN. By Douglas C. McMurtrie.

RECONSTRUCTING THE CRIPPLED SOLDIER. By Douglas C. McMurtrie.

REHABILITATION OF THE WAR CRIPPLE. By Douglas C. McMurtrie.

VOCATIONAL REËDUCATION FOR WAR CRIPPLES IN FRANCE. By Grace S. Harper.

TOURVIELLE: A TRADE SCHOOL FOR WAR CRIPPLES. By Gustave Hirschfeld.

TRADE CATALOGUES

CENTRALIZED BALL MILL COMPANY. San Francisco, Cal.
Theory and Practice of Ball Milling. Descriptive circular.

CLEVELAND MILLING MACHINE COMPANY. Cleveland, Ohio.
Stock List of Cutters, June 15, 1918.

CROCKER WHEELER COMPANY. Ampere, N. J.
Bulletin No. 183. Motor Drive for Printing Machinery. April, 1918.
Bulletin 184. Direct Current Lighting and Power Generators. March, 1918.
Bulletin 185. Coupled and Belt Types of Alternating Current Generators. March, 1918.

GAERTNER, WM., & COMPANY. Chicago, Ill.
Catalog S. T. O. Universal Laboratory Supports, Balances, Weights, Glassware and Supplies. 1918.

GENERAL ELECTRIC COMPANY. Schenectady, N. Y.
Bulletin No. 46018A. Portable Instruments, Type P-8. 1918.

GENERAL ELECTRIC COMPANY. Schenectady, N. Y.
Class 317, No. 68202. CR 3100 Drum Type Controllers for Series, Shunt or Compound Wound Motors. 1918.

MANUFACTURING EQUIPMENT & ENGINEERING COMPANY. Boston, Mass.
Metal Equipment, Price-List, March 15, 1918.
Sanitary Drinking Fountains. Partial List of Users.
Sanitary Bubbling Fountain with Ice-Cooled Water Supply for Shop, Factory, Office and General Use.
Sanitary Washbowls (Dept. A).

MONARCH ENGINEERING & MANUFACTURING COMPANY. Baltimore, Md.
The New Monarch Vertical Non-Crucible Tilting Metal-Melting Furnace. Descriptive Booklet.

POOLE ENGINEERING & MACHINE COMPANY. Baltimore, Md.
Folder 200-04, 206, 208-214. Turbogear. May, 1918.

STANDARD SHOP EQUIPMENT COMPANY. Philadelphia, Pa.
CAD Nuts, Bolts, Clamps, etc. Illustrated Folder.

THE EFFECT UPON FUEL ECONOMY OF DIFFERENT ARRANGEMENTS OF BAFFLES IN BOILER TUBES

By Lieut. William G. Eager,[1] Philadelphia, Pa.

When it is considered that the cost of fuel is invariably from forty to sixty per cent of the operating cost of producing power and that even in a small plant this cost runs to many thousand dollars a year, it is surprising that so little time is given by operators to investigating the effect upon fuel economy and boiler capacity of varying the paths of the gases between the combustion chamber and the uptake.

Considerable thought seems to be given to the design of the boiler shell, tubes and accessories to make them more nearly perfect theoretically and mechanically. An arbitrary relation is taken between heating surface and grate area based upon years of experience, and much ingenuity is used in the development and application of different types of mechanical stokers and other labor-saving appliances. There seems to be, however, among some boiler makers and operators an indifference in the matter of investigating the actual results obtained by varying the location of the baffles in the banks of boiler tubes.

Upon this phase of boiler practice depends to no small extent the ultimate economy of the boiler. If the gases pass through the banks of tubes in too direct a course, they carry with them up the stack an unnecessary amount of valuable heat. On the other hand, if the arrangement of baffles in the tubes is such as to restrict unduly the passage of the gases, the boiler may evaporate water economically but it will not readily respond to unusual demands on its capacity.

Again, the baffles may be so arranged as to form pockets of inactive gases, which are excellent non-conductors and which will tend to cut down the effective heating area. This would lower both the efficiency and capacity of the boiler.

Object of Tests

With these facts in view, a series of tests was made upon three similar boilers of the Heine type to determine the arrangement of baffles for this type of boiler which would give the best evaporation in pounds of water from and at 212 deg. fahr. per pound of coal, and at the same time meet the requirements of full capacity and a moderate superheat temperature.

These tests were made under commercial operating conditions at the combination ice and electric plant of the Valdosta (Ga.) Lighting Company and extended over a period of six and one-half weeks, beginning March 10, 1913. No records of previous investigations along this definite line and no references dealing with this specific phase of boiler practice were available. While it was not possible to introduce such refinements as are obtained in laboratory work, it is believed that the tests conducted under these normal and fairly uniform operating conditions have satisfactorily brought out the valuable features of the matter under investigation. The questions of the effect of baffling on draft, combustion, circulation and scale forming are of interest and importance, but these are problems which could each be made the major subject of an extended investigation. It is not intended in this discussion to attempt to differentiate between the effects produced by each of these factors, but to accept the effects as a whole as reflected in the final results.

Had a CO_2 recorder been available these records would prove of value and importance in that they would indicate what degree of uniformity of combustion was obtained in the various cases. Such an instrument, however, was not at hand, and, with a view to obtaining a comparison which would indicate any wide variation in the method of firing, tests were conducted on each of the three boilers, using the two arrangements of baffles which showed best results.

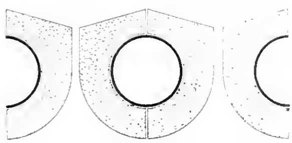


Fig. 1

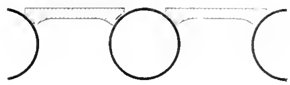
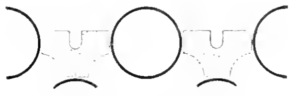


Fig. 2



Figs. 1-3 Types of Baffle Tile Used in Boiler Tests

Note.—Tile in Fig. 3 falls away from tubes at top and closes passage between tubes.

Principles and Methods Employed in the Investigation

The problem involved in this work was fundamentally the choosing of that location of the baffles which would enable the heating surface of the boiler to extract the greatest amount of heat from the coal burned without impairing the capacity of the boiler, and this brought up for consideration several important points and principles. First of all, an encircling tile shown in Fig. 1 was used on the lower bank of tubes. This baffle remained the same in each test, and it is interesting to note that it offered a hot surface against which the unburned gases might impinge, thus burning the volatile matter and carbon particles more completely than as if they had been allowed to strike the cold surface of the tubes. Secondly, this encircling tile saved the lower banks of tubes by protecting them from wide and sudden temperature variations and the intense heat over the bridge wall.

The orifice between these baffles on the lower bank of tubes and the back water leg must be large enough not to restrict the flow of the gases and yet close enough to the rear water leg to force the gases well back in order to take full advantage of the large heating area of these tubes, which would be lost if the gases were cut off too soon. The middle course of baffles, where one is used, must be placed with this latter thought in

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Abstract of a paper presented at a meeting of the Atlanta Section of The American Society of Mechanical Engineers, April 9, 1918.

mind, and in addition it must be remembered that the falling temperature of these gases at practically constant pressure gives a corresponding reduction in volume, and for this reason this course of baffles should be pushed nearer to the front water leg than the lower baffle is to the rear water leg. This type of baffle is shown in Fig. 2. If the split baffle is used, that is, if the baffle does not extend to either water leg, it should be installed in such a way as to split evenly the gases, as the heating surfaces either way are practically the same. Moreover, equal care must be taken not to obstruct the gases here.

Another item to be considered in connection with this baffle is that its position will affect the temperature of superheated steam to a considerable extent, as will be shown. The principles regarding the reduction in volumes and the undue restriction of gases also apply to the top course of baffles. This type is shown in Fig. 3. It must be borne in mind that the heating area under the drums is much less than that available in the banks of tubes above the middle baffle, and also that if the gases are permitted to do so, they will rise under the drums and move along it to the uptake. If these gases are therefore to be split at this point, they should be divided roughly in the ratio of the effective heating area under the drums and that available in the tubes. In this connection, however, it is well to note that the gases in the banks of tubes will tend to creep along the top banks to some extent, and that these banks will consequently do more than their share of the work. Care must also be taken in the placing of baffles to see that they are not so located as to prevent the proper blowing of the soot from around the tubes.

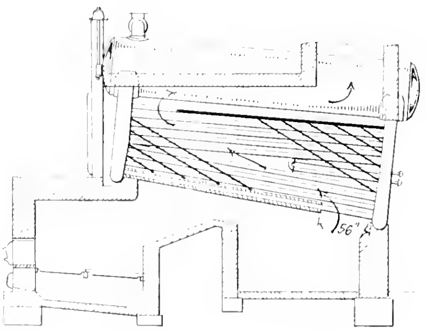

Fig. 4 Location of Baffles and Path of Gases in Boiler, Case A

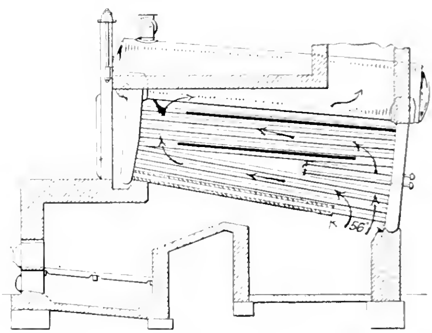

Fig. 5 Location of Baffles and Path of Gases in Boiler, Case B

It is of the greatest importance that all air leaks be stopped and that the stack damper be always in good operating shape and intelligently used. No matter what form of baffling is used, it is absolutely necessary, from the standpoint of economy, that there be no holes or missing baffles in any course. Such a condition will cause the gases to short-circuit, and will be indicated by decreased evaporation per pound of coal and higher stack temperature.

All these tests were carried out according to the code of The American Society of Mechanical Engineers. The alternate method of starting and stopping was used. Each test was from 58 to 120 hours' duration. Observations were made hourly. With the boilers cold, readings were taken on the gage glass and the water meter simultaneously as the boiler was filled to determine the volume of water admitted for each fraction of an inch on the gage glass. This was done to determine the amount of water blown off. The coal used was Crane Creek No. 1, run of mine, from Colmar, Kentucky. It was dumped in one large pile and was taken from different points in this pile as required. The term "combustible" is used to designate coal dry and free from ash and refuse. This was determined by deducting from the coal as weighed the percentage by weight of moisture, found by drying it artificially, plus the weight of ashes and refuse taken from the ashpits. The feedwater was treated with soda ash and tri-sodic phosphate before reaching boilers, and was fed as uniformly as possible under the varying operating conditions. Water was weighed at average feedwater temperatures.

A thin, fast fire was invariably carried, and the load, which consisted of steam turbines used for generating electricity and an engine driving an ammonia compressor, was quite variable at different times of the day and night, due to the variation of the electric load and the occasional shutting down of the ice machine. To bring out clearly the extent of this variation, figures have been compiled which indicate the ratio of the average boiler horsepower developed during the whole test and the average horsepower developed over the hourly period during which the total output for the hour was a maximum.

Description of Boilers

The tests were made upon three similar boilers of the Heine return tubular type, made by the Casey Hedges Company. They had a heating area of 5000 sq. ft. and a grate area of $86^{3}/_{4}$ sq. ft., giving a ratio of 56 to 1 between heating surface and grate area. The rated horsepower was 500. The boilers were equipped with Dutch ovens and were hand-fired. No. 1 had been in use but a few weeks, while No. 2 and No. 3 had been in service for about a year. No. 3 was equipped with Thomas elliptic grate bars, and Nos. 1 and 2 with the ordinary type of herringbone bars. The boilers were all equipped with Foster superheaters and Bayer soot blowers, and were thoroughly cleaned before beginning the tests. No. 1 was not insulated. The other two had a covering of 1½ in. of asbestos cement over settings and drums.

The apparatus used consisted of Howe scales, a Worthington turbine feedwater meter of the hot-water type, a Bristol recording steam gage, indicating gages, stack pyrometer and thermometers in feedwater line and steam lines. All instruments were checked and calibrated.

Arrangement of Baffles

Four different arrangements of baffles were used which are designated as cases *A*, *B*, *C* and *D*, shown in Figs. 4, 5, 6 and 7, respectively. Case *A* indicates the maker's arrangement of baffles in boilers Nos. 2 and 3. This consisted of a set of encircling tile (see Fig. 1 for detail of tile) around the lower course of tubes extending from the front water leg to within 56 in. of the back water leg and a set of special V-tile (see Fig. 3) resting upon the top course of tubes and extending from the rear water leg to within 42 in. of the front water leg.

The course of the gases would therefore be from the lower corner at back of boiler upward, then under the drums and out. Fig. 4 shows the arrangement of baffles and the course of these gases. Low evaporation per pound of coal indicated that the gases were passing through the banks of tubes too quickly, and an observation of the condition of the tubes led to the belief that the shaded area in Fig. 4 was in a practically inactive state.

The indications were that dead-air pockets were formed at these places, which were quite effectually preventing these parts of the tubes from getting their proportion of the heat and, therefore, from doing their proportion of the work. With a view to modifying this in such a way as to overcome this fault, and to distribute the heat more evenly over the whole length of the tubes, a split baffle was used over the lower course of the top section of tubes. This method is called Case *B* and is indicated in Fig. 5. The baffle in this case was of cast-iron tile and rested upon adjoining tubes. (See Fig. 2 for section of baffles.) The baffles were placed from within 40 in. of the front water leg to within 40 in. of the rear water leg. As far as the volume of gases at this point is concerned, this baffle could well have been extended closer to each water leg, but it was thought best on account of the position of the superheater in one path and the sudden change of direction of gases in the other path to locate it in this way. It was expected that an increase in the temperature of the superheated steam would result from this method because it permitted a part of the gases to pass through the whole of the superheater instead of merely crossing one end of it.

Fig. 6 indicates the maker's arrangement of baffles in boiler No. 1, which was new when tested. This is designated as Case *C*. It will be noted that the lower baffle is the same as in previous cases, that the middle baffle is moved 48 in. from the front water leg and is extended entirely to the rear water leg, and that the top baffle is split and extended to within 42 in. of each water leg, with a vertical wall around the drums and midway the baffle, which forces the gases after striking the drums to return and pass through the upper banks of tubes and then out. It was found that this arrangement reduced the capacity of the boiler so as to cause a failure of steam over the peak load. There was apparently no reason for this unless it was that an eddy or swirl was set up at *E* (see Fig. 6), due to the gases returning to the tubes after striking the drum. Such a swirl would, no doubt, seriously obstruct the passage of gases at this point, and there seems no other logical reason for the behavior of this boiler.

Case *D*, shown in Fig. 7, is a modification of this arrangement with a view to overcoming the difficulty apparently arising from this cause. With the lower and middle baffles the same as in Case *C*, the top baffle is continued to within 8 in. of the front water leg and the vertical wall around the drums is removed. This, it will be seen, causes the gases to divide, the main portion of them passing through the tubes and the smaller portion through the 8-in. orifice, under the drums and out.

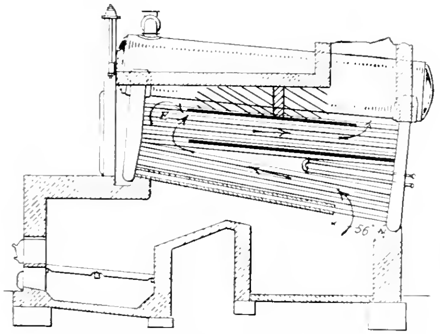

Fig. 6 Location of Baffles and Path of Gases in Boiler, Case *C*

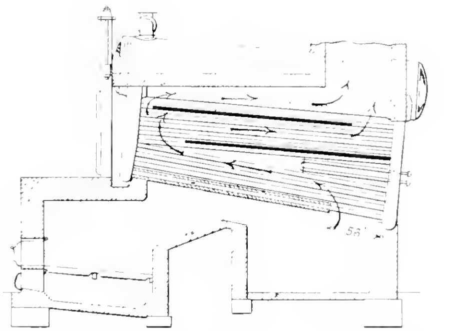

Fig. 7 Location of Baffles and Path of Gases in Boiler, Case *D*

Conduct of Tests

It was the original plan to have each test cover a period of 120 hours, and the first one was carried over this period. The second was begun with this idea in view, but because of the development of weakness in one of the tubes this test was closed at the end of 58 hours. On account of operating difficulties, it was decided to make the remaining tests of 58 hours' duration. Such important observations as weights of coal and water were checked and a record of all unusual conditions was kept in the daily log sheet. Each test was computed as soon as it was finished, and the data thus obtained were used in determining the arrangement of baffles in the next test and the desirability of checking that method on the other boilers. The principles and details of the method have been fully described. The indicating steam gages were checked against the recording gage from time to time. Care was taken to avoid inequalities in the coal, which was taken from different points in a large pile in rotation. Unusual care was taken in the starting and stopping of tests to see that the test conditions were satisfied.

The *A* test was not run on boiler No. 1 because the evaporation obtained in the *B* test on the other boilers was obviously better and because the results obtained from boilers Nos. 2 and 3 were in line when the relative horsepower developed and the

varying conditions were taken into consideration. The *C* test was not run on boilers Nos. 2 and 3 because the test on boiler No. 1 indicated that this arrangement of baffles would not be satisfactory from the operating standpoint on account of the cutting down of capacity. The choice seemed to lie between the *B* and *D* methods of baffling, and these tests were respectively made on each boiler.

Computations and Results

As the calculations are of minor importance and are not out of the ordinary, only an outline of the method followed will be given. A five-place table of factors of evaporation for different pressures and temperatures of feedwater, corrected in each instance for superheat, was compiled from the seventh edition of Peabody's Tables, and used to determine the equivalent evaporation from and at 212 deg. The figures for weight of water at various temperatures were determined by weighing the water at these temperatures. The results of the calculations are given in Table 1.

load conditions of a central station are varying, and that a fireman who is accustomed to the way the load comes on during the day is at a disadvantage on the night turn until he becomes accustomed to the load as it comes on during the shift. Care was taken to avoid these variations as far as possible, but because of their occurrence tests were conducted upon three boilers instead of upon one only. The results appear logical with few exceptions.

Test under case *A* on boiler No. 3 showed a much lower evaporation than the corresponding test on boiler No. 2. This was no doubt due to the lower average horsepower developed by boiler No. 3, which was only 342, as against 519 for boiler No. 2. All the tests on boiler No. 1 appeared abnormally low for a new, clean boiler, and this was probably due to the fact that while both the other boilers were well protected with asbestos covering, the drums and the setting of boiler No. 1 were exposed. Boiler No. 3 was the only one that did not show a decided advantage in evaporation for the *D* arrangement of baffles over the *B* arrangement. It will be noted, however, that the average horsepower developed in the *B* test was 535

TABLE 1 DATA OBTAINED IN BOILER TESTS

	A Test		*B* Test			*C* Test	*D* Test		
	Boiler No. 2	Boiler No. 3	Boiler No. 1	Boiler No. 2	Boiler No. 3	Boiler No. 1	Boiler No. 1	Boiler No. 2	Boiler No. 3
Date of test (1913)	Mar. 17	Mar. 10	Apr. 17	Apr. 21	Mar. 31	Mar. 24	Apr. 10	Apr. 14	Apr. 7
Duration of test, hours	58	120	58	58	58	58	58	58	58
Actual evaporation per lb. of coal as weighed, lb. Water not corrected for superheat	8.95	8.38	8.39	9.36	9.49	9.63	9.50	9.61	9.63
(*a*) Equivalent evaporation from and at 212 deg fahr. per lb. of coal as weighed, lb.	10.06	9.37	9.61	10.46	10.64	10.55	10.51	10.85	10.68
(*b*) Per cent of combustible in coal	89.2	88.5	89.6	88.2	90.1	89.2	89.0	89.0	89.6
Equivalent evaporation per lb. of combustible [= Item (*a*) × 100 ÷ Item (*b*)], lb	11.28	10.58	10.73	11.86	11.81	11.82	11.81	12.19	11.92
(*c*) Average horsepower developed during full period of test	519	342	458	482	535	542	448	463	519
Per cent of rated horsepower	104	68	92	96	107	108	90	93	104
Load factor [= ratio between average horsepower (*c*) and maximum horsepower developed for any 1 hr. of test; relation arbitrarily assumed for purpose of indicating variation in load on boiler]	0.55	0.50	0.69	0.63	0.69	0.71	0.62	0.62	0.69
Average temperature of gases in stack during test, deg. fahr.	486	586	612	542	617	541	568	527	613
Average temperature of feedwater at intake, deg. fahr.	187.8	189.3	195.5	204.0	189.1	197.2	184.7	187.5	196.6
Average temperature of steam leaving superheater during test, deg. fahr.	462.7	439.4	493.9	469.9	448.5	418.7	413.9	459.0	438.8
Average steam pressure in boiler during test, lb. per sq in. gage.	156	153	155	155	157	156	158	157	159

Accuracy of Tests, Methods and Results

While the instruments used were calibrated and checked, it would have made very little difference as far as the comparative value of the baffling was concerned as long as the same variation occurred in each test. The greatest inaccuracy which was likely to occur was in starting and stopping, and in this unusual care was taken. As 58 hours was the shortest period of any test, such an inaccuracy would be minimized in the final result, and it is safe to assume that the variation due to this cause alone would not have amounted to over one-half of one per cent.

It would appear that the personal equation in firing of boilers would be the most likely source of comparative variation. A fireman's physical condition will affect his firing, and a change of men might account for a rather wide variation. It has been observed that a remarkable increase in coal consumption is to be noted when firemen change from the day to the night shift, and vice versa. This is due to the fact that the

as against 519 in the *D* test, so that the gain, while less than in the other cases, is more marked than a glance at the figures would indicate. In the other two cases, although the horsepower developed in the *B* test was higher than in the *D* test and better economy would be expected on account of the increased horsepower, the *D* arrangement of baffles shows to advantage in economy.

Discussion of Results

Fig. 8 indicates graphically the results obtained in equivalent evaporation from and at 212 deg. per pound of coal and per pound of combustible in tests *A*, *B* and *D*. Case *C* is not plotted as this was run only on boiler No. 1, because with this arrangement of baffles No. 1 developed a weakness in overload capacity and, while the average horsepower developed was high, it was unable to carry the peak load. The objections are, first, an apparent interference with the passage of the gases

at E, Fig. 6, due to the gases returning upon themselves, and, secondly, an area heated only by convection, which for all practical purposes may be considered a dead area, between the top baffle and the drum and indicated by the shaded area in Fig. 6.

The full lines in Fig. 8 indicate the equivalent evaporation in pounds of water from and at 212 deg. per pound of coal, and the dotted lines the equivalent evaporation per pound of combustible. An interesting feature in connection with these curves is that the full-line curve of boiler No. 3 crosses that of No. 2 twice, whereas when the available combustible matter, which varies with the quality and firing of the coal, is taken into consideration, as indicated by the dotted lines, all three points of No. 3 fall below the corresponding points of No. 2.

There is a noticeable improvement in case B over case A and case D over case B in each instance. The low point No. 3 reaches in case A is without doubt due to the low horsepower developed and the wide variation in load. The horsepower was 342 against 535 for the B test and 519 for the D test. That is, while the average horsepower developed during tests B and D was slightly in excess of the boiler rating, it was in the A test 33.6 per cent under the rated capacity. The load factor, as this term is defined in Table 1, was 0.50 as against 0.69 in each of the other tests on this boiler. The low evaporation in the B and D tests on boiler No. 1 can probably be practically accounted for when it is noted that this was the only boiler not covered with asbestos.

The low evaporation obtained in the B test on this boiler, together with the high stack temperature and the unusually high superheat temperature, seem to be due to a partial short-circuit in the top baffle (see Fig. 5) near the rear water leg. This baffle was not put in permanently, and the poor fit of the baffle tile at the rear water leg would cause the gases to rush through the superheater and part of them directly up the stack, thus raising the superheat and stack temperatures and impairing the efficiency.

The results which placed the point on the curves for the B test on boiler No. 3 nearest to the curves of No. 2 were obtained when this boiler was developing an average horsepower 11 per cent in excess of that developed by No. 2 in the similar test. When the relative horsepower and the abnormal external influences are taken into consideration, it will be seen that the results obtained on the three boilers corroborate in a striking and conclusive manner the relative value of the three forms of baffling.

Fig. 9 indicates in full lines the stack temperature noted for each arrangement of baffles and in dotted lines the degrees of superheat developed in each case. It will be noted that the curves for stack temperature and for superheat in the cases of boilers Nos. 2 and 3 are almost concentric, and that, while No. 3 developed the highest stack temperature, No. 2 ran above it in superheat temperature. The unusually low stack temperature in the case of boiler No. 2 is undoubtedly due to the fact that it was impossible to locate the pyrometer in the breeching of this boiler in such a way as to avoid the cooling due to leakage in the dampers of the other two boilers. It was possible in No. 1 and No. 3, however, to locate the pyrometer in such a way as to avoid this difficulty.

As has been mentioned before, in the B test on boiler No. 1 the top baffle was not carried tight against the rear water leg, as this was put in temporarily. This would easily explain the unusually high superheat temperature for this test. The superheat temperature developed was in all instances higher in case B than in any of the other cases. Reference to the diagrams showing the location of baffles will make this clear, as it will be seen that the larger part of the hot gases pass through the superheater.

Conclusions as to Completeness of Tests

The D arrangement of baffles not only shows in each test an unquestionable superiority over the other arrangements from the standpoint of efficient evaporation, but it meets the other requirements for a thoroughly satisfactory commercial arrangement of baffles. It develops a low superheat temperature, which, as long as the steam is thoroughly dry, is considered of advantage in the case of the apparatus in use; it does away with inactive and dead air pockets, which is immediately apparent from an examination of Figs. 6 and 7; it presents

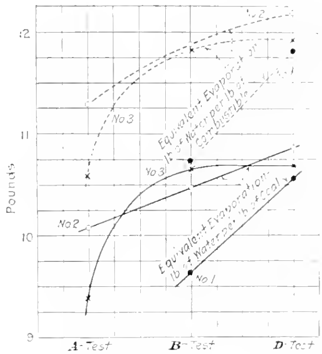

FIG. 8 CURVES SHOWING EQUIVALENT EVAPORATION PER LB. OF COAL AND PER LB. OF COMBUSTIBLE, CASES A, B, D, BOILERS NOS. 1, 2 AND 3

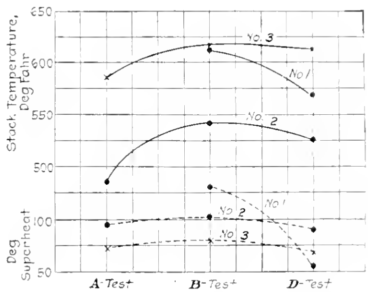

FIG. 9 CURVES SHOWING STACK AND SUPERHEAT TEMPERATURES IN DEG. FAHR., CASES A, B, D, BOILERS NOS. 1, 2 AND 3

an arrangement of baffles which may be easily blown by the soot blowers, and with this arrangement of baffles the boiler stands up satisfactorily to considerable overload.

Recommendations as to Further Research

While the principles involved in these tests and the results brought out by them will be true to a greater or less degree in the case of all boilers of similar design, it would probably be well before adopting a certain type of baffling in any boiler to conduct a series of tests to determine such details as the exact distance from water legs to baffles and the effect of various arrangements of baffles on draft, as this will vary for

each stack. The location of the baffles will be limited to some extent by the fact that they can be put only in certain courses of tubes that are accessible. The kind and quality of coal used will affect the results obtained, and an arrangement of baffles which would be thoroughly satisfactory in the case of a coal high in fixed carbon and low in volatile might prove unsatisfactory in the case of a highly volatile coal. The grate area and depth, the height of the bridge wall, the size of the combustion chamber and other factors will enter into the matter of the thorough burning of the coal. Whatever influence these factors may have, the arrangement of the baffles will influence to a considerable degree the matter of fuel economy.

Conclusion

The high evaporation obtained when using coal averaging less than 14,000 B.t.u. per lb. indicates that the boiler practice as a whole was unusually good. In one instance an average efficiency for the test of 75.2 per cent was obtained.

While the efficiency obtained during these tests is unusually high as compared with what is considered good practice, it is to be noted that the tests recorded are merely one stage of a continuous test which has been made on these boilers for the past nine months and to which the best principles of boiler practice have been applied. The improvements made represent not only those gained by a study of the theory of boiler practice, but those gleaned from several years of continuous boiler testing under similar conditions.

The improvement over these nine months has been gradually noted after changing of grate area, height of bridge wall, method of firing and arrangement of baffles to suit the grade of coal used. The drums and tubes are kept thoroughly clean within and without, air leaks of all kinds are carefully avoided, the boilers are equipped with Dutch ovens and two of them are protected with asbestos covering. The firemen are thoroughly trained, work eight-hour periods, and, because of the similar load conditions for each shift, are kept constantly on that shift. The increased efficiency thus brought about is reflected not only in the evaporation per pound of coal, but is corroborated by a corresponding decrease in pounds of coal per kilowatt of output.

One of the primary reasons for the installation of a battery of three 500-hp. boilers rather than two of larger capacity was the advantage to be gained in the matter of efficiency when the boiler could be loaded for the full period to its rated capacity or better. A glance at the tabulation of boiler tests (see Table 1) will indicate that this was the case during these tests.

The conduct of such a test under commercial operating conditions brings into it certain factors beyond the control of the engineer. At first blush this appears to be a disadvantage, but when it is considered that the practical problems which the engineers must face are invariably influenced by unusual conditions and that one of the most important phases of engineering practice is the determination of these conditions and the explanation of their bearing upon the problem under consideration, it will be seen that such a test under operating conditions, in which there are many unforeseen influences, may be made of more value than a laboratory test, where such conditions would probably not be found. Another feature to be considered is that an expenditure of three or four thousand dollars for fuel and labor would hardly be made, even if justified by the results, except under operating conditions.

The conduct of such a series of tests, while a tedious undertaking, is one which would amply repay any operating engineer who is responsible for the burning of a large amount of fuel. There are few improvements in the boiler room that can be made at comparatively small expense which offer such encouraging possibilities along the line of the more economical evaporation of water as the arrangement of baffles in the boiler flues to meet best the definite conditions peculiar to any boiler room.

ADVANTAGES OF HIGH PRESSURE AND SUPERHEAT AS AFFECTING STEAM-PLANT EFFICIENCY

By ESKIL BERG,[1] SCHENECTADY, N. Y.

The advantages of the steam turbine as a prime mover are today too well known to need much discussion. It is, however, interesting to note that in the early stages of the development, when the thermodynamic efficiency was only about 50 or 60 per cent, it still had such great advantages over its competitor, the reciprocating engine, that it rapidly began to take its place. The chief reason for this is, of course, that outside of its mechanical advantages of simple rotation, it could advantageously use steam at the lower pressure ranges, and a vacuum of $28\frac{1}{2}$ in. or higher is now called for as standard by larger central stations.

The development of the steam turbine has advanced very rapidly, the designer has constantly had higher efficiency in view, and has in this respect succeeded so that today turbines are in operation that are giving a thermodynamic efficiency of almost 90 per cent. While in the future this already high efficiency may be improved by a small percentage, we will have to look to other features of the power plant for further gains in fuel economy. Such gains can be made by increasing the temperature range of the steam, but as the lower range is fixed by the temperature of the cooling water, the gain must be made by going to a higher temperature in the beginning of the cycle, which can be done either by the use of higher steam pressure or by the application of superheat. It will be shown later that a combination of both will give the best results.

Efficiency of a Turbine

The thermodynamic or Rankine-cycle efficiency of a turbine is the ratio of the mechanical energy taken out of the steam by the turbine to the total energy in the supplied steam when this steam is expanded adiabatically from the pressure at the throttle valve to the exhaust pressure in the turbine casing. (Adiabatic expansion takes place when the lowering of the temperature of the steam is done entirely by extraction of work from the steam.)

The steam consumption of a turbine when connected to an

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electric generator is generally stated in pounds of steam per kilowatt-hour, and is the amount of steam required to deliver one kilowatt of electrical energy for one hour.

"Theoretical water rate" is a term generally used in all turbine investigations, and is the ratio of one kilowatt-hour expressed in foot-pounds (2,654,000) to the available energy in one pound of steam expressed in foot-pounds. The ratio, therefore, between the theoretical water rate and the actual measured water rate gives the efficiency. When the turbine is connected to an electric generator the combined efficiency of turbine and generator is generally given.

Formula for Calculation of Available Energy

The formula for calculating the available energy of steam expressed in foot-pounds, either dry or superheated, when expanding adiabatically to any back pressure, is seldom found in handbooks or textbooks, and when such formulæ are found they are rather complex and difficult to use. The formula can, however, be made very simple when expressed as the difference between the total heat input and the heat left in the liquid together with the latent heat in the mixture at the lower pressure. The formula then becomes:

Available energy in ft-lb. =

$$778\,[H_1 + C_p t_1 - (q_2 + x_2 r_2)]$$

where H_1 = total heat of saturated steam at initial pressure p_1
C_p = specific heat of superheated steam
t_1 = deg. fahr. superheat at pressure p_1
q_2 = heat of the liquid at lower pressure p_2
x_2 = quality of the steam at pressure p_2
r_2 = latent heat at pressure p_2.

All of these quantities are found in any steam table except x_2 (dryness factor), which is, however, easily calculated from the fact that the entropy is constant before and after the expansion.

Entropy of superheated steam is:

$$C_p \log_e \frac{T_1 + t_1}{T_1} + \frac{r_1}{T_1} + \phi_1$$

Entropy of moist steam is:

$$\frac{X_2 r_2}{T_2} + \phi_2$$

By making these equal and solving for x_2 there results:

$$x_2 = \frac{T_2}{r_2}\left(C_p \log_e \frac{T_1 + t_1}{T_1} + \frac{r_1}{T_1} + \phi_1 - \phi_2\right)$$

T_1 = absolute temperature at pressure p_1
T_2 = absolute temperature at pressure p_2
ϕ_1 = entropy of water at pressure p_1
ϕ_2 = entropy of water at pressure p_2

Example. Find the available energy of one pound of steam when expanding from 250 lb. gage pressure, with 250 deg. superheat, to 29 in. vacuum, (0.5 lb. abs.)

Available energy = $778\,[H_1 + C_p t_1 - (q_2 + x r_2)]$
$H_1 = 1202.3$
$C_p = 0.553$
$t_1 = 250$
$q_2 = 48$
$r_2 = 1046.7$

$$x_2 = \frac{T_2}{r_2}\left(C_p \log_e \frac{T_1 + t_1}{T_1} + \frac{r_1}{T_1} + \phi_1 - \phi_2\right)$$

$T_1 = 461 + 406.2 = 867.2$
$t_1 = 250$
$r_1 = 821.6$
$\phi = 0.5739$
$r_2 = 1046.7$
$T_2 = 461 + 80 = 541$
$\phi_2 = 0.0932$

$$x_2 = \frac{541}{1046.7}\left(0.553 \log_e \frac{1117.2}{867.2} + \frac{821.6}{867.2} + 0.5739 - 0.0932\right)$$
$$= \frac{541}{1046.7}\left(0.553 \times 0.2546 + 0.947 + 0.5739 - 0.0932\right)$$
$$= 0.5168 \times 1.5685 = 0.812$$

Dryness factor = 0.812

Available energy =
778 [1202.3 + 0.553 × 250 — (48 + 0.812 × 1046.7)] = 778 × 444.3 = 346,000 ft-lb.

[Theoretical water rate per kw-hr. = 2,654,000/346,000 = 7.67 lb.]

Gain by the Use of High Steam Pressure

It has long been recognized that a very large saving in fuel could be obtained by the use of high steam pressure. As early as 1897 DeLaval in Sweden supplied all the power for lighting the Exposition of Arts and Industries in Stockholm with his turbo-generating sets operated from boilers of his own design, using over 1500 lb. pressure. The units used were

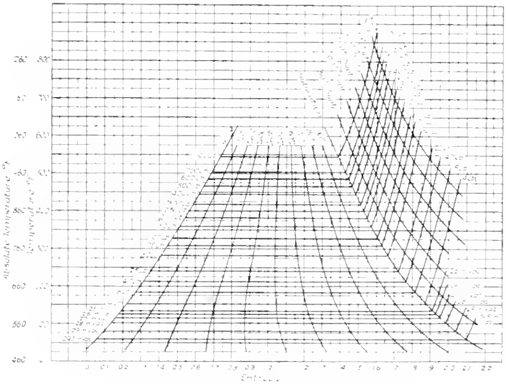

FIG. 1 ENTROPY-TEMPERATURE CURVES

naturally small, four of them having 100 hp. each and two of them 50 hp. each.

Boiler manufacturers in this country are today prepared to build boilers for 350 lb. pressure and see no difficulties in going to 500 lb. or even higher.

The theoretical gain due to the use of high steam pressure is plainly illustrated in Table 1, in which case 1 lb. of dry steam at 200 lb. pressure expanded to 28½ in. of vacuum is considered unity. It will be seen that by raising the boiler pressure to only 500 lb., there is a saving in fuel of 14.43 per cent. In money this saving would amount to about \$200,000 a year in a plant burning about 900 tons a day with coal costing \$5 a ton.

Theoretical Gain by Superheat

The theoretical gain by superheat is shown by Table 2, which is calculated on the basis of an initial pressure of 250 lb. gage expanded to a 29 in. vacuum. It will be seen that this gain is very small, being only 2.9 per cent when superheating up to 300 deg.

Practical Gain by Superheat

The practical gain by the use of superheat is often expressed by saying that the water rate is reduced 1 per cent for a certain number of degrees of superheat. The amount of this decrease varies with turbines of different design, but a figure

frequently used is 1 per cent gain in water rate for every 12.5 deg. of superheat. Column 5, Table 2, is based upon this assumption.

The actual net gain of fuel in per cent is therefore shown by column 8, which is the difference between column 7 and column 4. It will there be seen that the practical gain by superheat is about two and a half times as great as the theoretical. The reason for this large practical gain is that in a well-designed turbine of, say, the impulse type, the magnitude of the total losses is made up in about the following proportions when dry initial steam is used:

	Per Cent
Loss due to friction in nozzles and blades and windage loss of disks and blades	20
Leakage loss	3
Rejected energy (due to residual steam velocity)	3
Bearings, packings, etc.	1
Total losses	27
Efficiency of turbine	73

It will be seen that the first item is by far the most important one, and it is this item which is reduced by the use of superheat. The use of 200 deg. superheat will reduce the friction

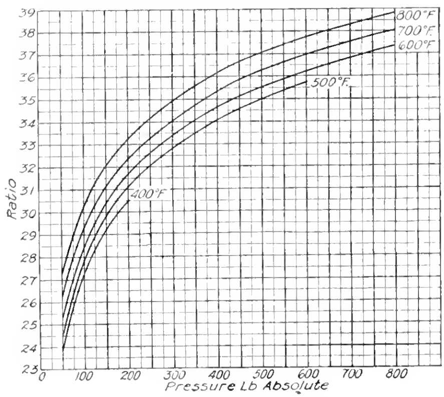

FIG. 2 CURVES SHOWING RATIO OF AVAILABLE B. T. U. IN STEAM TO TOTAL HEAT IN STEAM, FEEDWATER AT 90 DEG. FAHR.

and windage loss about one quarter or to 15 per cent, and the total loss would then be 22 per cent, making he turbine efficiency 78 per cent. This reduction is effected by the superheat reducing the moisture in all the stages. The reduction is best shown by the entropy-temperature diagram, Fig. 1. From this diagram it will be seen that starting with steam initially dry at 265 lb. absolute pressure and expanding it adiabatically to 29 in. vacuum through a turbine of 100 per cent efficiency, would result in steam of about 26.5 per cent moisture, whereas if the steam had been superheated to say 250 deg., this moisture would be reduced to about 19 per cent, a reduction of almost 30 per cent. In an actual turbine this percentage of moisture is of course a great deal lower, depending upon the efficiency.

Table 3 gives approximately the condition of the steam in all the stages of a ten-stage turbine, assuming the turbine has 80 per cent efficiency, is supplied with steam at 250 lb. gage pressure, 250 deg. superheat, and is exhausting into 29 in. vacuum. For comparison the last column of the table gives the steam condition in this turbine had the steam been initially dry.

EFFECT OF MOISTURE ON FRICTION

A great many formulæ and curves are given by various authors based upon experimental and theoretical data for calculating the friction losses, and they all have a constant which varies according to the conditions of the steam. Professor Moyer, for example, in his book on steam turbines gives a formula for rotation losses of buckets and wheel disks in which the constant C is as follows:

Superheat, deg			Per cent moisture		
100	50	0	5	10	20
$C = 0.875$	0.93	1.00	1.08	1.25	2.00

In other words, the friction loss is twice as great with 20 per cent moisture as it is with dry steam.

EFFECT OF THROTTLING

Throttling of dry steam always produces superheat; and it has often been said for this reason that there is practically no loss due to throttling, which is true as far as heat is concerned. There is, however, a considerable loss of available energy. The amount of superheat obtained by throttling is easily calculated because the total heat before and after throttling is the same. Assume that steam at 200 lb. absolute pressure is throttled down to 100 lb. absolute pressure:

TABLE 1 THEORETICAL GAIN DUE TO THE USE OF HIGH STEAM PRESSURE

Absolute pressure, lb.	Corresponding temperature, deg. fahr.	Total heat	Increase in total heat, per cent	Available energy in ft-lb. expanding to 28.5 in. vacuum	Increase of available energy, per cent	Net gain in fuel, per cent
200	381.9	1198.5	....	272,000	....	...
300	417.5	1201.9	0.28	293,000	7.72	7 44
400	444.8	1202.5	0.33	304,500	11.95	11.62
500	467.2	1201.7	0.27	312,000	14 7	14.43
600	486.5	1199.8	0.11	319,000	17.2	17 09
700	503.4	1197.4	0.902	323,000	18.7	18.79
800	518.5	1194.4	−0.342	327,000	20.2	20.54
900	532.3	1191.1	−0.617	329,000	20.9	21.51
1000	545.0	1187.6	−0.909	331,000	21 7	22 6

TABLE 2 THEORETICAL GAIN DUE TO THE USE OF SUPERHEAT

Degrees superheat	Temp., deg. fahr.	Total available energy per lb. of steam	Total B.t.u. per lb.	Per cent increase in coal to produce superheat	Per cent increase available energy due to superheat	Net theoretical gain, per cent	Actual gain, per cent	Actual net gain, per cent
(1)		(2)	(3)	(4)	(5)	(6) = (5–4)	(7)	(8) = (7–4)
0	406	298,000	1202 3	....	....	....	..	....
50	456	308,500	1237.0	2 89	3.53	0.64	4	1.11
100	506	318,000	1264 6	5.18	6.72	1.54	8	2.82
150	556	327,500	1290 5	7.33	9.90	2.57	12	4.67
200	606	336,000	1315 6	9.45	12.75	3.30	16	6.55
250	656	341,500	1340 5	11.50	14.60	3.10	20	8 50
300	706	347,000	1365.3	13.55	16.45	2.90	24	10.45

Total heat of dry steam at 200 lb. abs. = 1198.1

Total heat of dry steam at 100 lb. abs. = 1186.3

Assume that the specific heat of steam is 0.5:

$$1198.1 = 1186.3 + 0.5 \times t_1, \text{ or } t_1 = 23.6 \text{ deg.}$$

The available energy, however, assuming that the steam in both cases is expanded to 28.5 in. vacuum, is:

270,800 ft-lb. with 200 lb. pressure, dry steam

240,200 ft-lb. with 100 lb. pressure, 23.6 deg. superheat, or a loss in available energy of about 11 per cent.

Gain by the Combined Use of High Steam Pressure and Superheat

High steam pressure with no superheat has the disadvantage, as will be seen by the entropy diagram, of producing more moisture throughout the turbine, which means more friction. It is therefore advisable to combine high pressure with superheat so as to produce a more efficient turbine.

Fig. 2 shows the ratio of available British thermal units in steam to the total heat in the steam, with feedwater at a temperature of 90 deg.

The present practice in power plants in this country is to use, with turbine drive, a steam pressure of 200 lb. gage and about 150 deg. snperheat (temperature of 538 deg.), with a vacuum of 28.5 in. From Fig. 2 it will be seen that the ratio of maximum available heat for work to the total heat is only about 31.25 per cent.

TABLE 3 CONDITION OF STEAM IN THE VARIOUS STAGES OF A TEN-STAGE TURBINE

Assumptions: Steam pressure, 250 lb. gage; superheat, 250 deg.; vacuum at exhaust, 29 in.; turbine efficiency, 80 per cent.

Stages	Steam pressure, lb. per sq. in. abs.	Temperature of steam, deg. fahr.	Superheat, deg.	Per cent moisture	Per cent moisture assuming steam initially dry.
Steam chest	265	656	250	...	...
1	120	501	160	....	4.40
2	68	421	120	....	6.80
3	48	354	75	....	8.15
4	28	277	30	....	9.80
5	16	216	...	0.6	11.50
6	9	188	...	2.0	13.00
7	4.7	160	...	4.0	14.50
8	2.4	133	...	6.5	16.00
9	1.1	107	.	8.0	17.30
10	0.5	79		10.5	18.70

Steam temperatures as high as 700 deg. fahr. are now used in Europe, which with a steam pressure of 500 lb. would give 233 deg. superheat. The ratio of available heat for work would then be about 36.3 per cent, or a fuel saving over the above conditions of 16 per cent.

Turbine generator sets are now built having an overall efficiency of over 80 per cent inclnding generator losses, which with a boiler efficiency of 80 per cent would give an efficiency from fuel amounting to $36.3 \times 0.80 \times 0.80 = 23.25$ per cent. One kilowatt-honr = 3412 B.t.u., therefore the B.t.u. required to produce 1 kw-hr. at the switchboard=$3412/0.2325$=14,600.

On the other hand, had 800 lb. pressure and 800 deg. temperature been used, the efficiency would have been 38.75 per cent; and using a turbine efficiency of 85 per cent and a boiler efficiency of 88 per cent (which is obtainable with liquid fuel, forced draft, and preheated combustion air), a kilowatt-hour could be obtained by:

$$38.75 \times 0.88 \times 0.85 = 29 \text{ per cent, or}$$

$$\frac{3412}{0.29} = 11{,}750 \text{ B.t.u., or}$$

$$\frac{11{,}750}{19{,}000} \text{lb. of fuel oil} = 0.62 \text{ lb.}$$

Diesel-engine advocates now claim a consumption of about 0.55 lb. of fuel oil per kw-hr., but with a fuel about 50 per cent higher in price than the grade of fuel which can be satisfactorily burned under a boiler. It will thus be seen that when full advantage has been taken of the various processes that are used in transforming the energy of the fuel into mechanical energy through the medium of steam, the steam process compares quite favorably with results obtained at the present time with internal-combustion engines.

The conservation of our fuel resources is a subject which is being very carefully studied by all power-plant engineers at the present time, and improvements along the lines that have been discussed in this paper are now receiving serious consideration.

DISCUSSION

In the discussion following the presentation of the paper a number of questions were propounded which were taken up in order by the author as follows:

Dr. Thurston's remark to the effect that the most efficient all-round superheat would be that which would give dry steam in the exhaust, he said, was correct at the time when moderate steam pressure was used and the efficiency of the prime mover was around 50 per cent. Assuming however an efficiency in the prime mover of 80 per cent, 200 lb. steam pressure, and an exhaust pressure of $28\frac{1}{2}$ in. of vacuum, in order to obtain dry steam at the exhaust the superheat would be above 1000 deg. or in a territory that was practically unknown at the present time.

When the high-pressure boiler was developed, it would, in his opinion, be smaller, lighter, and cheaper per horsepower than the present boilers.

In regard to the question of moisture, for a given turbine efficiency the moisture was, of course, the same as the theoretical. If in practice the moisture was found to be excessive, it must be caused by the initial condition of the steam, either having less superheat than assumed, or it might be quite wet when entering the turbine.

In reply to the question whether the first 50 deg. of superheat was not more effective than the last 50 deg. of the 200, he would say that it was, because it reduced the moisture in the high-pressure end of the turbine where the friction loss is greatest. Turbine manufacturers recommended 50 deg. of superheat because it was easily obtained and it at least assured them of dry steam at the throttle. Very few boilers gave dry steam in practice.

In regard to high superheat showing a great saving in fuel with reciprocating engines, it was to be remarked that records of several European vessels operating with steam temperatures around 700 deg. showed that the saving in fuel was in some of them as high as 17 per cent and was sufficient to pay for the cost of installing the apparatus for producing superheat in a few trips across the ocean.

As to the inquiry made regarding the durability of packings, etc., at the higher pressures and temperatures, he would say that in all probability no packing would be used in the piping system and all joints would have to be welded. This, however, should not raise any difficulty. The paper had been primarily intended to point out the direction in which it was necessary for all to work in order to improve fuel economy, and to show that the advantages derived by the use of high steam pressure and superheat were infinitely greater than the disadvantages due to the few practical difficulties which had to be overcome.

A NEW SYSTEM OF REGENERATIVE EVAPORATION

By WM. L. DE BAUFRE, ANNAPOLIS, MD.

A NEW patented system of regenerative evaporation has been brought out recently in which the steam economy of multiple-effect operation is obtained with a single evaporator shell. This system has certain other unique advantages, and it may be applied to any make or type of evaporator. A brief description of the system will be given together with some of the test results obtained; but before doing so, the ordinary single- and multiple-effect systems will be described.

Single and Multiple-Effect Evaporators

The simplest method of evaporation is by the direct application of fire as diagrammatically illustrated in Fig. 1. The solution to be evaporated is contained in evaporator E, the vapor distilled off is condensed in condenser C, and the condensed vapor is collected in tank T. Evaporation takes place under atmospheric pressure and consequently at 212 deg. fahr. unless valve V be partly closed to throttle the flow of vapor to condenser C.

If evaporator E has not been designed with sufficient disengaging surface or ample vapor space, or if proper baffles are not provided, priming or the carrying over of particles of solution with the vapor will occur at atmospheric pressure. This priming may often be eliminated by operating at 5 lb. gage or higher for the reason that the volume of the vapor is thus considerably reduced. For example, the volume of 1 lb. of water vapor at 5 lb. gage is about 25 per cent less than at atmospheric pressure.

A considerable improvement in operation results by heating evaporator E with steam from a boiler B, see Fig. 2, thus providing a more readily controlled source of heat which is less liable to injure the evaporator E or its contents. The condensed steam is collected at S. Fig. 2 also shows the application of a pump P to produce a vacuum in evaporator E and thus carry on the evaporation at a temperature less than 212 deg. in cases where a better product is obtained thereby.

To maintain the evaporation in the single-effect plant shown in Fig. 2, somewhat more than one pound of steam must be supplied evaporator E for each pound of water vapor distilled off to condenser C. The ratio of steam to vapor varies but slightly with the steam and vapor pressures, but is greatly affected by the solution feed temperature. It is also affected by radiation from the evaporator and by loss of heat in the hot solution which must be discharged when the concentration within the evaporator reaches the limiting value. For sea-water evaporators, the loss due to radiation and blow-down is covered by assuming it equal to 5 per cent of the heat supplied in the steam.[2] Assuming an initial steam pressure of 125 lb. gage and atmospheric vapor pressure, it may readily be shown that the weight of steam supplied per pound of vapor produced is reduced from about 1.20 lb. with a feed temperature of 80 deg. fahr. to about 1.05 lb. with a feed temperature of 210 deg. Many methods of preheating the solution have been proposed and used, the most common probably being with exhaust steam from the evaporator feed pump.

Any further improvement in the steam economy of evaporators has been gotten in the past by resorting to the multiple-effect arrangement. Referring to Fig. 2, steam from boiler B is supplied to the steam jacket of the first effect E, but the vapor produced in E, instead of passing to condenser C, is condensed in the steam jacket of a second effect. Similarly, the vapor produced in the shell of the second effect is condensed in the steam jacket of a following effect, and so on until finally the vapor from the last effect is condensed in condenser C. On the assumption that 1.20 lb. of steam or vapor must be supplied each effect for the evaporation of 1 lb. of vapor therein, the relative steam economies in Table 1 are obtained for multiple-effect evaporators.

An inspection of Table 1 shows that very little additional saving in steam results by adding effects beyond the fourth:

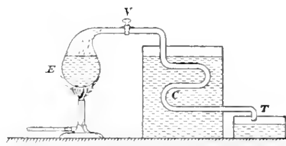

Fig. 1 Simple Method of Evaporation by Direct Application of Fire

in fact, most multiple-effect plants are limited to three or four effects with their complicated arrangements of piping, valves, traps, etc.

The New Regenerative Evaporative System

The essential feature of the new regenerative evaporative system which has been developed by the Regenerative Evaporator Company, of Baltimore, Md., is a highly efficient steam-

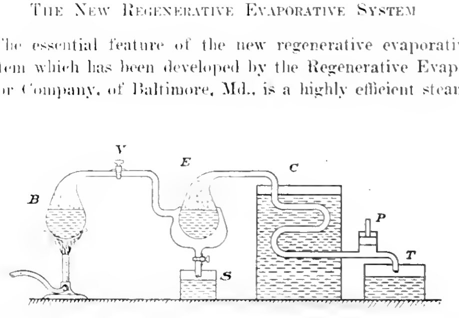

Fig. 2 Method of Evaporation in which Evaporator E is Heated with Steam from Boiler B

Table 1 Relative Economy of Multiple-Effect Evaporators

Number of effects	Steam economy per lb. of vapor evaporated, lb.	Saving in comparison with single-effect operation, per cent	Saving due to each additional effect, per cent
1	1.20		..
2	0.65	46	46
3	0.48	60	14
4	0.39	67	7
5	0.34	72	5
6	0.30	75	3

[1] Mechanical Engineer, U. S. Naval Engineering Experiment Station. Mem. Am. Soc. M.E.

[2] See Salt Water Evaporators, Calculation of Blow Down Loss, Heat Balance, Etc., by Wm. L. De Baufre, *Journal of the American Society of Naval Engineers*, November, 1915.

Abstract of a paper presented at a meeting of the Baltimore Section of The American Society of Mechanical Engineers, November 7, 1917.

jet compressor known as the "Jetflo" compressor and shown in Fig. 3. When applied to an evaporator in the manner represented in Fig. 4, the steam economy of a multiple-effect plant is attained with a simplicity of operation even greater than that of the ordinary single-effect plant.

Referring to Fig. 3, *S* is connected to the high pressure steam main, *V* to the vapor pipe from the evaporator shell and *E* to the steam jacket or more usually the steam coils within the evaporator shell, as represented in Fig. 4. With valve 3 closed and valve 2 open, the steam entering at *S* passes

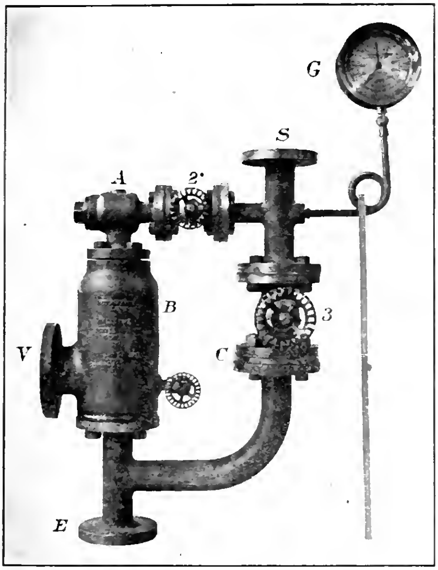

Fig. 3 The Jetflo Compressor

through a strainer in the head *A* and expands through nozzles in the compressor body *B*. At the outlet of the nozzles the steam by reason of its high velocity entrains a certain amount of vapor drawn from the evaporator through opening *V*. The commingled steam and vapor are compressed in a diffuser tube, also in the body *B* of the compressor, and are discharged through *E* into the steam coils of the evaporator with a pressure higher than the vapor pressure within the evaporator shell but lower than the initial steam pressure. Part of the vapor produced within the evaporator shell passes directly to the distiller condenser in the usual manner. The relative amounts of entrained and non-entrained vapor per pound of steam depend upon the design of the compressor and the temperature of the solution fed to the evaporator.

With valve 2 closed and valve 3 open, the steam bypasses the compressor and is supplied directly to the steam coils within the evaporator shell in the usual manner. An orifice in plate *C*, however, limits the flow of steam at the pressure available to that required for producing the maximum safe capacity of the evaporator.

The gage *G* not only indicates the pressure of the steam supplied but also the steam consumption of the evaporator with either the compressor or the bypass orifice in use. The inner scale is graduated to show the steam pressure in pounds per square inch gage. The outer scale is graduated to the capacity at which the evaporator is working, and when the reading is multiplied by a suitable constant, it gives the steam flow in pounds per hour.

The relation between the compressor and the evaporator is shown diagrammatically by Fig. 5 on which have been entered the data from a test run. The design of the compressor was such as to consume 147.8 lb. of steam per hour at 175 lb. gage pressure. The vapor pressure of 5 lb. gage within the evaporator shell was maintained by throttling the flow of non-entrained vapor to the distiller condenser. The efficiency of the compressor and the efficiency of the evaporator heating surface were then such as to set up a temperature difference between shell and coils of 16.8 deg. fahr. with 208.2 lb. of vapor entrained in the 147.8 lb. of steam, making 356 lb. of commingled steam and vapor to be condensed in the coils. There were produced in all 323.8 lb. of vapor, of which 115.6 lb. passed to the distiller condenser.

The data of Fig. 5 have been reduced to the basis of 1 lb. of vapor in Fig. 6, and the corresponding numbers of heat units have been entered thereon. From the standpoint of the evaporator alone, the performance is usual for a feed temperature of 200 deg. fahr., 1.10 lb. of commingled steam and vapor being required to produce 1 lb. of vapor. The function of the compressor was to make up 0.64 lb. of this mixture with entrained vapor, thus reducing the steam to 0.46 lb. The application of this compressor has thus saved 58 per cent of the steam that would have been required without it.

Test Results

The above data were obtained in a test made by Mr. M. C. Stuart at the U. S. Naval Engineering Experiment Station, Annapolis, Md., the results of which were summarized and

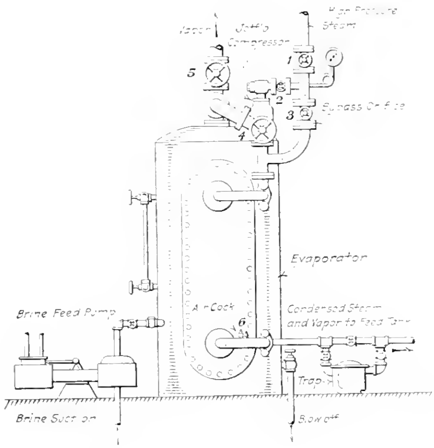

Fig. 4 Compressor of Fig. 3 Applied to an Evaporator

published in the *Journal of the American Society of Naval Engineers* for February 1918. [See abstract in The Journal, May 1918, pp. 245-247.—Editor.] While the compressor used was designed for 20 sq. ft. of heating surface in the evaporator and for an initial steam pressure of 175 lb. gage, the test covered the performance with 10 to 30 sq. ft. installed and with a range of initial steam pressure from 100 to 250 lb. gage.

The tabulated results of this test showed that the steam

economy was practically constant with a given evaporator over the wide range of steam pressures covered (averaging 0.017 lb. steam per lb. of total vapor with 20 sq. ft. of heating surface installed); and further, that the capacity produced was nearly proportional to the steam pressure (absolute). Hence the capacity of this regenerative system can be controlled without materially affecting its efficiency simply by throttling the steam supply.

One advantage of this regenerative system, however, is that the compressor can be designed for the desired capacity at the steam pressure available, thus eliminating the necessity of carefully regulating the steam supply. On naval vessels, the automatic pressure-reducing and regulating valve which it has been customary to install, may be eliminated when the compressor described is used.

Overload capacity at reduced efficiency is provided by the bypass, the orifice in which may be of such size as to pass at the available pressure the quantity of steam required to produce the maximum safe capacity of the evaporator. Since a careless attendant cannot operate the evaporator above its safe capacity, the purity of the fresh water obtained is assured. The operation of the evaporator is simplified by the application of such a compressor to the maintainance of the proper solution level within a single shell.

process must of course be continued until the desired concentration is attained. In the evaporation of sea water, however, the limiting concentration or salinity of the brine within the evaporator is determined by the danger of priming and the formation of scale and should not be permitted to exceed 3/32. A greater salinity is prevented either by a continuous or an intermittent blow-down. In the former case, the feed and blow-off valves are so regulated as to maintain a constant salinity of 3/32. In the latter case, the contents of the evaporator are completely discharged when the salinity reaches 3/32 and the shell refilled to the working level with sea water. The latter method is recommended for use with the compressors described by reason of the greater average efficiency of the heating surface and the cracking of the scale as explained below. Also, a schedule of blowing down can be worked out and followed without the necessity of taking salinometer readings.

As the evaporation of a solution proceeds, especially of sea water, the heating surfaces become coated with scale. Certain recent types of evaporators are so arranged that the scale may be cracked off the heating surface without opening the evaporator. This is accomplished by first turning off the steam supply, blowing out the evaporator contents, refilling to the operating level with cold brine, and finally suddenly admitting steam again. Difficulty with scale is reduced by operating with a low concentration, a low temperature and a small temperature difference.

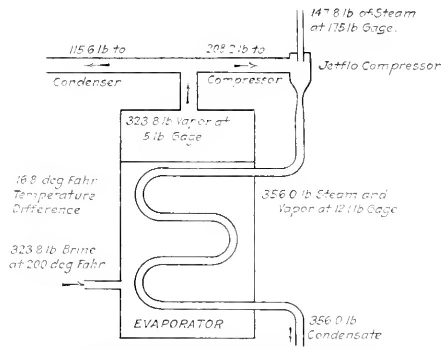

FIG. 5 DIAGRAMMATIC REPRESENTATION OF ACTION AND PERFORMANCE OF REGENERATIVE EVAPORATOR

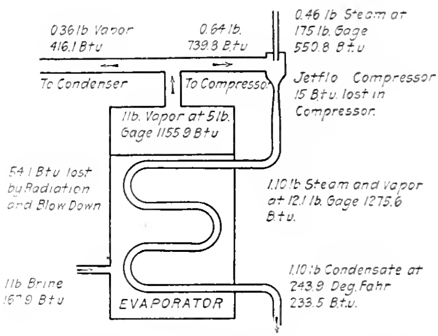

FIG. 6 HEAT BALANCE OF REGENERATIVE EVAPORATION SYSTEM

Operation of Evaporators

Several points in the operation of evaporators which must be observed are: freeing the steam coils of air; blowing down the concentrated solution; and scaling the coils.

In all apparatus heated by condensing steam, air and other non-condensable gases collect at the bottom of the steam space for the reason that air is about 50 per cent denser than dry saturated steam of the same pressure and temperature. Air cocks should therefore be provided on all evaporators near the point where the condensed steam leaves, as indicated at 6 in Fig. 4. This air cock should always be open to allow a perceptible escape of vapor during the operation of the evaporator; otherwise, the steam coils will become air bound and the capacity of the evaporator reduced.

As evaporation continues in an evaporator, the concentration of the solution increases with a consequent reduction in the efficiency of the heat-transferring surface. Where the object of evaporation is to secure a product of a given density, the

Evaporator Design

The steam economy of the ordinary single-effect or multiple-effect plant is practically independent of the design of the individual shells. The capacity, durability and ease of operation, however, are vitally affected by the design, so that different designs have been developed by experience for various classes of work. Some of the important points to be considered in design are: arrangement of steam space to produce a flow of steam across the heating surface and sweep away air and other non-condensable gases; arrangement of the solution space to produce if possible a circulation of the solution across the heating surface; sufficient volume of solution space to give a reasonable period between blow-downs; sufficient disengaging surface and vapor space to permit gravity separation of liquid from the vapor; placing of baffles so that the velocity of the vapor will be decreased rather than increased to aid the separation by inertia of the liquid from the vapor when the direction of flow is changed. With a Jetflo com-

pressor installed, the steam economy of the combination as well as the capacity is affected by the design of the evaporator.

Applications

The application of a steam-jet compressor of the type considered to the ordinary single-effect plant reduces the steam consumption by one-half and more, and the capacity obtainable depends upon the amount and efficiency of the heating surface installed in the evaporator. There is always obtainable, however, the original maximum capacity of the evaporator by means of the bypass. The compressor adds little weight and occupies practically no additional space. It is noiseless in operation, has no moving parts and retains its initial efficiency indefinitely. It makes for simplicity and safety in operation. The steam consumption of the evaporator and capacity at which it is working are indicated at all times.

In comparison with a multiple-effect plant, the same steam economy is obtained by applying a jet compressor to a single shell. This shell can be operated at atmospheric pressure; while, in a multiple-effect plant, the several shells must be of sufficient strength to withstand the high vapor pressures to which they are subjected. In the regenerative plant only one solution level need be attended to, unless it is considered desirable to divide the plant into two shells either of which may be operated at, say, quadruple-effect steam economy independently of the other shell.

On naval vessels, particularly destroyers, where two evaporators are installed for double-effect operation, the installation of these compressors enables either evaporator to be operated at triple-effect efficiency independently of the other evaporator. For a capacity of 7500 gal. per day this amounts to a saving on each destroyer of approximately 100 gal. of fuel oil per day in comparison with double-effect operation, and 400 gal. in comparison with single-effect operation. On many of the present naval vessels, the full rated capacity of the evaporators can be obtained with such compressors operating at triple-effect efficiency.

On merchant-marine vessels it is usual to install one evaporator only for make-up feed. The installation of a Jetflo compressor reduces the amount of coal burned for this purpose by 50 per cent and more. On some vessels it has been customary to carry 100 to 200 tons of fresh water for make-up feed and not to use the evaporator. To produce 100 tons of fresh water with an evaporator equipped with the compressor described would require approximately 7 tons of coal. It is questioned whether more than 7 tons of coal are not burned to carry 100 tons of make-up feed 3000 miles across the Atlantic. With weighty material such as coal and metals, the total cargo is limited by weight and not by the volume of the cargo space; hence the absence of 100 tons of make-up feedwater would enable the carrying of just that additional amount of cargo.

In many steam-generating plants the question of securing pure make-up feedwater is an acute one, particularly where superheaters are used. The least amount of sediment carried over by the moisture in the steam is deposited on the superheater surfaces. The use of evaporators equipped with Jetflo compressors insures the purest obtainable make-up feedwater with minimum expenditure of fuel to obtain it.

For the evaporation of milk and similar materials requiring narrow ranges of temperature operation and consequently low temperature differences, these compressors are peculiarly adapted. The evaporation can be carried out at any desired temperature above or below that corresponding to atmospheric pressure, and with high steam economy and great simplicity in operation. They can be readily applied to evaporators now in operation with but slight changes in the piping only. They are also suitable for operation with any make or type of chemical evaporator in which the object of the evaporation is the concentration of the product.

THE PUBLIC INTEREST AS THE BEDROCK OF PROFESSIONAL PRACTICE

Enlivening Discussion of Mr. Cooke's Paper at the Spring Meeting on the Responsibilities and Obligations of Engineers and Their Organizations, with a Summary of the Objects of Various Professional Societies

A discussion at the Spring Meeting which evoked a great deal of interest was that upon the paper by Morris L. Cooke on The Public Interest as the Bedrock of Professional Practice.[1] *This paper consists mainly of a review of the statements of purposes of various engineering and other professional organizations, as embodied in their constitutions or codes of ethics. The specific purpose of the author was to determine what has been, and is now, the attitude of engineering organizations toward the public interest. By this means he sought to develop the engineer's concept of his public relationships and responsibilities as contrasted with such relatively minor obligations as those to the profession of engineering, to a client, to fellow-engineers, and to himself.*

The Author,[2] in presenting his paper at the meeting, referred to features typical of the codes of the various engineering societies. These usually include references to an engineer's relations to his firm and his clients; his relationship to his fellow engineers; the maintenance of the standards of the profession; and some other requirements, as, for example, a deprecation of advertising.

In our own code we have introduced a section relative to the engineer's relations to the public which slightly, though not materially, modifies and enlarges the scope of the codes as usually drafted. The significant statement in the A.S.M.E. code, however, is that the engineer should consider the protection of clients' or employers' interests his first obligation and, therefore, avoid every act that could be considered as in any way contrary to his duty.

In contrast are the principles of professional practice of our professional brothers, the architects, which decree that the architect should not engage in, nor encourage, any practice contrary to law or hostile to the public interests, even under his client's instructions; for, as he is not obliged to accept a given piece of work, he cannot, by pleading that he has but followed his client's instructions, escape the condemnation attaching to his unethical or unlawful acts.

[1] Published in The Journal for May 1918, page 382.

[2] Washington Representative, U. S. Shipping Board, Emergency Fleet Corporation, Washington, D. C. Mem.Am.Soc.M.E.

The medical profession has for its prime object the service it can render to humanity. Reward or financial gain should be a subordinate consideration. In choosing this profession, an individual assumes an obligation to conduct himself in accord with its ideals. The following is from the code of the medical profession:

"Physicians should warn the public against the devices practiced and the false pretenses made by the charlatans, which may cause injury to health and loss of life"—a very emphatic statement. We find the same idea in the lawyers' code, which ends as follows: "Above all, a lawyer will find his highest honor in a deserved reputation for fidelity to private trust and to public duty as an honest man and as a patriotic and loyal citizen."

"Unfortunately," the author said, "my experience as an engineer and as a public official has given me the best of reasons for believing that this spirit is not representative of the engineering ethics of today."

High National Standards Depend on High Individual Standards

Bringing the matter onto a national basis, he said that recently in reading the life of John Fiske[1] he had found the following significant quotation relative to the moral principles of the Civil War:

> President Lincoln, by the summer of 1862, had come to see that the war as it had been conducted by the Administration had no clearly defined moral issue back of it, and that he could no longer find justification in continuing such a terrible conflict as he was waging against the people of the Southern States on the sole issue of an interpretation of the Constitution. He saw the necessity, for the salvation of the Nation, of getting the issue squarely on its merits as a moral issue—a conflict between the idea of freedom and the idea of slavery, and then uniting the moral and political forces of the North in support of this policy.
>
> To this end he moved on his own initiative; and one of the finest chapters in all statesmanship is the history of his skill, his patience, his wisdom, his faith in rousing the dominant moral feeling of the North and focussing it in support of his Proclamation of Emancipation.

Similarly, the speaker believed that the successful prosecution of the present war would be largely a question of our ability to keep it where President Wilson had placed it, namely, on high moral ground. This is not the work of one man, but of all the people. It is our work in all our relationships, whether they be those of town life, church life, or professional life. In this hour of real national peril, can we do less than write into our code that from this day forth it is unprofessional for an engineer to safeguard any private or special interest at the sacrifice of public welfare? Do we seek power, influence, prestige, opportunities? These and more will come when we provide for our profession this moral leadership.

Now is the Time for Code Revision

Fred J. Miller[2] (written). I think the actual attitude and practice of our members with regard to public service are far in advance of our code.

If American citizenship means anything, it means that no citizen can honorably take part in work that he knows to be against the public interest, and that principle applies to engineers, as well as to doctors, lawyers and architects.

[1] John Fiske, Life and Letters, by John Spencer Clark, vol. 1, p. 189.

[2] Major, Ordnance Reserve Corps, Ordnance Department, Rock Island Arsenal, Rock Island, Ill. Mem.Am.Soc.M.E.

Now, when so many are making sacrifices for the general good, not only of our own country but of the whole world, would seem to be the proper time to rewrite our code in the spirit of the times.

Richard A. Feiss[1] (written). Today every calling involves special knowledge and special training and the men pursuing these callings in the field or in the workshop must view their work as professional work; for each calling is today a profession. The majority, moreover, of these new professions are to be classified under the head of "engineering." The men pursuing them are by every right eligible to membership in the engineering societies. The vast majority of all these "engineering professions" are dealing more and more concretely and specifically with the handling of organized human effort. This involves social and other problems inherently of public interest.

We have all learned during the years of the war at least one thing—that no man or group of men are a law unto themselves. A man's rank or the rank of any association or group of men is no longer to be judged by the amount of worldly goods he may possess, or the amount of knowledge, or the accident of birth, but solely by the quantity and quality of service to the common good. It is therefore necessary that a society of professional men such as this take the leadership in making its prime object the setting up of standards for the profession and the development of a membership whose object is first of all the best service in both quality and quantity to the public interest.

H. J. Macintire[2] (written). We are living in an era of change. Ante-bellum conditions both in the material and spiritual world are probably gone forever and when the war ends we must face a period of reconstruction. In this new time about to dawn the heavy national debts will have to be assumed by the rich whose wealth will thus be depleted, while the increased wage of labor is automatically raising the material level of the mass of labor.

Standing between these two classes, materially speaking, is the professional man, who will have a chance such as he has never had before. Having maintained a position at neither of the extremes of society, he will be in a position for calmer judgments, for firmer progress. He will be called upon for leadership, but he can make his position enviable and assume this leadership deservedly only by such conduct as will command the esteem and confidence of the public and the respect of his fellow-engineers.

The engineer, in common with every person of education and sensibility, should be guided by the spirit of the law instead of by a slavish adherence to the letter. And surely it is not too much to ask that The American Society of Mechanical Engineers take the lead in demanding this broader ideal by so framing its code that every member of the society will be under pressure as a member (as well as an individual) to consider the interest of the community to be his greatest responsibility.

Suggestions for Code Revision

John B. Mayo[3] (written). I have read Mr. Cooke's paper and greatly admire its spirit. I find nothing to criticise and

[1] Gen. Mgr., The Joseph & Feiss Co., Cleveland, Ohio. Assoc. Am. Soc. M. E.

[2] Assistant Professor of Mechanical Engineering, University of Washington, Seattle, Wash.

[3] In Drafting Department, Electric Boat Company, Groton, Conn. Mem.Am.Soc.M.E.

cannot add to it except to remark that it has always seemed to me that the public interest might well be led up to by a reference to the description on the certificate which is framed and hangs in my hall and is signed by Eckley B. Coxe and reads thus:

"An organization for promoting acquisition of that knowledge which is necessary to the mechanical engineer to enable him most effectively to adapt the achievements of science and art to the use of mankind."

Robert J. Hearne[1] (written). That the code of ethics of The American Society of Mechanical Engineers may need rewriting, is natural; but there is nothing in the code which is directly antagonistic to the consideration of the public welfare by an engineer. The code must be read as a whole.

Although one section states that "the engineer should consider the protection of a client's or employer's interest his first obligation," yet the preceding section says he must "be governed by principles of honor and honesty and should satisfy himself . . . that the enterprise . . . is of legitimate character, and if it is of questionable character he should sever his connection with it as soon as practicable, *avoiding in so doing reflections on his previous associates*." (The italics are mine in this case, and are used to emphasize the last paragraph, which I think were better omitted.)

There are times for keeping silent, and there are times when one should speak out, and if a man is satisfied that his former associates are connected with a disreputable enterprise he should not keep silent, even if it hurts him to speak. It surely is unethical to keep silent when one knows of wrongdoing or incompetence.

It would be well, I think, to amend the section first referred to as follows:

> "The engineer should consider the protection of a client's or employer's interests his first obligation, and, therefore, should avoid every act contrary to his duty, *provided, however, that his client's or employer's interest does not infringe the rights of the public or any individual.*"

Charles M. Horton[2] contributed an interesting discussion of the ethics of daily life, the distinction between right and wrong, and the influence of environment, training and the conditions of existence. The discussion does not bear abstracting and space, unfortunately, does not permit its use here in its entirety. Mr. Horton's conclusion, however is here quoted:

"So let us write our code. And let it begin with a phrase having to do with a broad, spiritual outlook upon life, with reference to our profession, and let it end with a kindred generous phrase. Let us not talk of things having to do with the 'unprofessional' and 'inconsistent' and 'undignified.' Let us forget that kind of admonition. We do not need it. What we do need, though, and which should be embodied in the code, is forceful language having to do with the spirit embodied in the phrase of 'live and let live'—the things which, after all, are necessary if life shall be worth the living, not physically but spiritually, and a living to all, for all. Let us not be negative. Let it be written what we shall do, not what we shall not do; the negative, through inference, will take care of itself—and woe unto him who disobeys and is found guilty. Such a code would be eminently practicable. Such a code we should write. We cannot do more; we certainly should not do less. Let us go big in this thing, and let the Society stand behind it to a man."

[1] Secy-Treas., Durbrow & Hearne Mfg. Co., New York, N. Y. Mem. Am.Soc.M.E.

[2] Hadley, N. Y. Jun.Am.Soc.M.E.

Unfair Dealings with the Government Deprecated

C. Wellington Koiner[1] (written). In times of peace the best interests of the Government are not considered very seriously. The principle of "every fellow for himself and the devil take the hindmost," is usually carried out to the letter. Special privilege is sought and obtained regardless of the effect on public interest; as an illustration, too many people take the stand that the Government must not be permitted to do anything aside from certain negative functions, as it were, especially if somebody is making money out of the things that the Government should do. The scandalous claims and setups for intangible values that have been made recently before the railroad commissions and other regulating bodies is another illustration of how far some lawyers and some engineers will go in opposition to the public interest and in violation of their code of ethics.

"All for the state and the state for all" means that her interest is to be considered first and at all times conserved, in order that we, as individuals, may, at all times, receive the maximum benefits from her protection.

I heartily subscribe to Mr. Cooke's sentiment that "every code now in use by engineers in this country and abroad should be entirely rewritten on much broader lines and in a more inspiring key."

Thomas M. Roberts[2] (written). Business methods of long usage are in practice among engineers and contractors, and the custom of driving a sharp bargain is too often passed as legitimate. Such methods may be expected between man and man as long as ethical standards are held cheaply or of little value. But we may well consider their effect on our country and its Government during war, as well as the reflex action on the influence of engineers in public life.

It seems unfortunate that the Government in assembling war materials is repeatedly handicapped by the covert efforts of some engineer-contractors to insert in their specifications misleading phrases which to the Government officials seem correct, yet later result in considerable trouble and loss to the project in development. These men and their specified bids for public service cover the letter of the law, but they violate the ethical features of honest professional practice.

Mr. Roberts then cited specific instances of questionable practices in dealing with the Government in which the contractor inserted in his bid certain modifications of the original specifications which the Government was prevailed upon to accept and which became legal as soon as the bids were signed. Later, when the apparatus agreed upon was found inadequate, the Government was obliged to revert to the requirements of the specifications in order to secure satisfactory results, and had to pay the difference in cost between the device originally called for and the device offered in the bid.

"These examples," he wrote, "may not strictly be classed as acts of 'Aiding the Enemy,' but they represent a species of unethical dealings which no society of engineers or engineer-contractors should countenance.

"Let us emphasize this fundamental feature of our republic

[1] Gen. Mgr. and Engineer, Pasadena (Cal.) Municipal Light & Power Co. Mem.Am.Soc.M.E.

[2] Bureau of Yards and Docks, Navy Department, Washington, D. C. Mem.Am.Soc.M.E.

that a public interest is inseparably bound to the common welfare, and therefore every engineer and engineer-contractor in dealing with a public interest is bound by an ethical tie, which is paramount to the written law, and he should have a keen sense of justice toward the public commonweal."

Conditions Not as Bad as They Seem

Thornton Lewis[1] (written). While it is true that the codes of ethics of the various organized engineering societies are sadly lacking in definite expression upon the obligation of engineers to the public interest, nevertheless my observation leads me to believe that engineers as a class fulfill their duty to the public just as faithfully as the men of the other professions such as doctors, lawyers, etc.

This is no reason, however, why our codes should not express the fact that public interest is the first duty. In fact, there are many positive reasons why they should do this. Among them may be mentioned the inspiration and stimulation to unselfish action which the younger men of our profession would and should receive from our codes. The very nature of our profession carries many of our members to wild or remote places where they necessarily are out of touch with any large body of engineers, and so have no opportunity for consultation as to the relation of engineers to the public. Definite standards of conduct and expressed ideals in our codes would be of inestimable value to them in their endeavors to hold true to the best that is in them and their profession.

Since engineers more and more are becoming dominating factors in public-service corporations and the manufacturing industries, can we not in reality bring around a better condition of society in general by helping them to see more clearly the path of duty to the public, which, in the long run, will be to the best interests of their corporations and to their best selves?

Our new codes of ethics must embody the thought that he who serves humanity most serves himself best.

A. F. Nagle[2] (written). I regret to differ with the author, whom I believe to be actuated by sincere motives; nevertheless, I believe his paper is uncalled for.

That the founders of the Society were not indifferent to the ethical, or moral, character of its membership, is evidenced by the fact that they required a rigid search to be made by the Council into an applicant's experience and character, and if favorably acted upon, his name was to be submitted to a voting membership, consisting, at present, of over 8000, where but *two* negative votes would exclude him (see C 17). What an ordeal to go through! It is a wonder that any of us could pass through it. If, perchance, a bad man should slip in, he can at any time be expelled by a two-thirds vote of the Council (see C 25), hence one has to be not only a good man to get in but he has to remain good to stay in.

Mr. Cooke's plea that the public interest, be it city, state, nation, or humanity at large, should have paramount service from us, prompts me to ask what is implied. If our engineer be the sort of man we rightly assume him to be, he will deal faithfully with all his clients. What more can he do? I have been in the employ of cities, state and nation nearly one-half of my business life, and I can unhesitatingly say that the personnel of the engineers I have met in the public service have compared very favorably with those outside.

[1] Lewis, Robinson & Grant, Philadelphia, Pa.

[2] Elmira, N. Y. Mem.Am.Soc.M.E.

Engineers as Legislators

Oberlin Smith[1] said that while it is undoubtedly true that the engineering profession owes much to the public which has fostered and used its work, the statement regarding the duty of engineers to the public suggests, per contra, what duties the public owes to engineers. In this progressive age, with its enormous increase in efficiency due almost altogether to engineering inventions, why do we see our halls of Congress peopled with lawyers, merchants and farmers, not to say professional politicians, with scarcely an engineer in the whole conclave? The engineers, with their brethren, the architects and physicians, have not only collaborated in the building up of science and art, but of the good morals and the health and wealth of their communities. They certainly have a large share in the making of laws which tend to greater production, with greater efficiency, of the tools with which our civilization is builded.

As most of us do not have time to become practical politicians, we must depend upon our non-engineering friends to work gradually toward such a reform. This can only be done by the promotion of a proper enlightened sentiment among the mass of the people.

Correct Ethics Should Be Taught the Student

Constructor James Reed, Jr., U. S. N.[2] (written). The paper starts with the statement that "the members of our Society *individually* are doing everything in their power to help win the war" (italics are mine). We of the Government's permanent staff of engineers are tempted to elide that word "individually," or else add to it the words "and *collectively*," so magnificent has been the patriotic response to the Government's need on the part of the engineering societies and their members. Even in peace times we have believed we were a patriotic nation, but our patriotic duties did not embrace the broader view of what comprises real patriotism, namely, a consideration of the public interest always.

Judging from my own educational experiences at technical schools, there is at such schools an almost complete lack of emphasis placed on the importance of realization by engineers of the public interest.

I firmly believe here is the remedy: a thorough and constant teaching at our engineering schools of the higher ethics of the profession, the citizenship duty of the engineer, just as at our West Point and Annapolis the highest ideals of patriotism and loyalty are unceasingly held before the students.

I have never forgotten marching into section room one morning for recitation when a month-old "plebe" at Annapolis, and hearing the lieutenant instructor, standing erect before the class, say impressively, "Gentlemen—before you take your seats—you have read in the morning papers of the death of Lieutenant Philip Lansdale, U. S. N., killed in action in Samoa, and of Ensign Monahan, who refused to leave his wounded superior and fell while trying to clear a jammed Colt automatic to hold off the enemy. Always remember this act: in it are embodied all of the best traditions of our service!" I therefore offer the suggestion that a constant effort be made to hold before the student the importance of this realization in the practice of his profession, that the public interest is not to be forgotten or put aside for the benefit of the corporate interest.

[1] President and Engineer, Ferracute Machine Co., Bridgeton, N. J. Mem.Am.Soc.M.E.

[2] Mare Island Navy Yard, Vallejo, Cal. Mem.Am.Soc.M.E.

Resolution on Modification of Aims of the Society

L. P. Alford.[1] The discussion clearly calls for us to reframe our code of ethics. We ought to associate with that reframing the restatement of another provision of the Society, namely, the statement of the aims and objects expressed in our Constitution. They are quite narrow and technical, yet the tendency for the last few years has been to make the Society industrial rather than purely a society of mechanical engineering. We have broadened the activities of the Society beyond its statement of aims. The restatement of the code of ethics is to reframe for us the ideal of the duties of the engineer. When the revised draft of the code of ethics is presented there should also be presented a consistent revised draft of the objects and aims of the Society.

The following resolution was then introduced by Mr. Alford, and was carried by vote of the meeting:

> Because of the interest aroused by the paper presented by Mr. Morris L. Cooke at the Worcester meeting, and because of the frequently expressed belief that the work and activities of The American Society of Mechanical Engineers have outgrown its statement of aims and objects, it is respectfully suggested to the Council of the Society that steps be taken to reformulate the objects and aims of the Society as presented in the Constitution, and to recast the Code of Ethics of The Society to bring these in keeping with the interests and activities of the Society as a whole.

Professional Ideals

Calvin W. Rice. I have been making the spirit of this paper a religion in my administration of the office of Secretary of the Society and welcome this opportunity to express my faith in the ideals of the engineering profession.

Mr. Cooke referred to the way in which President Lincoln aroused the dormant moral feeling of the North in the support of his proclamation of emancipation, and I want to point out that from the very fact that this feeling *was* dormant, it already existed in the minds and hearts of the people and needed merely to be aroused.

Mr. Cooke has also told how President Wilson, with great ability, sensed the ideals of the Nation in this time of the world war. In the same way as before, these ideals were already existent and needed only to be phrased; and I claim for the engineers of the country, as individuals and idealists in an ideal profession, that they have contributed their share to the state of opinion and to the ideals of the nation in this present war, such as the President has expressed.

As a concrete example of the point I am making, I have just returned from a trip to the Sections of the Society and stopped at Dayton, Ohio. There I found the magnificent new clubhouse of the Dayton Engineers' Club, donated to the engineers of that city by two members of our Society. It is of chaste architecture and is located on a beautiful site overlooking the river. What is more important than this, however, is the fact that the club, as stated in the literature which it issues, is dedicated to *the dissemination of truth* and to *the creation of civic righteousness.*

This is a cheering example of the new spirit of the Nation, which shows that in this case at least the engineering profession is alive to the spirit of the times.

I have made a study (see Appendix) of the stated objects of the scientific societies of the world: of the English societies, the Royal Society, the Institution of Civil Engineers, which is the oldest engineering society—it celebrated its one hundredth anniversary just a few months ago; the societies in France, the Academy as well as La Société, corresponding to our engineering society; the Italian societies; and the societies of America, including the National Academy of Sciences. It is no reflection upon our Society that it does not stand out preëminent above all the others in its stated objects, or that it falls behind our new national ideals. There is only one society and, strange to say, it is in Germany, that in its constitution approaches what we here aim to do. As nearly as I can remember the objects of the Verein Deutscher Ingenieure are twofold: devotion to the engineering profession, and to the development of engineering *for the benefit of the Fatherland.* Here, however, the one thing is lacking that we find lacking in the whole of Germany. There is no expression of the spirit—it is all for the state.

It is not sufficient that we have the objects of this Society and of our profession for the benefit alone of the United States of America. That would be far short of the goal. We must, as Dr. Hollis has exhorted us, reconsecrate ourselves to our new ideals, as displayed in the dedication of the Dayton Engineers' Club.

Mr. Rice then stated that he had noted in the public press that Mr. Isham Randolph, a former director of the American Society of Civil Engineers, had been extended an invitation, either through Mr. Cooke or through some appropriate convention, to prepare a new code of ethics for our profession. He recommended that the Society should get in touch with Mr. Randolph so that he might include a statement applicable to mechanical engineers.

Later a motion was made and carried by the meeting requesting the Secretary to communicate with Mr. Randolph.

R. Sanford Riley,[1] speaking as the President of the Worcester Chamber of Commerce, as well as one of the older members of the Society, referred to the broadening conception of the engineering profession, and said that when he entered the profession he had not realized that engineers were as well qualified as others for service to their country. It is easy to criticise engineers because of the fact that Congress is filled with lawyers and others in lines of business different from our own; but it is largely our own fault. We are growing in numbers, and growing in importance. To grow proportionately in power we must be interested in larger affairs than our own. Worcester is important as a city largely because it is a city of engineers. They continue so large a proportion of the community that from necessity they have formed the habit of doing things in a public way—and the city has not lost anything in consequence.

The Author, in closing, called attention to a remarkable document, A Study in Hospital Efficiency, comprising a case report of the first five years of a private hospital, by E. A. Codman, M.D., 15 Pinckney St., Boston. The price of the report is $1. This report is remarkable because it analyzes with freedom and truthfulness every case treated and shows whether there were errors on the part of the surgeon through poor diagnosis or lack of technique; faults in nursing; faults on the part of the patient, etc. This was instanced by the author as an advanced step in professional ideals. The report also constitutes a strong condemnation of fee splitting, which so often leads to unnecessary surgery. The application to other professions is obvious.

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[1] Chief of Staff, *Industrial Management*, New York, N. Y. Mem.Am. Soc.M.E.

[1] President, Sanford Riley Stoker Co., Ltd., Worcester, Mass. Mem. Am.Soc.M.E. Supervisor Trial Trips, Emergency Fleet Corporation, Philadelphia, Pa

APPENDIX [1]

OBJECTS OF PROFESSIONAL SOCIETIES CLASSIFIED

In examining the objects of some ninety of the largest and better-known professional societies, including professions other than engineering, both of the United States and abroad, the resemblances are found to be many. In the great majority of the societies the objects incline toward the advancement of their respective professions, the improvement of the professional standing of their members and the fostering of the social spirit within the various groups. Practically all agree as to the methods to be employed in attaining these objects—the establishment of society rooms, the holding of frequent meetings, both social and professional, the presentation of papers and the soliciting of discussion, with their publication and distribution to the membership through the medium of monthly journals or bulletins or yearly transactions.

A limited classification has been made to show in a very general way how the societies are grouped under certain headings. In most cases, of course, a society is mentioned in connection with two or three different objects, all of which it may desire to attain.

Perhaps the aim most frequently stated is the advancement of a particular science (usually incorporated in the name of the society) or in some cases of two or three of the allied sciences. Below is given in tabulated form the list of such societies with the wording used by them in this connection:

American Bar Association—to advance the science of jurisprudence
American Chemical Society—advancement of chemistry
American Electrochemical Society—advancement of the theory and practice of electrochemistry
American Institute of Accountants—to advance the science of accountancy
American Mathematical Society—to encourage and maintain an active interest in mathematical science
American Physical Society—advancement and diffusion of the knowledge of physics
American Political Science Association—encouragement of the scientific study of politics, public law, administration and diplomacy
American Water Works Association—the advance of knowledge of the design, construction, operation and management of water works
California Academy of Sciences—the promotion of science
Cleveland Engineering Society—the advancement of engineering, architecture and applied science
Chemists' Club of New York—the advancement of the science and application of chemistry
Clinical Society of London—cultivation and promotion of the study of practical medium and surgery
Franklin Institute of the State of Pennsylvania—the promotion and encouragement of manufactures and the mechanical and useful arts
Institution of Civil Engineers—promoting the acquisition of that species of knowledge which constitutes the profession of a civil engineer.
Institution of Mechanical Engineers—to promote the science and practice of mechanical construction
International Association of Municipal Electricians—the acquisition of knowledge relating to fire, telegraph, heat, light and power systems
Mineralogical Society—to advance the study of mineralogy, crystallography and petrology
National Fire Protection Association—to promote the science and improve the methods of fire protection and prevention
New York Academy of Medicine—investigation and promotion of the science and art of medicine
New England Water Works Association—advancement of knowledge relating to water works and water supply
North East Coast Institution of Engineers and Shipbuilders—the advancement of the sciences of engineering and shipbuilding
New York Electrical Society—dissemination of the knowledge of theoretical and applied electricity.
Oregon Society of Engineers—to advance the science of engineering and architecture
Philosophical Society of England—the furtherance of philosophy as a separate science
Surveyors' Institution—the acquisition of that knowledge which constitutes the profession of a surveyor
Western Association of Technical Chemists and Metallurgists—the general advancement of technical chemistry
Society of Mineral Industry—the progress of the mining and metallurgical arts
French Physical Society—the advance of physical science
International Society of Electricians—to promote the popularization and development of electricity
Swiss Society of Engineers and Architects—to encourage progress in architecture and mechanics

The promotion of the arts and sciences in connection with their respective lines of endeavor is another important end to be attained and the following societies have so worded this clause:

Aeronautical Society of America—the advancement of the theory and practice of aeronautics and of the allied arts and sciences
American Institute of Electrical Engineers—the advancement of the theory and practice of electrical engineering and of the allied arts and sciences
American Institute of Mining Engineers—to promote the arts and sciences in connection with the economic production of the useful minerals and metals
The American Society of Mechanical Engineers—to promote the arts and sciences in connection with engineering and mechanical construction
American Society of Refrigerating Engineers—to promote the arts and sciences connected with refrigerating engineering
Institute of Radio Engineers—the advancement of the theory and practice of radio engineering and of the allied arts and sciences
National Electric Light Association—activities shall be for the fullest development of the electrical engineering arts and sciences in all their branches
Society of Automotive Engineers—to promote the arts and sciences connected with the design and construction of automobiles, self-propelled or mechanically propelled mediums for the transportation of passengers or freight, and internal-combustion prime movers
United Engineering Society—to advance the engineering arts and sciences in all their branches
Institutio Polytechnico Brazileiro Escola Polytechnica—the study and diffusion of theoretical and practical knowledge of different branches of engineering and of the auxiliary sciences and arts

The advancement of engineering knowledge and practice is the statement in a general way of the aims of the following societies:

American Society of Civil Engineers—the advancement of engineering knowledge and practice
Engineers' Society of Northeastern Pennsylvania—the advancement of engineering knowledge and practice
Engineers' Society of Pennsylvania—the advancement of engineering in its several branches
Engineers' Society of Western Pennsylvania—the advancement of engineering in its several branches
Oregon Society of Engineers—to advance the science and practice of engineering
Society of Engineers of Eastern New York—the advancement of engineering in its several branches
Washington Society of Engineers—the advancement of engineering knowledge and practice
Western Australian Institution of Engineers—the advancement of engineering knowledge and practice
Western Society of Engineers—the advancement of the science of engineering

Another and very important purpose of a professional society is the maintenance of high professional standards. The methods of expressing this purpose are so nearly alike

[1] To accompany remarks of the Secretary.

that merely the names of those societies avowing it are given:

American Association of Engineers
American Bar Association
American Institute of Accountants
American Institute of Electrical Engineers
American Society of Civil Engineers
American Society of Engineering Contractors
American Society of Heating and Ventilating Engineers
Engineers' Society of Northeastern Pennsylvania
Engineers' Society of Pennsylvania
Engineers' Society of Western Pennsylvania
Florida Engineering Society
Institute of Radio Engineers
Mining and Metallurgical Society of America
Municipal Engineers of the City of New York
Oregon Society of Engineers
Society of Engineers of Eastern New York
Society of Municipal Engineers of the City of Philadelphia
Washington Society of Engineers
Western Australian Institution of Engineers
Swiss Society of Engineers and Architects

Either for social or professional reasons, and often for both, all societies desire to further intercourse among their members and they employ the same methods of meetings, publications and correspondence.

Research plays a large part in the aims of many, as the following enumeration shows:

American Association for the Advancement of Science—to give a stronger and more generous impulse and a more systematic direction to scientific inquiry
British Association for the Advancement of Science—to give a stronger impulse and a more systematic direction to scientific inquiry
Canadian Society of Civil Engineers—to encourage original investigation
Colorado Scientific Society—the promotion of scientific observation
Michigan Academy of Science—encouragement of research
National Academy of Sciences—to investigate, examine, experiment and report on any subject of science
New York Academy of Medicine—the investigation of the science and art of medicine
Rensselaer Society of Engineers—the encouragement of original scientific research
Royal Society of Canada—to aid researches
Belgian Royal Academy of Sciences—researches in the field of sciences and letters, in particular mathematics and physics
National Institute of Sciences and Arts—to perfect sciences and arts by constant research
International Society of Electricians—by means of money or instruments to promote work on research and scientific undertakings
Western Association of Technical Chemists and Metallurgists—to encourage research in the metallurgy of precious and rare metals

Certain societies are devoted either to the encouragement of research and inquiry in, or the material development of, certain sections of the country, as:

Missouri Historical Society—encouragement of historical research and inquiry, especially within the state of Missouri and the Mississippi Valley
Municipal Engineers of the City of New York—to further the material development of the City of New York
New York Historical Society—to discover, procure and preserve whatever may relate to the natural, civil, literary and ecclesiastical history of the United States in general and of the State of New York in particular
Society of Municipal Engineers of the City of Philadelphia—to further the material development of the City of Philadelphia

The note of service to the public is struck by a few societies and though doubtless all aim to do this, nevertheless the following think it wise to state so quite definitely:

American Institute of Architects—to make the profession of ever-increasing service to society
Institution of Mechanical Engineers—to give an impulse to inventions likely to be useful to members of the Institution and to the community at large
National Society for the Promotion of Industrial Education—to bring to public attention the importance of industrial education, to promote the establishment of institutions for industrial training
Oregon Society of Engineers—to organize engineering opinion in matters of public interest
Surveyors' Institution—to promote the general interests of the profession and to maintain and extend its usefulness for the public advantage
Society of Civil Engineers of France—to promote by the active assistance of its members, professional education among the workmen and foremen in the industries and shops
Royal Statistical Society—to collect, arrange, digest and publish facts illustrating the conditions and prospects of society in its material, social and moral relations

In a few of the societies' purposes there is a clause relating to the promoting of the interests of the members of the societies, for instance:

American Foundrymen's Association—the advancement of the interests of foundry operators
American Institute of Accountants—to safeguard the interests of public accountants
Michigan Electric Association—to foster and promote the common interests of its members
Mining Society of Nova Scotia—to mutually benefit and protect its members
French Society of Alumnae of the National School of Mines at Saint Etienne—to secure for each member a position in the industry

With many, libraries and their maintenance are considered of sufficient importance to be mentioned in the statement of their purposes, and here we have the following list:

American Institute of Mining Engineers
The American Society of Mechanical Engineers
California Academy of Sciences
Franklin Institute of the State of Pennsylvania
Insurance Society of New York
United Engineering Society

Employment of their members and the rendering of financial assistance, when possible, are other laudable motives displayed by the following societies:

French Society of Alumnae of the National School of Mines at Saint Etienne—to create an assistance fund permitting pecuniary assistance to those who may need it and to secure for each one of them a position in the industry
Society of Architects Holding Diplomas from the French Government—to come to the assistance of the members by granting pensions and financial assistance
Society of Civil Engineers of France—to search for and announce to its members vacant positions to which they might aspire and to assist temporarily within the limits of its resources those of its members who may be in need of such assistance

Two entirely different elements are introduced in connection with publicity and legislation and here we find:

American Association of Engineers—supervising proposed legislation affecting the engineering profession, and taking any action necessary or advisable to safeguard the profession's welfare; promulgating the Association's ideas through proper publicity
American Bar Association—to promote the administration of justice and uniformity of legislation throughout the union

The improvement of the professional education of their members is another aim expressed by the *American Institute of Accountants*, and by the *Insurance Society of New York*.

The *Mining and Metallurgical Society of America* has for one of its objects the conservation of mineral resources, while the *American Society of Engineering Contractors* stands for "the elimination of those practices and abuses that now exist in the engineering and contracting business."

REPORT OF THE COMMITTEE ON WEIGHTS AND MEASURES OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS[1]

To the Council of the American Society of Mechanical Engineers:

In its study of the extent of use of the metric system, your committee secured copies of a report entitled, "The Metric System in Export Trade," made by Mr. F. A. Halsey to the American Institute of Weights and Measures, an organization having for its main objects the maintenance and improvement of the English system of weights and measures.

This report is based upon more than fourteen hundred answers to a questionnaire which was sent to several thousand manufacturing concerns in the United States, some or all of whose product is shipped to countries which are supposed to use the metric system.

It is the only instance which we have been able to find where an earnest and sincere effort has been made to get at the actual facts with respect to the use of the metric system in export trade from the United States. While a great deal has appeared in print on this subject, nearly all of it was based on conjecture or limited knowledge. This report, as stated, gives the actual facts reported by more than fourteen hundred manufacturers.

The information contained is of such great interest and value to all who are studying this question with a desire to get at the truth, that we feel that our Society would be rendering a real service if the essential facts of this report as deduced from the replies to the questionnaire were presented to the membership. Your committee, therefore, offers herewith a comprehensive abstract of this report which comprises a careful summary of the replies received and the conclusions to be drawn from them.

Respectfully submitted,

L. D. Burlingame, *Chairman*
E. M. Herr
F. A. Halsey
J. Sellers Bancroft
A. L. De Leeuw
Committee on Weights and Measures

In view of the thoroughness of the inquiry, this report may fairly be regarded as a census of the use of the metric system in this country.

The inquiry took the form of a questionnaire, which was sent to the following lists of manufacturers:

1 Our own members, of whom many are exporters

2 The members of the American Manufacturers Export Association

3 Those included in a card list of exporting manufacturers compiled by the American Manufacturers Export Association.

The total number of those to whom questionnaires were sent exceeded 6000. No selections were made from these lists, the questionnaires being sent to every name upon them. The number of countable replies received was 1445.[2]

The promise of a copy of our report to each one who answered the questionnaire (see form letter below) brought many replies from those who added to their questionnaires that they did no export business, or that their export business was confined to English-speaking countries. Such questionnaires, having no significance, were not counted.[1]

A considerable number of replies were received, filled out in due and proper form, except that they were unsigned. Such questionnaires were not counted, except those unsigned questionnaires enclosed with signed letters or in envelopes carrying printed firm or corporate names and addresses.

A few replies were received from exporting merchants but, since it is physically impossible for a merchant to record on one sheet the practice in producing the numerous products in which he deals, such replies were not counted. This was foreseen and provided for in the first paragraph of the form letter, by which the inquiry was restricted to exporting manufacturers.

The questionnaire was sent out with the form letter and immediately follows it.

Dear Sirs:

In accordance with the purpose of the Constitution of this Institute to investigate the usage of weights and measures in their various applications, we enclose to you, and to a large number of exporting American manufacturers, a questionnaire intended to discover at first hand how much truth there may be in the assertion that this country should adopt the metric system if it expects to succeed in the cultivation of foreign markets.

Such an inquiry is obviously a necessary preliminary to the proper consideration of a change in our fundamental units of weight and measure, but, until now, no effort has been made in any quarter to conduct one. You will, we are sure, agree that it is a matter of first importance and we believe you will be glad to assist us by filling out and returning the blanks of the questionnaire.

This questionnaire represents but a small part of the investigations which we have in progress, and your coöperation is of even greater importance than here appears.

In order that you may retain a copy for your files in convenient form, the blanks are enclosed in duplicate.

When completed and published a copy of our report will be forwarded to all who show interest by supplying the asked for data.

Please answer whether you do or do not use the metric system. We want the facts on both sides.

Form Letter

——————1917.

American Institute of Weights and Measures,
20 Vesey Street, New York.

Gentlemen:

Referring to your inquiry regarding our experience with weights and measures in foreign trade, you will find that experience summarized below:

We have been engaged in foreign trade for .... years.

Our line of products consists of ....

1. In our factory work, and in order to adapt our goods to the needs of buyers in metric countries, we have found it desirable to abandon English measures and use, instead, metric measures for the various dimensions of our products to the following extent:

Not at all		Make a cross in the appropriate square.
Slightly		
Considerably		
Extensively		
Exclusively		

Exclusively is understood to mean the absence of all English

[1] Presented at the Spring Meeting, Worcester, Mass., June 1918, of The American Society of Mechanical Engineers. The report is here printed in abstract form. Copies of the complete report may be obtained in pamphlet form; price 15 cents to members; 30 cents to non-members.

[2] A list containing the names and addresses of the manufacturers who replied to the questionnaire and whose replies form the basis of this report may be obtained from the American Institute of Weights and Measures.

[1] From the standpoint of *export trade*, as distinguished from *export trade with metric countries*, these latter replies (which, of course, show no use of the metric system) should have been counted.

dimensions in the product—not a few metric dimensions in every shipment.

Remarks and Particulars

2. We have found it advisable to pack our goods for trade with metric countries in containers of metric dimensions or containing metric weights to the following extent:

Not at all	
Slightly	
Considerably	
Extensively	
Exclusively	

Make a cross in the appropriate square.

Remarks and Particulars

3. In our literature for and correspondence with metric countries, we have found it advisable to give information regarding weights, output, capacities, over all dimensions, etc., in metric terms as follows:

Not at all	
Slightly	
Considerably	
Extensively	
Exclusively	

Make a cross in the appropriate square.

Remarks and Particulars

Yours very truly,

The Questionnaire

Confusion Between the First and Second Questions

The first questionnaires sent out were addressed *Manager Export Department,* but this was soon found to have been a mistake. Export departments are very familiar with shipping methods, but frequently they know little of factory practice, and their footnotes under Remarks and Particulars and accompanying letters showed that the two were frequently confused.

The object of the first and second questions was to discriminate between production and shipping methods. This is a distinction not of place but of kind, but in numerous cases it was ignored because, the packing and shipping being frequently done in the factory, they were regarded as part of the factory work. In such cases, the use of the system in shipments was made to give an answer for its use in production, and in other cases the giving of metric equivalents of English dimensions in catalogs and correspondence and even the giving of prices in metric terms were made the bases of replies showing the use of the system, in production, *so stated on the same sheets.* Some of these replies were naive in their simplicity, showing that those replying had no conception of the industrial uses of weight and measure other than shipping weights and price units.

This tendency to confuse shipping and commercial with factory methods was discovered after about 5 per cent of the questionnaires had been sent out, and thereafter they were addressed *Attention of Factory Superintendent* and, to make still plainer the distinction between the first and other questions, the following rubber-stamp impression was added to each outgoing questionnaire alongside the first question:[1]

This question relates EXCLUSIVELY to factory methods and measurements.

It has nothing to do with price units, sizes or weights of parcels or sales methods for which see other side.

[1] To further clear up any possible chance of misunderstanding in the replies, five other form letters were eventually sent out covering points which it was suspected that the writers had not fully understood.

Incomplete Answers

A considerable number of questionnaires were received in which but one or two answers were given. Examination showed that most of the answers given were in the affirmative; that is, they showed a greater or less use of the metric system. There is no reason why every return should not have included answers to all three questions. Every exporting manufacturer does or does not use the metric system in the three ways specified, and when replies were received, showing two affirmative answers with the other one blank, two explanations were possible. The first one was that the signer of the questionnaire had placed crosses for those uses of the system which he knew about and omitted the one with which he was not familiar, and the other was that the answers covered those cases in which the system is used, but passed over those in which it is not used, or, in other words, that in such cases no answer is equivalent to a negative answer.

The studiously non-partisan character of our form letters and questionnaire led many to believe that we are supporting the metric system, for which supposed activity we received both compliments and protests. But one letter of the opposite kind was received against many showing this impression, which led some to suppose we wanted only those replies that would support the metric propaganda.

Whatever the explanation, it was desirable to have the answers complete and another form letter was sent to many who failed to answer the first question.

The First Question

In our factory work, and in order to adapt our goods to the needs of buyers in metric countries, we have found it desirable to abandon English measures and use, instead, metric measures for the various dimensions of our products to the following extent:

This question is by far the most important of the three. When a manufacturer makes his products to the millimeter to the exclusion of the inch, he has, in truth, adopted the metric system and until he does that, he has not adopted it. The giving of catalog information in metric terms is a use of the metric system, but a use exactly comparable with the use of the Spanish language in catalogs for Spanish America and is no more the adoption of the metric system than the printing of such catalogs is the adoption of the Spanish language.

The fact that the commercial use of weights and measures is before us in every business transaction of every-day life leads many to assume the commercial use to be of paramount importance, and, indeed, to ignore the factory use. When we reflect that, excepting some foodstuffs, substantially everything we buy is made before it is sold, that factory measurements largely outnumber (frequently 100 and sometimes 1000 to 1) those which appear in sales transactions, that commercial measurements are usually the roughest approximations while factory measurements are often of the highest degree of refinement by precision measuring instruments developed for that purpose, we find that the primary, important measurements of civilization are those made in the production of commodities.

Replies to the first question are summarized in Table 1.

No Use of the Metric System in Production

The following extracts from letters make a suitable introduction to this phase of the subject.

The Addressograph Company (addressing machines, in export trade 12 years) write of only one request for goods to be

TABLE 1 SUMMARY OF REPLIES TO THE FIRST QUESTION

	Count of returns	Per cent
Not at all.	1188	82.2
Slightly	160	11.2
Considerably	29	2.0
Extensively	16	1.1
Exclusively	6	0.4
No reply to this question	46	3.1
Total	1445	100.00

marked in the metric system in the past twelve years.

The Babcock Printing Press Mfg. Co. (printing machinery; in export trade 30 years) write:

We consider the proposition of changing our system of weights and measures to the metric system as no more necessary or desirable than teaching the men in our shop the language of the country in which the machine is to be run.

The Berger Mfg. Co. (sheet-metal products; in export trade for 15 years) write:

We find that customers [in metric countries] are invariably acquainted with our system and that they are able to make conversions into our weights and measures the same as we do when an inquiry comes to us in metric.

The Black-Clawson Company (paper-mill machinery; in export trade 25 years) write:

We have had no trouble whatever using English measures.

The Boston Pressed Metal Company (metal stampings; in export trade 10 years) write:

France, Russia, Argentine, Brazil, Denmark, Australia and Canada use regular stock of inch sizes.

The Bristol Patent Leather Company (in export trade 12 years) write:

The largest leather-producing countries use the square foot as their basis, therefore, the square foot is a familiar unit even in countries using the metric system.

F. W. Brody & Co. (cottonseed products, in export trade "many" years) who reply Not at All to all of our questions, add:

And our exports the past season were approximately $1,000,000.

The Brown Folding Machine Company (paper-folding machinery, in export trade 20 years) write:

We cannot recall any instance where we have been asked to give anything but United States standard weights and measures.

The Brown Portable Conveying Machinery Company (portable conveying machinery; in export trade 6 years) write:

The foreign buyer buys from our standard sizes nearest to his approximate metric requirements.

The Cleveland Automatic Machine Company (machine tools) write:

We rarely have occasion to make up specifications using the metric system for abroad. We ship a vast amount of material to foreign countries.

The Collins Company (cutting tools; in export trade 70 years) write:

Our business is nine-tenths with foreign countries. We have no need whatever to use the metric system in our business.

Curtis & Marble Machine Co. (cloth-finishing machinery; in export trade 40 years) write:

Where the goods are measured by the roll or drum system, we use the regular yard circumference drum and then use compensating gears to reduce this to meters. In the South American trade there are four or five different lengths used, none of them metric and each a specific measurement for individual countries.

The Benjamin Eastwood Company (textile machinery) write:

There is no call for the metric system of weights and measures in building textile machinery for export.

The Chase Turbine Manufacturing Company (woodworking machinery; in export trade 40 years) write:

One customer has a scale attached to the machine to indicate width of opening. This scale is graduated according to the metric system.

The William J. Dines, Jr., Company (plantation machinery; in export trade 6 years) write:

When we receive orders for machinery, it is usual to receive a sketch showing the proposed installation and the dimensions are more often given in feet and inches than in the metric measures even from countries using the metric system.

The Dodge Steel Pulley Corporation (steel pulleys; in export trade 17 years) report exclusive use of English dimensions.

Eastman, Gardiner & Co. (building lumber; in export trade 12 years) write:

Last year we took up the matter with our agents in France, Belgium, Italy and England. They stated that although the metric system was used in some of the above countries, that in lumber, the buyers were so accustomed to using the English measure that it would be a great mistake to make any change in our method of figuring.

Fairbanks, Morse & Co. write:

We have been actively engaged in developing foreign trade for the past 15 years, and our experience touches practically every country in the world. The lines of goods that we manufacture and sell abroad are quite varied, embracing internal-combustion engines, steam, power, and centrifugal pumps, electrical dynamos and motors, railway supplies and windmills.

We are, of course, sending our goods to countries where the metric system is used, but we have not seen any necessity whatever for abandoning the English standard of weights and measures.

The Fawcus Machine Company (gears and gear drives; in export trade 16 years) write:

On one occasion we made some special machinery to drawings furnished by a customer in Spain on which metric dimensions were used. We readily transcribed them into English.

The Glasgow Iron Company (steel and iron plates, etc.) write:

Orders for our product come to us in feet and inches, and are so marked when shipped.

The R. P. Hazzard Company (men's shoes; in export trade 10 years) write:

We have never had called to our attention any metric system for designating sizes of boots and shoes.

The National Radiator Company (steam radiators, boilers and fittings) write:

Our foreign customers have taken our products just as we manufacture them for domestic trade.

The Penn Engineering Company (steam and water specialties, in export trade 18 years) write:

We have never used anything except English measures, nor found any need to change them at any time.

The Russell, Burdsall & Ward Bolt & Nut Co. (bolts, nuts, rivets and washers; in export trade 20 years) write:

We ship our goods to almost every country throughout the world and find that the English weights, measures, etc., are generally satisfactory.

William Sellers & Co. (machine tools and power-transmission machinery; in export trade 60 years) write:

Notwithstanding the large volume of foreign inquiry we receive, so little of it calls for adherence to the metric system as to be practically negligible.

The Walter A. Wood Mowing and Reaping Machine Company, who reply Not at All to all of our questions, say:

We do a large export trade in Scandinavia, France, Germany, Russia, Austria-Hungary and Roumania.

Manufacturers Who Replied that Metric Measures Were Unnecessary for Their Products

Representatives of some 570 different industries replied to the first question regarding the use of the metric system in the production of their goods for export by placing their crosses in the Not at All line.[1]

From the large number of chemical industries reporting it is seen that manufacturing, as distinguished from laboratory work, chemistry is conducted on the English system. The numerous electrical industries which follow the English system show that the prevailing impression that the electrical is a metric industry is unfounded.

Many of the industries from which replies were received, such as chemicals, agricultural machinery, mining machinery, etc., produce not one, but great lines of products. Such industries, however, are considered as single items, the number referring not to products, but to industries.

Partial Use of the Metric System in Production

The reports of partial use are, in some respects, the most instructive of all. From them, we learn that it is only in rare cases that the units of measure used in the production of a commodity have anything to do with its salability in any market, the calls for the metric system being always special and of no general application or significance.

For e ample, in substantially all lines of machinery, foreign purchasers of automobiles, electrical, mining, ice-making, agricultural machinery, etc., care no more about the units to which the parts of these machines are made than the reader cares about the English or metric units used in the construction of his own watch. The only exception to this law is found in about one-third of the reports for machine tools. Here the metric features called for are those few immediately concerned in measuring the products made on the machine.

Again, in the case of chemicals, it must be clear that the units used in the productions of the goods have nothing to do with the salability of the products. In steel and iron products—structural material, pipe, etc.—the preponderance of English-speaking countries in the production of these goods has made their products the standard of the world as is true, also, of automobile tires; while in textiles a letter of the American Printing Company saying that "practically all of our goods for export trade are measured in yards," shows the extent to which the yard is used as a price unit in the metric countries.

The most striking illustration is found in weighing and measuring instruments designed for weighing in metric units. In these instruments the construction remains strictly English, the only metric feature being the graduated dial or scale by which the indications are read; and in the case of recording instruments, these graduations are placed on ruled sheets of paper which are not even parts of the instruments.

[1] A list of the industries and the replies received in each is given in the complete report.

Representatives of the following industries reply to the first question by placing their crosses in the Slightly, Considerably or E clusively lines as indicated by the figures in parentheses.

Automobiles and automobile trucks: Not at all (22), Slightly (20), Considerably (2).

The use of the metric system in the automobile and automobile-truck industry to meet the needs of export trade is limited to speedometers, spark plugs, tires and wheel rims to suit the tires. Speedometers are graduated to read in kilometers just as, for Russia, they are graduated to read in versts. In both cases, we give the customer what he wants and one practice has as much and as little significance as the other.

It will be observed that most of the automobile companies who use the metric system at all place their crosses against Slightly for the use of the metric system for these items. The extent of this use is shown by the following extracts from letters.

The Cadillac Motor Car Company say:

Until a year ago millimeter-sized wheels and tires were shipped with cars to Australia, but our distributor there changed to inch sizes. Most South American countries take inch sizes, with the exception of Chile, which takes millimeter.

The Paige-Detroit Motor Car Company say:

At the present time, the demand for metric wheels, rims and tires is extremely limited. Since the first of the year, we have only shipped 6 cars so equipped.

The Dart Motor Car Company, Dodge Brothers, the Elwell-Parker Company, the Ford Motor Company, International Motor Company, Lexington Motor Company, and the Maxwell Motor Sales Corporation, all report the use of American-size tires in their trade.

Metric spark plugs are so called because of the metric screw thread by which they are secured in place, all their other dimensions being English. Such plugs, however, are not universal in metric countries. The Cole Motor Car Company say in reference to export trade:

We use the 7/8—18 S.A.E. standard spark plug.

The J. B. Crockett Company say:

The percentage of metric spark plugs against those of standard thread as used by ourselves which are exported is about two-thirds metric—the balance, 1/8, 1/2 inch and 7/8 inch, that is, omitting the regular Champion X Ford plugs. The greater portion of Ford spark plugs shipped into foreign countries are the same as the regular standard American used here.

The Paige-Detroit Motor Car Company say that requests for the metric spark plug are practically obsolete at present, and Dodge Brothers report annual shipments valued at $1,000,000 to metric countries, but all cars are furnished with standard English spark plugs.

Automobile crankshafts: Slightly (1). The Automobile Crankshaft Corporation (in export trade three years) who make this report, say:

About 60 per cent of crankshafts we are making for export are in English measurements, 20 per cent in English and metric (that is, some dimensions English and some metric) and 20 per cent in metric only.

Athletic goods: Not at all (1), Slightly (1).

Agricultural machinery: Not at all (9), Considerably (1), Slightly (1).

Abrasives and sharpening stones: Not at all (3), Slightly (1).

Ammunition: Not at all (1), Extensively (2).

Belting: Not at all (2), Slightly (4), Considerably (1), Extensively (1).

The Rossendale-Reddaway Belting and Hose Company who report Extensively, say:

We do not use it at all as far as the actual manufacturing is concerned. We do, however, receive many inquiries and orders from other countries in which they request length, breadth and thickness of belting according to the metric system, and in filling the orders, we supply them with the nearest measurements we have in feet and inches.

Brass and copper goods: Not at all (6), Slightly (2), Extensively (1). The Bridgeport Brass Company (in export trade 25 years), who report Slightly, say:

We have furnished during the last two or three years large quantities of brass disks for the manufacture of cartridge cases, the dimensions of which were specified in metric units. These metric units we simply translate into the corresponding English equivalents and proceeded with the order. We have made seamless tubes in a similar manner and several million copper bands for shrapnel.

Bolts, nuts and rivets: Not at all (4), Slightly (3). Boiler tubes: Not at all (1), Considerably (1). Ball bearings: Not at all (1), Slightly (1). Balls: Not at all (2), Considerably (1).

Brick: Slightly (1). Boiler tube cleaners: Considerably (1). The William B. Pierce Company (in export trade 19 years), who make this last report, say:

In countries using the metric system we merely use that system for turning and measuring the outside diameter of the machine.

Boat oars, hardwood dimension stock, etc.: Slightly (1).

Cutting tools: Not at all (14), Slightly (4), Considerably (5). The Cleveland Twist Drill Company (in export trade 30 years) who report Considerably, say that to France, Sweden, Italy and Spain their shipments are 90 per cent to 100 per cent metric. Shipments to Norway, Holland, Denmark and Russia are about 50 per cent English and 50 per cent metric. Shipments to Japan are about 90 per cent English and 10 per cent metric. Shipments to Central and South America are 95 per cent to 100 per cent English.

There are two types of cutting tools—those which by their own size determine the size of the work done by them (twist drills, reamers, taps, dies, milling cutters for gear teeth, etc.) and those which do not (most mechanics' hand tools). The replies showing the use of the metric system relate to the former type in all cases.

The remarks under weighing and measuring instruments below apply here almost without change. Sizing tools of millimeter dimensions are not made for use at home, but to sell for use abroad.

In 1916 a report on The Metric System in Export Trade was issued from the Bureau of Standards. Of thirty-three pages of illustrations of American metric products, twenty-seven show weighing and measuring instruments and sizing-cutting tools made for sale and use abroad, while three of the remaining six illustrations show lathes so arranged that others may cut metric screws when necessary, but every one of them fitted for cutting English screws as a primary function with makeshift translating gears to make possible the cutting of metric screws.

To those who do not understand, the illustrations make an impressive showing of the progress of the metric system; to those who do understand, they make an equally impressive showing to the contrary.

Many of these tools and instruments are of American invention. Metric countries learn of their merit and call for them. We adapt them to the needs of such customers by suitably spacing and numbering the divisions by which their indications are read.

Chemicals: Not at all (19), Slightly (1), Extensively (1). Chemical machinery: Extensively (1). The Werner & Pfleiderer Co., who report Extensively, say:

When originally starting here in this country, we took over a number of patterns and drawings in metric which we have used ever since.

Corsets: Not at all (1), Slightly (2), Considerably (1). Car wheels, chilled rolls, and roll-grinding machines: Not at all (2), Slightly (1). The Lobdell Car Wheel Company (in export trade nearly 50 years) who make this last report, say:

We occasionally get orders for chilled rolls for calendering paper to go abroad and the dimensions of the journals and necks are sometimes specified in millimeters. We have also had orders for a few wheels and axles with the metric sizes specified for the axle and hub dimensions.

Cotton duck: Not at all (2), Slightly (1). The Elm City Cotton Mills (in export trade 10 years) who make this last report, say:

We have shipped quite a bit of cotton duck to Cuba and there have been a few instances where they have asked for metric measurements. For the last few years probably 95 per cent of the shipments we have made have been billed and branded with the usual English measurements.

Clay-working machinery: Not at all (1), Slightly (1). The American Clay Machinery Company (in export trade 37 years), who make this last report, say that this use of the system refers only to dies and molds used in presses and other machines for making clay goods.

Candles, stearine, glycerine, etc.: Not at all (1), Slightly (1).

Drop forgings: Not at all (1), Slightly (2). The Armstrong Brothers Tool Company and the Billings & Spencer Co. who both report Slightly, say that this use of the system refers only to "openings in machine wrenches."

Electrical machinery: Not at all (14), Slightly (1). The Westinghouse Electric and Manufacturing Company (in export trade 20 years), who make this last report, say that metric requirements are given in only a small fraction of the business taken—too small to state in figures.

Elevators, escalators, conveying and hoisting machinery: Not at all (8), Slightly (1). Explosives: Not at all (1), Slightly (1). Electrical wires, cables and accessories: Extensively (1).

Firearms, sporting: Not at all (4), Considerably (1). The A. H. Fox Gun Company (in export trade 5 years), who make this last report, say:

About half of our foreign orders are received with the dimensions of the guns in the metric system.

Firearms, military: Not at all (2), Slightly (1). Fireclay products: Slightly (1).

Filters: Not at all (2), Slightly (1).

Glass, including plate, window, jars and bottles: Not at all (8), Slightly (2).

Ground-steel shafting: Slightly (1). The Cumberland Steel Company (in export trade 20 years), who make this report, say:

We do not think we have finished any metric sizes for two or three years, and the quantity we made at any time is very small—hardly worth considering.

Grinding wheels: Not at all (4), Slightly (1), Extensively

(1). The Abrasive Company (in export trade 17 years) who report Slightly, say:

The grinding wheels that we supply to countries using metric measure are according to English and metric measures. It would be difficult to give an approximate idea of the percentage of the two kinds of measurements used, but perhaps we would not be far wrong in specifying 3 per cent metric and 97 per cent English.

The Hampden Corundum Wheel Company (in export trade 32 years) say:

Customers frequently order in metric specifications, but we supply the nearest English equivalents to their entire satisfaction.

Gas, gasoline, and oil engines: Not at all (12), Slightly (1). Gas-engine specialties: Slightly (1). The Kokomo Electric Company (in export trade seven years) who make this last report, say:

Only in one article—a metric thread spark plug.

Hoisting machinery: Not at all (2), Slightly (1).

Hammers: Slightly (1). Fayette R. Plumb, Inc. (in export trade 30 years), says:

The only cases are a certain pattern of carpenters' hammer and a certain pattern of sledge hammer used in South America.

Handles for hand tools: Not at all (2), Slightly (1).

The Turner, Day & Woolworth Handle Co. (in export trade 30 years), who make this last report, say:

Under normal conditions, shipments to those countries in which millimeter measurements are used will run about 25 per cent against 75 per cent on which inches are used.

Ice machinery: Not at all (4), Slightly (1). The Vilter Mfg. Co. (in export trade 30 years), who make this last report, say:

We do not think we ever made any of our compressors to millimeter sizes, but have made pipes, fittings, etc., at times. [The ice machine is, essentially, a gas compressor.]

Insulated electric wire and cables: Slightly (1).

Ingot metals: Slightly (1).

Knit goods: Not at all (2), Slightly (1).

Locomotives: Not at all (1), Slightly (2), Considerably (1). The Davenport Locomotive Works (in export trade 10 years) who report Slightly, say:

Only for track gage of locomotives.

Leather goods: Not at all (1), Slightly (1). Lubricators: Not at all (4), Slightly (1). The Richards & Phoenix Co. (in export trade 6 years), who make this last report, say:

Whitworth pipe threads are usually called for.

Machine tools: Not at all (60), Slightly (32), Considerably (3).

Machine tools are the machines with which machine shops are equipped. On them all other machines of whatever kind and for whatever purpose are made and the dimensions of their parts determined. Here, if anywhere, the need of the adoption of the metric system in export trade would be imperative and the returns from this industry are hence the most instructive of all.

The returns show the greatest use of the metric system to be in this industry and it is in this industry that The American Institute of Weights and Measnres had its origin and has today among its members the greatest number of representatives, which is to say that those who have had the most experience with the system are also those who have organized to resist its further extension.

Some types of machine tool are fitted with attachments for indicating sizes and adjustments, and some are not. Such attachments, like weighing and measuring instruments for metric countries, are made to read in millimeters and frequently the graduations of these attachments are the only metric features of the machines. Thus we have drilling machines with indicators for the depth of the hole drilled reading in millimeters, but with no change in the machines. Since the circumferential speed of the cutting tools is an important thing to know, we also have cases in which tables are attached to the machines showing the speeds of different-sized drills at different rates of revolutions per minute in meters per second instead of feet per minute. We also have milling machines in which adjustments are made through the use of screws and graduated dials. In order that the indications may be made in millimeters, the screws (three in number) are cut to metric pitches and the dials graduated to read in millimeters with no other change in the machine.

Of a special class are lathes because of their important function in cutting screws, and this function has been a storm center of this controversy from the beginning. For this purpose lathes are fitted with lead, guide or master screws from which screws of other pitches are cut by the aid of combination or change gears.

How few metric countries call for any metric features of machine tools is shown by the following remarks by machine-tool builders. Except for lead and adjusting screws, which a few metric countries call for on some machines, the requirements are insignificant. About two-thirds of the replies show no metric features whatever to be asked for.

The Automatic Machine Company (automatic threading lathes; in export trade 12 years) say:

We furnish the various countries of Europe with our standard lead screw with the exception of France, Spain and Italy, to which three countries we furnish the lathes with metric lead screws.

Baker Brothers (keyway-cutting machines; in export trade 20 years) say:

We furnish some cutting tools in metric widths for keyseats, but the majority are furnished in English measurements even for metric countries.

The E. W. Bliss Company (metal-working machinery; in export trade 40 years) say:

We do not often find it necessary to make any part of our machines to metric measurements. Occasionally, some part, where tools already existing must fit, is required to be made to dimensions in millimeters.

The Cincinnati-Bickford Tool Company (drilling machines; in export trade "many" years) say:

We use metric speed and feed plates and give metric graduations on spindle sleeves or dial depth gages.

The Cincinnati Gear Cutting Machinery Co. (gear-cutting machines; in export trade 9 years) say:

For European countries we furnish a metric elevating screw for the work arbor and cutter arbor of metric diameter. All other dimensions are English.

The Cincinnati Milling Machine Company (milling machines; in export trade 20 years) say:

This applies to the feed screws which, for metric countries, are made so that the dial reads in millimeters instead of thousandths of an inch.

The Detrick & Harvey Machine Co. (planers, horizontal boring machines, gun lathes, etc.; in export trade 25 years) say:

Only in the matter of furnishing metric reading scales on certain machines. We have sold machinery in England, France, Germany,

Russia, Italy, Holland, Norway, Japan, South Africa, Chile, and other foreign countries.

The Gleason Works (gear-cutting machinery) say:

The only use we make of metric dimensions in our work is when we manufacture adjusting screws to metric standards to be used in conjunction with metric scales which show relative movements of parts of the machines.

The Lees-Bradner Company, Lodge & Shipley Machine Tool Co., The Kempsmith Manufacturing Company and the Springfield Machine Tool Company all report the use of metric units only in parts of articles for export to France.

The Norton Grinding Company (cylindrical grinding machines; in export trade 16 years) say:

There are four small parts of our grinding machines that we make to metric measurements for a few customers in some European countries.

The Rockford Drilling Machine Company (drilling machines; in export trade 17 years) say:

Metric dimensions are stamped on drilling-machine quills on machines for certain foreign countries.

Shortly after the beginning of the great war the *American Machinist* sent a commissioner (Mr. O. P. Hood) to South America. Mr. Hood's papers show that in the machine shops of South America—of which there are more than most people realize—39.3 per cent of the machine tools are American, 43.2 per cent are British and the remaining 17.5 per cent are German, Belgian and French. While South American shops have the world from which to buy, they choose machine tools made to English over those made to metric measures in the ratio of nearly 5 to 1.

Mechanical presses: Not at all (2), Slightly (1).

Magnetos: Not at all (1), Slightly (1). Machinery and equipment pertaining to the meat industry: Slightly (1).

Optical goods: Not at all (5), Slightly (2), Considerably (2), Extensively (1).

The use of the metric system in optical work applies only to the grinding of lenses, the mechanical parts of cameras, microscopes, etc., being made to the English system. This system was not adopted for the benefit of export trade, as is shown by the following from the Eastman Kodak Company:

It is customary in this work to use the metric system of measurement, probably because the practice in U. S. A. followed foreign practice where lens optics were first perfected.

Lens manufacture is one of many examples of the manner in which an industry, when transferred from one country to another, carries with it the units of measurement on which it was developed.

Another illustration is found in shoe machinery. The United Shoe Machinery Company write:

Our company established factories in England, France, Germany and Austria, and have exported goods and maintained subsidiary companies or branch offices in practically all of the countries of South America.

In order to maintain uniformity in such machines as we manufacture both at home and abroad, the English system of measurements is used in all countries so that if necessary machines and parts may be supplied from one country to another.

Another illustration is found in machinery and appliances for the chemical trade, regarding which the Werner and Pfleiderer Company write:

When originally starting here in this country, we took over a number of patterns and drawings in metric which we have used ever since.

Again, the Whitehead torpedo carried the English inch from England to Austria; as, again, steel balls carried it from the United States to Germany. The methods of wholesale precision manufacture of balls were developed in this country and taken to Germany where the customary practice today is to make steel balls to inch dimensions—German formulæ for the carrying capacity of ball bearings containing a factor for the diameter of the balls in English inches.

In the manufacture of silk fabrics, among Western nations France early gained the leading position and, as a result, the French system of numbering silk based on the denier (a weight) and the aune (a unit of length) became not only the silk standard of France, but of all countries, and is today the world standard for silk. In like manner, the early dominance of England in the cotton trade has made the English system of numbering cotton yarn based on the yard and pound the standard of the world, the only exception being France.

Equally striking is the establishment as world standards of the English standards for numbering linen and jute yarn.

But the most impressive example of the spread of standards of measurement as a result of industrial development is presented by Russia, whose system of linear measurements is based on the English inch and foot as a result of the visit of Peter the Great to England about 1701. The Russian duim is the English inch; the Russian foot is the English foot; the arshine is 28 inches; the sagene is 7, and the verst is 3500 English feet. All these are standards that will survive revolutions and invasions and are, with the language, the most stable of the country's institutions.

Oil-mill machinery: Slightly (1).

Oilless bearings: Slightly (1).

Oxygen apparatus: Extensively (1).

Power-transmission machinery: Not at all (8), Slightly (3). The Dodge Manufacturing Company (in export trade for 25 years) who make one of these reports, say:

Probably 99 per cent of our export production is made on English measurements and weights—that is, inches, feet and pounds.

The Standard Pressed Steel Company (in e port trade 10 to 12 years) find it necessary to babbitt the bearings in the shaft hangers to a diameter corresponding to shafting of millimeter diameter in use in some foreign countries.

Perforated metals: Slightly (3). The Harrington and King Perforating Company (in export trade "many" years), say:

On receipt of an order it (the metric system) is changed to the English system and thus put through the factory with a few exceptions. We often use the metric system for specifying the size of perforations in our own factory and to both foreign and domestic customers.

Pipe: Not at all (8), Extensively (1). In this case, cast-iron pipe. Platinum: Extensively (1). Paper: Not at all (13), Considerably (1), Extensively (1).

Picture frames and moldings: Not at all (2), Slightly (1). The Indiana Moulding and Frame Company, who make the last report, say:

Very few orders received requiring lengths or sizes in meters.

Piping: Not at all (1), Slightly (1).

Rubber goods, including automobile tires, hose, etc.: Not at all (11), Slightly (9), Considerably (2), Extensively (1). The practice regarding automobile tires is given above under automobiles. The Boston Woven Hose and Rubber Company (in export trade 30 years), who report Slightly, say:

The manufacture of hose for countries using the metric system is identical with the process used for hose consumed in this country with the single exception that the hose is made of a definite number of meters long instead of feet.

The Electric Hose and Rubber Company (in export trade 12 years) report that about 2 per cent they export to metric countries are made to millimeters and the balance to English sizes.

The Goodyear Tire and Rubber Company who have been widely heralded as having "adopted" the metric system, say:

We are shipping tires made in both English and metric sizes to countries using the metric system. We estimate that somewhat less than 20 per cent of our total tire exports are made up of metric sizes. In addition, we are actually making partial use of the metric system in manufacturing practice.

Railway material: Not at all (2). Slightly (2).

Seamless steel tubing: Not at all (1). Slightly (2). The Elwood Ivins Tube Works (in export trade 20 years or more), who make one of these reports, say:

When any person orders tubing made by metric measure, we immediately translate it in decimals of an inch. We never bill our tubes in metric measure, billing them in decimals of an inch. It is not by any means frequent that we get orders by metric measure.

Steel and iron products: Not at all (1). Slightly (1). Considerably (2). Shackle bolts and auto accessories: Slightly (1). The Bowen Mfg. Co. (in export trade 22 years), who make this report, say:

On one occasion we had to make a lot of spring-shackle bolts having a metric thread at one end.

Sugar machinery: Not at all (8). Slightly (2). The Joubert & Goslin Machine and Foundry Co. (in export trade 12 years), who make one of these reports, say:

The only time that we are called upon to follow metric dimensions is where we furnish some repair parts or make some addition to a machine built in Europe.

Scientific instruments: Not at all (2). Slightly (1). Extensively (1). The Brown Instrument Company say:

We build instruments [pyrometers] using both the fahrenheit and the centigrade scales. In this country probably one out of every hundred orders calls for the centigrade range.

Semi-rare ores and their products: Slightly (1).

Steam and plumbing supplies: Not at all (4). Slightly (1). The John Simmons Company (in export trade 27 years) say:

Lengths of pipe in meters for some countries.

Safety fuse: Slightly (1). The Ensign Bickford Company (in export trade 50 years), who make this report, say:

For export to South America and certain other countries, we are often required to measure the length of the fuse as well as given dimensions and weights in metric units.

Shirts and collars: Not at all (2). Slightly (1). Surgical, dental and hospital equipment and supplies: Not at all (7). Slightly (1). Spark plugs: Not at all (1). Considerably (1). The New York & Brooklyn Auto Supply Co. say:

According to our experience 50 per cent are shipped in metric thread and the balance in American threads.

Textile machinery: Not at all (9). Slightly (1). J. E. Windle (in export trade "several" years) says:

We have had to make measuring dials register in metric measure on several machines we have exported the past few years.

Tractors: Not at all (4). Slightly (1). The Knox Motors Company (in export trade three years) say:

Metric-sized spark plugs are used in our cylinders on export shipments, also metric measure is used in some ball bearings.

Transmissions for marine explosive engines Slightly (1).

Tobacco: Not at all (7). Slightly (1).

Textiles: Not at all (13). Considerably (1).

Stay bolts: Slightly (1).

Tool holders: Slightly (1). The Western Tool and Manufacturing Company (in export trade 10 years) say that this refers to threading tools only.

Vulcanized fiber. Extensively (1).

Watches and watch cases: Not at all (5). Extensively (2). The metric system was not originally applied to American watch manufacture for the benefit of export trade, but because it was believed to be better adapted to the industry. The pioneer American (the Waltham) works adopted it at an early date and have continued it. Later, the Waterbury (now the Ingersoll) Works were fitted out by men from the Waltham Works who took the metric system with them, but all other American watch works conduct their operations on the English system.

A parallel example is found in steam-boiler injectors. This industry was imported from France by William Sellers & Co., who adopted and have continued the use of the metric system, but no competitor has followed their example, all other injector factories being conducted on the English system.

Another example is found in card-indexing and filing systems. The pioneer in this industry—The Library Bureau—was founded by Mr. Melville Dewey, who was a metric enthusiast and therefore adopted the metric system at the beginning. Competitors failed to follow the example of the Library Bureau, and that company has now abandoned the system.

The Library Bureau say:

Some years ago all attempt at working to metric sizes and bringing out new cases was abandoned and the old lines were duplicated with full dimensions.

Our draftsmen and mechanics failed to make any attempt to familiarize themselves with the metric system, but simply translated the metric dimensions into English inches or fractions thereof, and worked accordingly. I do recall, however, having known one man connected with Library Bureau in former days who was inclined to brag that he had mastered the metric system sufficiently so that he could actually think in it as well as he could in feet and inches, but I take it that his was a very rare case.

A fourth example is found in magnetos. The Ericsson Mfg. Co., who manufacture the Berling magneto, write:

As a matter of fact, 10 years ago we used the metric measures in this plant exclusively, but owing to inability to get American mechanics who could use the metric system, we found it necessary to shift to the English measures and they are now used exclusively by us both for our product for domestic and export manufacture.

A fifth example is found in the chemical industry of the Solvay Process Company, of which the drawings used in the construction of the first plant came from Belgium and were in the metric system. These units were abandoned for lack of workmen educated to use them. It should be added, however, that the Solvay Process Company have continued to use metric measures of weight and capacity.

Here are five examples of the attempted adoption of the metric system under the most favorable possible conditions, namely, at the beginning of an industry. In two of these cases, it has been abandoned outright, and in the third, abandoned for measures of length.[1] In the other two cases, it has been continued in the factories where it was introduced, but it has not spread to other factories which followed them in point of time.

Moreover, those who continue to use the system because they have established an industry upon it and find the same difficulty in changing from it that they would in changing from the English system, do not find the anticipated advantages.

[1] It is well known that the great difficulty of the change centers about the unit of length.

William Sellers & Co., who introduced the system in the manufacture of injectors, write:

Our experience with the metric system, extending over 50 years, does not encourage us to extend its use beyond the borders of the shop and the class of work for which it was originally started.

Weighing and measuring instruments including pressure gages, etc.: Slightly (8), Considerably (2). The H. W. Johns-Manville Company, who report Slightly, say:

When we have orders for speedometers for Latin countries or Germany, we make them to show kilometers and not miles. On orders from Russia, we make them to show Russian versts and not miles. The number of instruments sold to these countries is very, very small as compared with countries using miles.

The L. S. Starrett Company (in export trade 25 years), who report Considerably, say:

We estimate that not more than 5 per cent of our product is in the metric system.

The Richardson Scale Company (in export trade 12 years) who report Slightly, say:

Our scales being of the even arm type, our weights are all dead weights and it makes no difference what kind of weights are used. [Which is to say that the scales supplied to metric countries are *identical* with those supplied for home trade.]

American makers of weighing and measuring instruments have developed a large export trade and, for metric countries, they are, of course, to give their indications in metric units. For example, weighing scales of the dial type are made to read in kilograms, linear measuring instruments in millimeters and pressure gages in kilograms per square centimeter.

Worm gears and lead screws: Slightly (1).

Exclusive Use of the Metric System in Production

One representative of each of the following industries replies to the first question by placing his cross in the Exclusively line.

Carbon products (1), proprietary medicines (1), coin-operated machines and violin virtuoso instruments (1), piston-head packing rings for automobiles (1), drills, reamers and tools (1), adamite rolls and miscellaneous castings (1).

The Second Question

We have found it advisable to pack our goods for trade with metric countries in containers of metric dimensions or containing metric weights to the following extent:

The use of the metric system disclosed by the second question, while of trifling importance as compared with the use covered by the first question, is even more instructive as a means of showing the slight call for its adoption for the benefit of export trade.

If we pass over the use of the system in shipments due to the fact that several foreign governments compel its use for customs purposes, the conclusion is forced upon us that, were this government support withdrawn and the system left to stand or fall by its merits, this commercial use of it would practically disappear from our export trade. Three producers of food products report slight use of metric containers (two of them for lard only), one reports considerable use of such containers, and one extensive, if we include corn products which are partly food products.

The second question was intended to cover those goods which are shipped in tin cans, pasteboard boxes and other containers of definite metric weight or capacity.

Replies immediately began to come in with crosses opposite Slightly, Considerably, Extensively and even Exclusively, but with remarks added in footnotes or accompanying letters that the practice consisted only in marking weights in kilograms on shipping cases, and bills of lading to meet the requirements of foreign customs departments and consular invoices or of customers who called attention to the requirements.

This use of the metric system is on an entirely different basis from the use of metric containers. Metric containers are used because of a commercial need, but this use of the system represents a case in which the laws of other countries reach into our own.

Putting a machine in a box, weighing the box in pounds and then stenciling the equivalent weight on the box in kilograms does not make it a metric container. To clear up this point the following rubber-stamp impression was added to outgoing questionnaires, alongside the second question:

If this use of the metric system consists of nothing more than giving weights of shipments in kilograms to meet Customs and Consular Invoice regulations, that fact should be noted under Remarks and Particulars.

Following is a summary of the replies to the second question:

TABLE 2 SUMMARY OF REPLIES TO THE SECOND QUESTION

	Count of returns	Per cent
Not at all	746	51.6
Slightly	24	1.7
Considerably	16	1.1
Extensively	13	0.9
Exclusively	1	Negligible
Give metric weights and, in a few cases, dimensions on shipping cases and bills of lading	546	37.9
No reply to this question	99	6.8
Total	1445	100.00

Certain classes of goods cannot possibly be shipped in tin cans, pasteboard boxes or other metric containers. Those which obviously belong in this class are as follows:

Slightly: Automobile trucks (1), Elevating machines (1), Pumps (1), Automobile accessories (1), Oil-mill machinery (1), Rock-crushing machinery (1), Oil-well supplies (1), Gas engines (1), Wrenches (1), Belting (1), Oiled clothing (1), Counting Machines (1), Cotton goods (1), Shirts and collars (1), Steel castings, wheels and springs (1). Total (15).

Considerably: Grain-cleaning machines (1), Electrical machinery (1), Chains (1), Mining machinery (1), Ice-making machinery (1), Automobile tires (1), Machine tools (1), Fertilizer machines (1), Bolts, nuts, and rivets (1). Total (9).

Extensively: Cast-iron pipe (1), Automobile tires (1), Paper (1), Cotton duck (1), Athletic goods (1), Gas meters (1). Total (6).

Exclusively: Machinery pertaining to the meat industry (1).

There remain the following industries which are here credited with the use of metric containers.

Slightly: Food products (3) (in two cases, lard only), Photographic apparatus, materials and supplies (1), Tape measures (1), Petroleum products (1), Tobacco products (1), Rubber goods (1), Zinc products (1). Total (9).

Considerably: Food products (1), Scientific apparatus (1), Flour and feed (1), Candles, stearine and glycerine (1), Varnishes, etc. (1), Lubricants (1), Lithopone (1). Total (7).

Extensively: Corn products (1), Belt preservatives (1), Chemicals (2), Candles, stearine and oil (1), Radium, vanadium and uranium (1), Products not named (1). Total (7).

Exclusively: None.

Put in tabular form, we have the following figures for those who may be credited with the use of metric containers, although some of them are very, very doubtful:

	Count of returns	Per cent
Slightly	9	0.6
Considerably	7	0.49
Extensively	7	0.49
Exclusively	0	0.0
Total	23	1.58

Repeatedly, in these papers such expressions as "to South America only," or "to certain South American countries" appear, with several special references to Chile as the most insistent of all countries in this matter. A few follow the practice when shipping to some European countries, but the requirement that bills of lading and weights of parcels shall be given in metric terms appears to be confined to South American, and, perhaps, Central American countries.

Replies to the number of 106 place the cross for the second question in the Not at All line, and follow this under Remarks and Particulars with the statement that they make out shipping documents and give weights of shipping parcels in metric units. Such replies are clearly a discrimination between metric containers and the giving of weights of shipments in metric terms, and, in the intended meaning of the second question, should be included in the Not at All replies. This, however, has not been done, all such replies being included in the classification of those who give metric weights on shipping cases and bills of lading.

The questionnaire was not framed to bring out the effect of the laws of foreign countries on shipping methods, and, had it been so framed, no definite summary of the facts could have been obtained because the extent of this use of metric units in the case of any shipper depends upon the countries to which he makes shipments. However, many remarks upon the papers throw light upon this phase of the subject. Of these, the following are typical examples:

In a small part of our shipments, we find it necessary to give weights in kilograms. (In export trade 10 years.)

In some instances we have had to make crates with metric dimensions and weights, and have given metric dimensions on invoices. (15 years.)

We sometimes mark tags and boxes with the metric system.

Possibly 2 per cent of the export shipments. (10 to 15 years.)

This is not required on more than 10 per cent of our export shipments. (25 years.)

In some instances we have been requested to put the weights in the metric system as well as our own. (135 years.)

Occasionally, besides the English net and gross weights, we are requested also to give the kilos. (9 years.)

Sometimes asked to give all particulars of weights and measurements in metric figures. (60 years.)

For customs purposes in a very few instances. (12 years.)

Occasionally we have a request to give size of crate and weight of shipment in advance in the metric system. (15 years.)

Applies to about 1 per cent of our shipments. (20 years.)

Occasionally requested to give not only the weights in kilos, but also the metric measurements of the packages. (10 years.)

This applies to dimensions of packing cases which all countries accept from us in cubic feet and cubic inches. (10 years.)

The request for use of the metric system is not general or universal from all our customers in any one country. Some customers require it, while others in the same country do not. (30 years.)

Ship both English and metric containers to the same countries. (Almost a century.)

Have several times shown metric dimensions, weights, etc., on invoices and cases. (20 years.)

Occasionally give weights of shipments in kilograms. (30 years.)

Many more similar quotations could be given, but the above are sufficient.

The Third Question

In our literature for, and correspondence with, metric countries, we have found it advisable to give information regarding weights, output, capacities, over all dimensions, etc., in metric terms as follows:

Following is a summary of the replies to the third question:

TABLE 3 SUMMARY OF REPLIES TO THE THIRD QUESTION

	Count of returns	Per cent
Not at all	835	57.8
Slightly	279	19.3
Considerably	114	7.9
Extensively	78	5.4
Exclusively	38	2.6
No answer to this question	101	7.0
Total	1445	100.00

The use of the system covered by the third question involves the case of machinery, no more than the giving of capacities, weights and overall dimensions in metric equivalents; in the case of structural materials, the giving of weights in kilograms per meter instead of pounds per yard with leading dimensions of sections in approximate metric equivalents; and in other cases the giving of prices per kilogram or per liter instead of per pound or per gallon.

Why do but 42 per cent of our exporting manufacturers find occasion to make any use of the system and but 8 per cent of them to make extensive or exclusive use of it in this simple way? Because buyers in other countries understand our units precisely as we understand theirs—but better.

Conclusion

The conclusion is that the export trade of the United States is conducted by the English system. From Table 1 we learn that 82 per cent of our exporters to metric countries use the metric system not at all in production, while 14 per cent use it partially and in ways that, when explained, are inconsequential; and 0.4 per cent really use it exclusively.

In the commercial use of the system the results are equally striking. By the supplementary table under the second question we find that 1.6 per cent of our exporters thus use the system in response to a commercial need, *not one* exclusively, and, while 38 per cent make some use of it in shipments because compelled to do so by the laws of foreign countries, these uses, in the light of the extracts from letters in reply to the second question, are unimportant and show that the influence of such laws when confronted with the customs of commerce is slight.

APPENDIX

Since this Report was prepared, information has been received from England regarding the outcome of the metric agitation in Great Britain. In 1916 the British Government appointed a Committee on Commercial and Industrial Policy After the War, a copy of whose official Report to Parliament has been received. This Report deals with many phases of Great Britain's future industrial policy, Chapter X being devoted to Weights and Measures. From this Chapter, the following brief extracts are made:

Having given very full consideration to the subject, we are unable to recommend the compulsory adoption of the metric system in this country.

In our opinion, it is absolutely certain that the anticipated uniformity could not be obtained for a very long period, if ever.

There is, further, the serious objection that if we induced the above-mentioned countries to change over to the metric system, we should be surrendering to Germany the advantage which our manufacturers now enjoy over here, both in their markets and our own.

We are informed that even in France, which has made the metric system nominally compulsory for more than half a century, the "pouce" (or inch) is used in textile manufacture and numerous local measures still survive.

In referring to these considerations, we have to point out that there is no unanimity even as to the theoretical merits of the metric system as compared with our own. The practical argument that its adoption is desirable in order to secure uniformity in the markets of the world has been shown to be unfounded. We are not satisfied by any evidence which has been brought before us that trade has actually been lost to this country owing to the fact that the use of the metric system is not compulsory.

But to attempt to make the use of the system universal and obligatory in this country would cause great loss and confusion at a particularly inopportune moment for the sake of distant and doubtful advantages. We are convinced that, so far from assisting in the reëstablishment of British trade after the war, such a measure would seriously hamper it.

As regards the educational advantages claimed for the change, we have been referred to a statement quoted by the Select Committee of 1895 that no less than one year's school time would be saved if the metric system were taught in the place of that now in use. The information which we have received does not support that statement, and even if it were well founded, it must be remembered that for at least a generation, children would have to learn both the new and the old measures and how to convert from one to the other.

It is often popularly supposed that the introduction of the metric system would render possible the immediate sweeping away of many complicated and varying weights and measures. As we have already indicated, this belief is, in our opinion, wholly fallacious.

We are not convinced that the metric system is, upon the whole, even theoretically superior to the British system, and we are satisfied that the practical objections to the proposed change are such as decisively to outweigh any advantages which are claimed for it.

It is to be noted, moreover, that while in an Appendix to the Report several members of the Committee, which consists of nineteen members, file reservations regarding certain items, there is no reservation regarding the Chapter on Weights and Measures. In other words, the Report, so far as this Chapter is concerned, is unanimous.

The American Institute of Weights and Measures has several members in Great Britain through whom this Report has been transmitted. Letters from these members point out that in England this Report is looked upon as concluding the discussion and ending the controversy.

LABOR TURNOVER MEETING OF NEW YORK SECTION

A WELL-ATTENDED meeting of the New York Section of The American Society of Mechanical Engineers was held at the Engineering Societies Building, New York City, on Tuesday evening, May 21, 1918, to discuss the timely subject of Labor Turnover, George R. Woods acting as chairman.

The first speaker, James J. Pearson,[1] explained the British system of zoning the country for munition orders. All factories, he said, were either registered or not; i. e., if they had voluntarily offered their services to the Government and had been accepted they became registered and were kept busy on Government work. The country was divided into areas and the Government was represented in each area by an engineer, secretary and staff, and by an employment office. All workmen were listed and were either W. M. V. (Workmen Munition Volunteers) or not; in the first case they could be sent to any part of the country where their particular services were most required. Further, each workman was classified as A, B or C, according to his fitness. The labor unions had sidestepped their internal grievances and coöperated with the Government in meeting the needs of the times. The speaker was of the belief that the present labor troubles in England were essentially local in character and quoted several instances attesting the patriotism and determination of the people in general who applied their whole energy to increase the output of munitions. During an air raid over Bolton, which resulted in the death of about 130 workmen, the women workers stuck to their jobs in the factories while their men folk were facing murder and sudden death outside.

Orrin W. Sanderson[2] complained of the excess to which discussion on labor turnover was carried without seemingly coming to a definite estimation of its causes. His company employed over 20,000 men and operated 60 different departments, one of them being the Industrial Relations Department. The records of the employment office which were kept very elaborately and included the reasons prompting the men to leave, appeared to indicate that while there was no absolute remedy for labor turnover, it could be nevertheless considerably lessened by giving more consideration to the workmen and by curtailment in the advertising for help.

[1] Late of the British Ministry of Munitions.

[2] Director of Labor, B. F. Goodrich Co., Akron, Ohio. Assoc.-Mem. Am.Soc.M.E.

Dudley Kennedy[1] illustrated some of the difficulties his corporation had encountered from the labor standpoint. With a contract to build 120 ships in 18 months starting from November 1, they had succeeded in keeping an average of 25,000 men a day on duty by employing 130,000 men in six months. This excessive turnover of 420 per cent was to be explained in part by the lack of commodities and conveniences of the new place where the corporation had rapidly established itself. He emphasized the fact that there was more labor turned over in the United States than was necessary to man all of the industries of the country and that this must be checked. The practical step recently taken by the Government in appointing a labor dictator to regulate wages would help toward keeping them at a reasonable level so that there would not be an incentive for a man to change from one job to another.

H. F. J. Porter[2] dwelt on the necessity for organization by a group of men before it could have dealings with any one. Therefore, he concluded, if two groups were properly organized, one on the part of the employer to devote its energies in looking after the conditions of labor, and the other on the part of the employee to bring workmen into a condition of efficiency, it would be possible for these two to coöperate in improving labor turnover by considering the suggestions or grievances of the laborers and discussing them through representatives with the management.

[1] With American International Shipbuilding Corporation, in charge of shipbuilding plant at Hog Island.

[2] Consulting Industrial Engineer, 200 Fifth Ave., New York, N. Y. Mem.Am.Soc.M.E.

John Calder[1] summarized the reasons why employees left after short periods and the motives which prompted the employers to release or dismiss them. Incompetency, unwillingness, etc., were plausible causes for dismissing a workman, and yet in some cases they might arise from conditions which it would be easy to remedy, such as failure on the part of the employer to teach beginners. Outside of these reasons, however, there were two others more important in causing labor turnover, namely, draft selection and competition of manufacturers. The present military necessities had developed an undesirable state regarding the classification of the drafted men and some of these had been called from industrial occupations where they were rendering their best possible service to the country. Such a condition had existed in England and France at the beginning of the war and had created there a present shortage of skilled laborers, many of whom had been disabled in the fields of battle. His own experience in building up a force of 1000 employees at short notice had led him to believe that a great deal of good could be accomplished and much future trouble avoided by maintaining friendly relations with the local and district draft boards, who had no time to visualize the situation and would be greatly assisted by any information regarding the needs of the industries in their district.

Capt. Boyd Fisher[2] told the audience of a six weeks' course for employment managers given at Rochester University and of his efforts to have this preliminary course given at other institutions. The plan was to select from among the men with from three to five years' industrial experience and a fairly complete high-school or college education those who had the temperament and personality required of an employment manager and give them this brief training. The Ordnance Department, the Quartermaster's Department, the Navy Department, the United States Fleet Corporation, the Department of Labor, and the Educational Committee of the General staff, had all combined on this program.

L. D. Burlingame[3] presented a record of the results obtained by his company during the sixteen months that they had hired women in their shops. The record showed that during each month of this period the hirings were greater than the number leaving, the opposite being the case with the men. The comparison of turnover between the two sexes was made by obtaining for each the number hired per *job made vacant*. Thus, for employees averaging $1\frac{1}{2}$ months in service, the same job would have to be supplied eight times, and if there were 800 who had left with that average service, they would represent but 100 jobs made vacant. In this manner it was found that during the year 1917 but 1.5 women were employed for each job vacant, the record for the whole shop, including men, being 2.2 hired per job vacant. During the first four months of the present year these figures were 1.8 and 2.6, respectively. While on the basis of those leaving a larger percentage of women than of men had so far been discharged this year, on the basis of those entering the figures were reversed, that is, fewer of the women hired had been discharged in proportion, this being in the ratio of 15.6 per cent men to 11.8 per cent women. During 1917, 23 per cent of the men were discharged and only 11 per cent of the women. Among those leaving voluntarily the percentage of women leaving was greater than among men. It should be remarked, however, that night work, in which men only were engaged, was distasteful and many men left because they objected to such work. These investigations indicated that an important asset in reducing turnover consisted in providing for the convenience of employees in securing homes with comfortable surroundings. Another important consideration was the relation of foremen and fellow-workmen, as this had very much to do with a man's contentment and efficiency in his place of employment. As to the class of girls who could be successful in work of the character here referred to, it was found that those who had had previous experience in employment were far more likely to become permanent and satisfied employees than those who came directly from homes and had had no background of training.

H. E. Miles[1] classified labor turnover as a symptom of defective management. Just as a shop required a tool room, so it required a training room to produce the machinists who would manufacture the goods. In every factory in England that did war work they compelled them to adopt this training-room method, and in France the Ministry of Munitions had studied all of the ways that had been tried out in their three years of war, and more than a year ago they had required every factory in France employing 300 people or more to put in a training room to train the operators. Mr. Miles showed some slides of the work women were doing in the English factories. In tool rooms girls worked to 0.008 in. after sixty days' training. There was not a single piece in aeroplane work that was not being constructed by women, from the roughing of the crankshaft to the last bit of canvas or muslin put on the machine. Women were grinding to 0.0004 in. and were taught to do this in sixty days. He concluded that in view of the records of the English and French factories where labor turnover had been so greatly reduced by the establishment of a training room, it appeared that the employers of this country had a second obligation which they had been slow in recognizing.

Major E. N. Sanctuary[2] said that an officer had been appointed by the Secretary of War to coördinate all of the various branches of the department with the idea of reporting back to headquarters with any corrections or suggestions that would tend to eliminate the lack of coöperation which had existed in the past. This officer had suggested the proper utilization in the army of the large number of men who, on the final physical examination, had been found unable to go abroad with their divisions. Thus the conservation of man power would be effected through this new agency of the War Department working in connection with the War Service Exchange, the Committee on Education and Special Training, which was turning out 10,000 technical men every month, and other organizations that would help in delivering the right kind of men to the Government.

J. J. Swan[3] summarized the work done by the Committee on Classification of Personnel in the Army, which has, among other duties, the allocation of all skilled tradesmen throughout the Army. Following the example of England, where 70,000 shipbuilders, 15,000 machinists, and 40,000 coal miners had to be called from the fighting line after several months of training, some 7,000,000 cards, each one indicating a drafted man's trade and his first, second and third preferences as to the character of employment he would desire, were kept on file

[1] Aero Marine Plane and Motor Company, Keyport, N. J. Mem.Am. Soc.M.E.

[2] Ordnance Department, U.S.A.

[3] Industrial Superintendent, Brown & Sharpe Mfg. Co., Providence, R. I. Mem.Am.Soc.M.E.

[1] Member Council of National Defense.

[2] War Service Exchange of the Adjutant General's Office, Washington, D. C.

[3] Member Committee on Classification of Personnel in the Army, Washington, D. C. Mem.Am.Soc.M.E.

with the Provost Marshal. When a call came for specialists the information was passed through to the local Boards and the tradesmen furnished. All the trades were analyzed and standardized, as well as the language throughout the entire Army, and the results printed in book form, alphabetically arranged, with an index covering the trade and a cable index for foreign communication. Similarly the Labor Department had undertaken the standardization of the munitions and shipbuilding trades. There would be specifications of the jobs and it was hoped that there would be ultimately a telegraphic clearance of labor conditions throughout the country as was the case with the Weather Bureau at this time, thus doing away with destructive competition. The question of wages would be taken care of automatically, the local price being determined by reference to local living conditions and other considerations. It was realized that it was impossible to draw the number of tradesmen required, and so the Government had instituted a series of trades schools, of which there would soon be one hundred equipped to give 100,000 men an eight weeks' training course.

J. B. Densmore[1] stated his belief that the fundamental difficulty the Government had had in handling the labor problem on a large scale, was lack of standardization of wages in both skilled and unskilled labor, lack of housing and local transportation, and the permission granted to all war industries to recruit their own labor. He assured the meeting on the part and with the authority of the Government that all of the competitive bidding and all of the independent labor recruiting by the war industries in this country was going to be stopped by the Government. There were a few preliminaries which must be taken care of before the whole machinery to handle the entire economic problem of labor in production could be arranged and announced. He felt that the only remedy for the present conditions was the standardization of wages and the establishment of a single labor-supply agency. It was shown by the records of the U. S. Employment Service that in places where it had had the exclusive labor supply, both skilled and unskilled, the labor turnover had been considerably reduced.

G. K. Parsons[2] prior to adjournment of the meeting, proposed a motion to the effect that the chairman appoint a committee to take immediate action to determine how the Society could render the greatest assistance in the solution of the problem of labor turnover. This motion was carried.

Suggestions to Aeronautical Inventors

It is announced by the Air Ministry of Great Britain that the Air Inventions Committee, formed about nine months ago, has now received and examined upward of 5000 inventions and suggestions relating to the air service and a statement has been issued to facilitate the work both of inventors and of the Committee. These suggestions are of equal interest to those in this country.

Owing to the conditions of the war, it is practically useless to submit inventions which would necessarily take a long period to develop; and, generally speaking, no very startling change in the present type of aircraft is anticipated, although improvements in parts and details are always possible, and may produce very important results.

The stage of development in construction which has now been reached is such that major improvements can only be expected from those possessing the requisite scientific and mechanical knowledge, skill and experience. Thus, radical changes in the shape of the wings of aeroplanes, the body, and the propellers are only possible after long and patient research carried out in aeronautical laboratories. Again, many inventors have forwarded proposals for helicopters and aircraft of a similar nature, which, if an efficient design could be produced, would possess certain advantages—but probably not to the extent at one time imagined. Others have suggested flapping wings and rotatory planes. Such schemes do not give any promise of being capable of development for use during this war.

As regards minor improvements, inventors should bear in mind that many details, such as turnbuckles, clips, etc., are now standardized, and that a change would only be justified by some very marked superiority. Safety devices for the machine and the pilot form a numerous class among the ideas submitted. The chief means suggested is the parachute, either applied by a harness to the pilot or directly attached to the machine. Those who have seen a passenger dropped by parachute from an aeroplane for exhibition purposes often fail to realize the conditions under which a parachute may have to be used as a safety appliance. The machine may be out of control, dropping at a velocity of 150 to 200 miles per hour, or spinning downward in flames. Many other safety devices such as automobile stabilizers, wind brakes, etc., have been proposed at various times. The additional weight incurred by the use of many of the suggested safety appliances must remain a very serious factor so long as war conditions prevail.

The engine is the heart of the aeroplane, and on its reliability depends the safety of the pilot. People acquainted only with motor-car engine practice sometimes do not realize the exacting conditions under which an aeroplane engine must work. The engine has to be capable of running for the whole of the time of flight at its maximum power. The lubrication and ignition must be perfect, and the engine must not become overheated. The rating applied to an aeroplane engine is its weight per horsepower. Engines which differ radically from present-day practice—such as the internal-combustion turbine—have small possibilities of being adopted, for successive design and reconstruction entailing probably several years' work are necessary before satisfactory results can be expected.

A subject intimately connected with the power plant is its noise. This noise constitutes one of the disadvantages of an aeroplane. For night flying a method by which it would be possible to hear from one aeroplane the approach of another would be of great advantage. The engine can be silenced without serious disadvantages, but the noise of the propeller and the hum of the wires are so great that silencing the engine is not sufficient to achieve the object in view.

Many hundreds of inventions and suggestions for inclinometers and instruments for straight flying and accurate bomb dropping have been investigated. Efficient and well-designed instruments for these purposes have been available for some time past, but it is quite possible that improved forms may still be produced, though it is scarcely likely that this can be done by any one who does not possess the scientific and mechanical knowledge required for an investigation of the nature involved. Some inventors of aeronautical instruments entirely disregard the action of centrifugal force upon pendulum and spirit-level devices. Many gyroscopic instruments have been proposed which show the inventors to possess insufficient knowledge of the correct application and limitations of a gyroscope. (*The Engineer*, vol. 126, no. 3262, July 5, 1918, p. 5)

[1] Director of U. S. Employment Service, Department of Labor, Washington, D. C.

[2] President, The G. K. Parsons Corporation, New York, N. Y. Mem. Am.Soc.M.E.

ENGINEERING SURVEY

A Review of Progress and Attainment in Mechanical Engineering and Related Fields, Including Abstracts of Articles in Current Technical Periodicals

Tractor Tests at Salina, Kan.

At the National Tractor Farming Demonstration, held at Salina, Kan., July 25 to August 2, fifty tractors of nearly as many different makes were represented, and on the afternoon of the second day all started plowing a 240-acre field of winter-wheat land, some of the furrows being half a mile in length.

Belt, fuel-economy and drawbar-pull tests were conducted on many of the tractors exhibited by a committee of agricultural engineers selected from different state agricultural schools under the direction of J. B. Davidson, Mem.Am.Soc.M.E., professor of agricultural engineering at the University of California, but owing to objections of a number of tractor makers the results of these tests will not be made public until later.

Prior to the trials proper, however, the Parrett Tractor Company, of Chicago, Ill., started a 100-hour non-engine-stop plowing demonstration, the results of which have been given out. According to correspondence in the issue of *Automotive Industries* for August 8, the engine was run on kerosene for 103 hr. 19 min., during which period there were two stops totaling 5 min. 40 sec. due to sediment in the fuel line between the kerosene tank and the carburetor. It was necessary, however, to stop plowing for 13 hr. 28 min. on account of rain.

The tractor plowed for a total period of 80 hr. 42 min. 20 sec. and averaged 2.4 miles per hour while pulling its three 14-in. Oliver plows and plowing furrows averaging 6.36 in. in depth. Traveling at this speed it averaged 0.95 acre per hour. Kerosene was used exclusively as a fuel and the consumption was 1.99 gal. per hour, equivalent to 2.008 gal. per hour-acre, the unit of measurement adopted.

The consumption of lubricating oil was 1 gal. per 12 acres plowed, or 0.084 gal. per hour-acre. A water air cleaner was used and 7.5 gal. of water were required. Much of this water was found to enter the cylinders and serve in keeping down the temperature of the kerosene mixture. During the test 24.2 gal. of water were used in the radiator, or 0.314 gal. per hour-acre.

It was demonstrated during the test that plowing can be done at night as efficiently as in the daytime. The tractor was equipped with two Prest-O-Lite lamps which provided ample illumination for this purpose.

Report on Airplane Problems

The desire to enlist the inventive talent of America in the solution of aeroplane improvements has led to the issuance of a new bulletin by the Naval Consulting Board and the Engineering Council's War Committee of Technical Societies. The bulletin opens with a summary of the possibilities for improvement in aeroplane motive power, following which is a paper contributed by E. H. Sherbondy, of the U. S. Airplane Engineering Department, Bureau of Aircraft Production, War Department, in which are further discussed the various elements in which improvement may be expected.

For manufacturing reasons the Government finds it necessary to standardize motor design and is not now in a position to consider improved motors and systems of power. Such questions must be deferred until after the pressing needs of the hour have been met. The main problems are in the connection of the engine with the airplane and in the accessories which are necessary for the proper control of engine and plane. This includes the arrangements of pipe, wire, radiators, water connections, etc. New arrangements of tanks to make the plane more bullet-proof and to decrease the danger from fire should be studied.

The following figures for the efficiency of the aeroplane motor and propeller are of interest:

Energy of fuel delivered by engine shaft to propeller (Thermal efficiency). For the indicated hp. 30%. For the brake hp.	25%	
Energy consumed by engine friction	5	
Energy lost by cooling	30	
Energy escaping in exhaust (including that of unburned fuel)	40	
Total fuel contents	100	
Mechanical efficiency of propeller		75%
Net energy of fuel delivered by propeller and available for flight (0.75 × 0.25)		19%

The question of carburetion under the extremes of barometric and temperature conditions met with in flying are fully discussed. The richness of the carbureter mixture increases with the altitude and varies inversely as the square root of the ratio of barometric pressures. Temperature effects are relatively much smaller. Carbureter regulation for varying altitude, therefore, is of the utmost importance, and for this purpose at least two devices have already been produced, which are mentioned in the bulletin. Thermostatic apparatus for temperature control is less important and its value largely depends upon its freedom from complication.

In spite of the fact that the best talent of the country has been at work upon ignition problems, this is still a promising field for investigation. The difficulties met with in automobile practice are multiplied in the airplane, due in part to the higher compression. Good electrical conductors are poor heat conductors, and the high temperatures of the aeroplane motor cause a breaking down of the electrical insulating qualities of the spark plugs. At low engine power also there is the trouble from carbonization, which can be corrected by a better system of lubrication.

W. F. Durand, Mem.Am.Soc.M.E., Scientific Attaché, American Embassy, France, contributes a valuable chapter on Problems in Aeronautics, in which he discusses materials for airplane construction, ties and fastenings, supercharging engine, airplane instruments, etc. He draws attention to the possibility of a greater use of sheet metals, the chief advantage of which for wing surface or covering would be noninflammability and perhaps greater durability, but no wing covering can be considered which is markedly heavier than present forms for the same strength. Present coverings weigh from 4 to 4.5 oz. per square yard and have a tensile strength per inch of width of 70 to 80 lb. Any proposed substitute form must also give a smooth and continuous surface comparable with present forms. For the wing skeleton or frame, steel or aluminum alloys are attracting attention and seem to offer possibilities.

For fuselage construction steel or metal construction seems here also to offer hopeful possibilities, but under general limitations of equivalence regarding weight and strength com-

pared with wood. For ties the use of steel wire cable is standard and practically universal. This product is of very high grade, but there is room for improvement even here, both in the material employed, in the mode of laying up wires to form a complex tie member and in the form of section of such member. Joint fastenings are commonly made of sheet steel or sheet bronze. There is room for improvement expressed in terms of ease of manufacture, economical distribution of material, facility for attachment of wire or cable ties, and general adaptation to purpose.

The report closes with an extended bibliography.

Inventions and ideas should be submitted to Thomas Robins, secretary Naval Consulting Board, 15 Park Row, New York.

Machine Tools for Relining Guns

A recent development in the heavy-machine-tool situation is the announcement in the *Official Bulletin* of August 12 of the equipment which will be required for the Arsenal in France where the heavy guns of the American forces are to be relined. The relining of big guns is one of the biggest salvage operations in the war, as several times the value of the guns is saved by this process. The project for this relining plant is one of the largest undertaken by the Ordnance Department, and calls for the expenditure of between \$25,000,000 and \$30,000,000. The machine tools will cost between \$12,000,000 and \$15,000,000, and will consist of gun-boring lathes, engine lathes, rifling machines and grinders.

Among the equipment are to be nearly fifty 102-in. gun-boring lathes, which it is understood are to have reinforced-concrete frames, and a very large number of 84-in. lathes. In the building of the 102-in. lathes, a giant planer with a bed 500 ft. long, now under construction, will be used. It is stated that the bed is of such length that in its alignment a correction will have to be made to allow for the curvature of the earth's surface.

In addition to the machine-tool equipment required, the relining plant in France will include extensive shrinkage pits, traveling cranes of 240 tons capacity and an electrical generating plant of several thousand kilowatts capacity.

During the past few months, while the Ordnance Department has been outlining its requirements for heavy machine tools, the Society has assisted in every possible way. The subject was discussed at the Spring Meeting at Worcester, and President Main appointed the Society's Committee on Machine Shop Practice as a Committee on Heavy Machine Tools. Through its efforts, Mr. G. E. Merryweather, Mem.Am.Soc. M.E., was appointed by Mr. Baruch as "Machine Tool Dictator," and members of our Committee have been in consultation with him and with Government officers at intervals.

Grenades

The War Department authorizes the following:

More than 18,000 persons are employed in plants throughout the country in the manufacture of hand and rifle grenades. Hand grenades are now being produced at the rate of 2,000,000 a month, and within the next four months this rate will be doubled. Rifle grenades are being produced at the rate of about 1,000,000 a month, and this rate will be multiplied appreciably within the next six months.

The hand grenade may be of the defensive, the offensive or of the chemical type, of which latter there are two classes, phosphorus and gas.

The defensive grenade is the most powerful and the one generally used when tactical conditions permit, being thrown from cover at an advancing foe. It is about the same size and shape as a very large lemon with a body or shell of gray cast iron scored with deep grooves longitudinally and transversely to insure proper fragmentation when it explodes.

The offensive grenade differs from the defensive in that it depends entirely upon its explosive effect for its usefulness against the enemy and is generally used at shorter range, in offensive tactics, and when the grenadier is not necessarily under cover.

The phosphorus grenade has a barrel-shaped container of drawn sheet steel, about $3\frac{1}{2}$ in. long and $2\frac{1}{4}$ in. in diameter; to one end of this body is welded a steel collar or bushing, threaded on the inside. Into this collar is screwed a steel thimble which runs down into the center of the inside of the body of the grenade; this thimble is designed to prevent the phosphorus charge from coming into contact with the detonator and fuse. These last, together with the standard *bouchon* assembly of which they form a part, are screwed into the top of the thimble, which is threaded on the inside for this purpose. The grenade is painted gray when loaded (live).

The phosphorus grenade furnishes a shower of burning fragments of phosphorus as well as a cloud of dense white smoke, which can be used to repel an advancing attack, or if thrown during an advance, would both furnish a screen to conceal the advance and repel any enemy parties that might be in the open.

The gas grenade is in construction similar to the phosphorus grenade. It produces a low-lying cloud of dense white gas of an intensely irritating nature which may be classed as suffocating gas. It is used largely in what might be termed "mopping-up" the trench, cleaning out dug-outs by forcing the enemy into the open, or forcing him to wear a gas mask during the advance.

Rifle grenades are used to fill in the gap between the hand grenade and the light trench mortar. The type used by our army was designed by two Frenchmen, Vivens and Bessieres, and in their honor is called the V. B. rifle grenade. It is about $2\frac{1}{2}$ in. long, 2 in. in diameter and is fired from the discharger which fits over and is attached to the muzzle of the rifle in the same manner as a bayonet.

The regular rifle cartridge is used and the grenade is thrown from the discharger by the gases from the cartridge. The bullet fires the primer in passing through the central tube of the discharger. The flash is transmitted to the fuse, timed to burn eight seconds; and the fuse in turn fires the detonator, which bursts the walls of the detonator tube, and fires the main charge, thus exploding the body of the grenade. The normal range, when the rifle is aimed at 45 deg., is about 200 yd. (*Office of the Chief of Ordnance, General Administration Bureau, Information Section*, August 3, 1918)

Training of Women Begins

Toward the middle of July a two-months' course to train women for war work as employment managers was opened in the Case School of Applied Science, Cleveland, Ohio. The course is under the direction of the United States Ordnance Department through the Committee on Labor Relations of the Cleveland Chamber of Commerce, and Miss Mildred Chadsey, of Western Reserve University, is directing the work.

Applications for enrollment were received from 200 women from all sections of the country, from whom 50 were selected. Many of these are college graduates, some have been teachers, and their ages range from 25 years up.

The course consists of daytime factory work and evening classes. It differs materially from the one given for men under Government direction in Eastern schools because few of the women have any practical experience around a manufacturing plant.

The Cleveland manufacturers are heartily coöperating in the work and have willingly taken the students in their shops. The plants in which they are employed as regular operatives include the American Multigraph Co., Cleveland Hardware Co., Cleveland Metal Products Co., Hydraulic Pressed Steel Co., Osborn Mfg. Co., Standard Parts Co., Standard Tool Co., Warner & Swasey Co., Kirk-Latty Mfg. Co., and the Steel Products Co. (*The Iron Age*, vol. 102, no. 4, July 25, 1918, p. 199)

Photomicrographs of Changes in a Metal's Structure When Under Repeated Stresses

A striking feature of the annual meeting of the American Society for Testing Materials at Atlantic City in June, was the presentation by Prof. H. F. Moore, of the University of Illinois, Urbana, Ill., of a film of photomicrographs taken at various periods in the disintegration under repeated stresses of a wrought-iron test piece. It evoked so much interest that on request it was repeated the next day.

Though applied in this instance to wrought iron because of its large crystals, distinct markings and easy deformation under stress, it is not improbable that that principle will be later applied to steel, non-ferrous metals and other alloys. This may solve many problems now not fully understood and may lead to a scheme of heat treatment prolonging the life of certain steels and rendering them less liable to fatigue.

A. G. Eldredge, head of the Department of Photography, University of Illinois, perfected the optical and photographic arrangement whereby the taking of these photomicrographs was made possible. (*The Iron Age*, vol. 102, no. 6, August 8, 1918, pp. 323 and 325)

The Peat Industry

According to statistics of the United States Geological Survey, the peat industry has increased 420 per cent during the past ten years. The gross market value of the present output is $709,900; with proper productive methods it is expected that the price per ton can be reduced to $2.50 from $7.29, price in 1917, when there were but 18 producing plants distributed on the Atlantic Coast and in the Middle West.

Peat or muck consists of partly decayed vegetable remains that contain enough carbon to burn freely when dry, and ranges from the imperfectly decayed kind, of a light yellow color, to the thoroughly disintegrated jet-black type. In an undrained swamp it contains about 90 per cent of water, which must be reduced to 30 per cent before it can be used for fuel. No artificial drying process of commercial value has been developed.

This material has frequently been used as a source of charcoal and coke, of various by-products from coke retorts, as well as in making paper, substitutes for wood, etc.

Deposits that can be used for fuel are found throughout Minnesota, Wisconsin, Michigan, New York and the New England States, and in the northern parts of Iowa, Illinois, Indiana, Ohio, Pennsylvania and New Jersey; also on the Atlantic Coast from New Jersey to southern Florida and westward along the Gulf Coast to the Mexican boundary. (*Engineering News-Record*, July 25, 1918, p. 202)

Substitute for Silks Being Tested by War Department

Preliminary tests made at the Aberdeen proving grounds indicate that a chemically-treated cotton cloth can be used as a substitute for silk, and if found practicable the discovery will effect the double result of meeting a serious shortage in silk and bringing about a money saving in the ordnance program estimated at between $25,000,000 and $35,000,000.

At present millions of yards of silk are required in making the bags which contain the large powder charges used in the firing of heavy artillery. These bags are inserted in the gun immediately behind the projectile, and the firing of them gives the propelling force that hurls the projectile at the target. The propelling charge is, of course, entirely distinct from the charge within the projectile that explodes the missile after it reaches the target.

Heretofore silk has been depended upon for these bags for the reason that no other cloth material has been found that would meet the peculiar conditions required. It is essential that not a particle of the bag container shall remain after the gun is fired. Otherwise a smoldering piece of the fabric might cause a premature explosion when a new charge is inserted.

Early in the war Germany is understood to have used a chemically treated cotton as a substitute for silk, but has since been compelled by the diminishing cotton supply to resort to other substitutes. (*Journal of Commerce*, August 12, 1918, p. 9)

Cost of Operating Air Mail

The first report of the comparative cost of the operation and maintenance of the Air Mail Service shows that the airplanes used in this service have broken all records for economy of gas consumption.

The total of all operating expenses of nine airplanes covering flights aggregating 7234 miles, was $3682. The total consumption of gas representing 113 hours and 8 minutes of flying was 1377 gal, which is $32.50 per hour—something over 50 cents per mile. The total cost of gas was $405 in flying 7234 miles.

The best performance in flying was made by a Curtis J-N-4 machine, which flew 26 hours and 40 minutes at a cost of $28.01 an hour and covered 1719 miles at a cost of 43½ cents per mile. A plane equipped with a Hispano-Suiza 150-hp. engine used approximately 8 gallons of gas per hour, and a plane equipped with a 400-hp. Liberty motor used 17 gallons per hour. This shows 40 per cent less gas consumed than generally required for airplane engines of these sizes.

The calculation of operating cost includes departmental overhead charges, interest on investment, replacement of parts, deadhead time of mechanics, gas, lubricating oils, office force, motor cycles and trucks; rent, fuel, light and telephone; pay of pilots, hangar men and mechanics.

The average consumption of gas for the nine planes was 12 gallons per hour. (*Official Bulletin*, July 25, 1918, p. 5)

Norway Rushing Work on Concrete Ships

Norway is racing with America for the honor of building the first concrete vessel to cross the Atlantic. Mr. Nick Fougner, president of the Fougner Concrete Shipbuilding Co. (Inc.), Christiania, Norway, states that he hopes to cross the Atlantic within the next two or three months on one of the larger boats which his company is building.

The shortage of wood and steel in Norway has made it necessary for shipbuilders to turn to the concrete vessel in order to offset the losses suffered by the depredations of the U boats.

The *Stier*, a 1000-ton concrete vessel recently built in the shipyards of the Fougner Concrete Shipbuilding Co., is a pioneer of the type of concrete vessel that is now under construction in Norway. It is equipped with an internal-combustion 320 hp. motor, and has four watertight transverse bulkheads of concrete, which, with a reasonable cargo, makes the ship practically unsinkable.

At present the Fougner Co. has under contract 12 additional seagoing concrete motor ships, varying in size from 200 to 3000 tons deadweight, and they have built and launched about 25 floating craft of various types, including tugs, lighters, motor ships, and dry docks.

It is expected that the Norwegian builders will adopt the new protective coating developed as the result of the research work of the engineers of the Emergency Fleet Corporation. (*Official Bulletin*, July 18, 1918, p. 9)

Over 2,000,000 Rifles Produced by U. S.

Up to and including July 27, 1918, the total number of rifles produced, inspected and accepted by the Ordnance Department was 2,000,768. This number includes 1,523,156 of United States Model 1917 and 280,000 Russian ri'es. It does not include the rifles on hand when we entered the war. The number of machine guns of all types produced, inspected and accepted since the beginning of the war up to July 27 was 96,006. The output of pistols during the same time was 414,015.

Machine-gun production continues to show a steady increase, although the output at all plants fluctuates. The number of heavy Browning machine guns inspected and accepted during the week ending July 27 was 1106, a decrease of 257 under production for the previous week. Light Brownings inspected and accepted during the past week reached a total of 2621, an increase of 557 over the previous week. Since the war began and up to and including July 27, the total number of machine guns of all types produced, inspected and accepted included 8428 heavy Brownings and 14,895 light Brownings. (*Official Bulletin*, August 7, 1918, p. 3)

General Notes

At the conference of the Engineering Division, Employment Service, Department of Labor, called by Director A. H. Krom on June 28 and held at the Engineering Club, Chicago, it was resolved to make a survey and registration of all technical persons. This register is to be compiled in conjunction with the War Industries Commission and the classification will be made by employing existing agencies represented by the various engineering and technical societies. Dr. P. L. Prentis, district superintendent, welcomed the assistance of those in attendance, who were: Dean John R. Allen, Dean Mortimer E. Cooley, W. W. DeBerard, C. E. Drayer, W. H. Finley, C. Francis Harding, A. H. Krom, Edgar S. Nethercutt, F. H. Newell, Edmund T. Perkins, J. A. Peterson, Dr. P. L. Prentis, Isham Randolph and George C. Dent.

The Government has now taken definite action designed to keep engineering students under military age in college until they complete their courses. The War Department plans to conserve this important war material through the establishment of Students' Army Training Corps in all the engineering colleges to supplement the Reserve Officers' Training Corps. Members of these organizations will be placed in the inactive service of the United States and will be classed in 5 D of the Selective Draft.

Such students will wear regulation uniforms furnished by the Government and will be required to attend training camps for a period during the summer vacations.

The draft board will not include such men in calls for induction so long as they remain in the Students' Army Training Corps.

By order of the Federal Government, the War Industries Board will supervise the filling of order of turbines of over 700 hp. This necessity grew out of a situation that developed when the Navy Department, the War Department and the Emergency Fleet Corporation were found to be competing for motive-power units, each claiming priority over the others. The twenty-one manufacturers that come under Government control have agreed not to fill orders for turbines in excess of 700 hp. for either civilian or Government purposes without a permit from the War Industries Board. It was indicated that all but a small portion of their output will be distributed between the Navy, Shipping Board and the War Department.

Detailed schedules of turbine engine requirements are being drawn up with the utmost care and will contain all necessary specifications to enable the War Industries Board to distribute the business to the best advantage among existing plants. (*The Iron Age*, vol. 102, no. 5, August 1, 1918, p. 274)

About 350 pieces of spruce are required in a single airplane. Practically all of the available spruce is in the United States and along the western coast of British Columbia. In the face of many complex problems existing in the spruce stands of the West, the Spruce Division of the Aircraft Bureau made a distinct record. In 45 days the world's largest sawmill was erected at a cost of $200,000; 1940 men operate it working in three shifts of eight hours each. A drying plant costing $350,000 was built at Vancouver Barracks and there spruce is seasoned by a kiln process worked out by the Forest Products Laboratory of the Forestry Service which effects a saving in shipping weight of 33⅓ per cent. The total spruce and fir shipped to June 15, including a large amount of each shipped to the Allies, is: spruce, 52,000,000 feet; fir, 20,800,000 feet. (*Official Bulletin*, August 7, 1918, p. 7)

The United States Fuel Administration reports a saving of coal at the rate of 350,000 tons annually in its campaign for fuel economy in steam-power plants. This saving has been initiated through the inspection of 300 of the larger plants. It is estimated that 20,000,000 tons of coal can be saved, and as fast as the work can be accomplished each of the 250,000 plants in the country will be inspected.

The Fuel Administration also announces the organization of the Industrial Furnace Section, Bureau of Conservation, to handle fuel conservation in all furnaces with the exception of those operated for the production of power, heat, and light. This includes those plants using fuel for direct heat, such as in the clay-products industries. This section is in charge of an experienced engineer who has under his immediate supervision 13 districts comprised of 31 states, covering the territory in which industrial furnaces are used. Each district has a local head who has in his organization an advisory board and a corps of inspecting engineers. A probable annual saving is estimated of 3,000,000 tons of coal.

REVIEW OF ENGINEERING PERIODICALS

SUBJECTS OF THIS MONTH'S ABSTRACTS

For Articles on Subjects Relating to the War, see Aeronautics, Engineering Materials, Machine Tools, Munitions, Varia

Aeronautics

Aluminum Pistons for Aeroplane Engines. Reprint of the official report received by the editors from the controller of the Technical Department, Aircraft Production, British Ministry of Munitions, on aluminum pistons from the 230-hp. Benz engines.

Some features are of interest. The domed head of the sand-cast aluminum piston is supported and strengthened by eight webs radiating from a central boss in the piston crown. Three cast-iron rings are fitted above the gudgeon pin and one scraper ring is provided below the gudgeon pin.

The rings are concentric and machine-hammered on the inside. They are exceptionally deep in section, being 5.25 mm. deep and only 3 mm. wide vertically. The piston-ring gap measured in position in a standard 230-hp. engine cylinder was found to be exceptionally wide, namely, 1.9 mm. The compression ratio is believed to be slightly higher in the engines fitted with the aluminum pistons than in the standard 230-hp. Benz, namely, 5.021 instead of 4.9421. (*Engineering*, vol. 106, no. 2740, July 5, 1918, p. 18, 4 figs., *d*)

The Present State of the German Aviation Program, E. H. Sherbondy. Brief historical review of the German aviation program in the last three years with some data on its present state. The most interesting part is that referring to the tests to which new planes for military purposes are put. (*Aerial Age Weekly*, vol. 7, no. 20, July 29, 1918, pp. 961-965, illustrated, *g*)

Air Machinery

Testing Air Compressors, N. S. Tennant. Description of tests on a 4000-cu. ft. Belliss & Morcom (Birmingham, England) air compressor. The data are of interest in view of the scarcity of data of tests of large air compressors.

In the present instance the output of air is controlled by a valve at the compressor intake, designed to operate intermittently, completely opening and closing as required to maintain a constant air pressure in the receiver. By this method the compressor runs continuously at full load and at its highest efficiency until such time as the demand for air is less than normal, when on a slight increase in the receiver pressure the intake valve shuts completely and the compressor runs unloaded. Under this condition the first-stage air piston runs in a partial vacuum and in the second stage the air in the clearance spaces is compressed to the discharge pressure and re-expanded to the intake pressure at every stroke. The compressor therefore runs either at full load or at no load.

The compressor in question is electrically driven by a three-phase induction motor running at a constant speed of 243 r.p.m. It is of the vertical two-stage double-acting type and is directly coupled to the driving motor.

The paper describes in detail the methods of carrying out the tests. The full-load tests were carried out by coupling the compressor to a steam engine, indicator cards being taken at frequent intervals. The no-load tests were made by driving the compressor by a 50-b.hp. direct-current motor previously calibrated on a Heenan and Froude water brake and directly coupled to the compressor for tests.

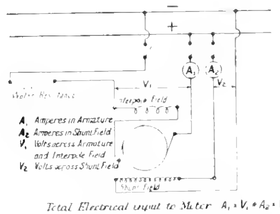


Fig. 1 Diagram of Electrical Connections for Testing Compressor at No Load by Direct-Coupled D. C. Motor

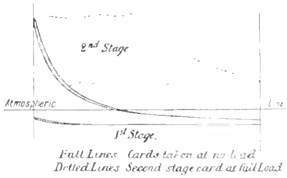


Fig. 2 Indicator Diagrams of Second-Stage Compressor Test (Full Lines: Cards Taken at No Load; Dotted Lines: Second Stage Card at Full Load)

The diagram of the electrical connections is shown in Fig. 1. The water resistance shown in the armature circuit was introduced to limit the armature current, thus protecting the motor against overloads occurring during the tests. Such protection was necessary, because if for any reason the air-inlet control valve opened during the tests, the full-load torque of the compressor would be applied to the motor.

The results of the run are shown in Fig. 3. The power at the commencement of the tests when everything was cold was, as might be expected, appreciably higher than when the normal

working temperatures were reached. The maximum power recorded at the start was 47.8 b.hp., which gradually fell with the rising temperature to the steady value of 38.2 b.hp.

Indicator diagrams shown in Fig. 2 were taken. These diagrams, among other things, show that the slip or leakage of air past the air valves is extremely small. Thus, the second-stage delivery valves have the full discharge pressure on them all the time, and any considerable air leakage would have greatly increased the area of the diagram. The temperature of the air at the compressor discharge was found to register no more than 100 deg. fahr. throughout the no-load tests. The loss due to mechanical friction alone could be deduced by subtracting the residual air i.hp. from the measured b.hp. input, which gave 38.2 — 16 = 22.2 b.hp. As a check

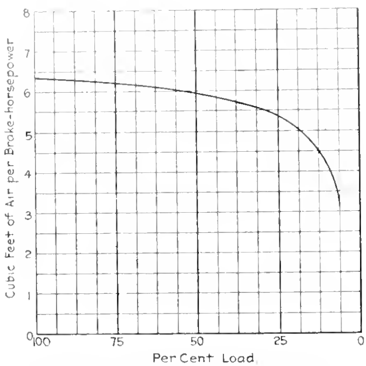


FIG. 3 EFFICIENCY OF BELLISS AIR COMPRESSOR AT VARIOUS LOADS IN CU. FT. OF AIR PER B.HP.

(Capacity, 4120 cu. ft. free air per min.; air pressure, 80 lb. per sq. in.)

on this result, the air pump was reconnected to the compressor discharge and a vacuum of about 15 in. applied. Cards taken under this condition were straight lines, no area being visible showing that the residual air hp. had been eliminated.

The input power to drive the compressor was found to be 21.6 b.hp., a result reasonably close to that deduced from the indicator diagrams. The mechanical efficiency of the compressor on the full-load test was found to be 93 per cent, which would indicate that the frictional losses increase from 3.25 per cent at no load to about 7 per cent at full load.

A further test was made to determine the loss due to piston-ring friction alone and for this purpose the first- and second-stage pistons were removed from the air cylinders. Under these conditions the power taken to drive the compressor at 243 r.p.m. was found to be 9 b.hp., this figure representing the frictional losses in the compressor bearings, main guides and metallic packing, the loss due to the piston rings alone being then 21.6 — 9 = 12.6 b.hp., or, roughly, 58 per cent of the total friction. The piston rings were examined after the test and found to be in correct adjustment, showing a good bearing surface without being unduly tight.

The no-load losses may therefore be divided as follows:

Residual air horsepower	16.6 b.hp.
Piston ring friction	12.6
Friction in bearings, guides and metallic packings	9.0
Total	32.2

(*Engineering*, vol. 106, no. 2740, July 5, 1918, pp. 8-9, 5 figs., *e*)

Engineering Materials

BRASS WEAKNESS, James Scott, Mem.Am.Soc.M.E. A microscopical investigation of brass purporting to throw some light on the causes of its mechanical weakness.

Broadly, the constitution of brass is divided by the author into three distinct grades: red, yellow and white. In the red, copper is predominant and the stage consists entirely or nearly so of alpha crystals which retain many of the qualities of the copper component and are soft and ductile. The yellow stages consist mostly of beta crystals which are stronger but not as ductile as the preceding. The white stages consist principally of gamma crystals and are very brittle. In the white stage zinc predominates and the crystals have a silvery luster.

One can, however, obtain, as it were, overlapping stages in which alpha crystals are yellow and the beta crystals red, the results depending on the action of certain proportions of the respective metals caused to undergo special processes.

A common brass may be composed of all three types of crystals most intimately mixed up, but it is the facility with which internal changes occur that most affects the mechanical properties of the metal.

Copper and zinc begin to separate out from the molten alloy at different temperatures and owing to the vaporizing tendencies of the zinc the routine of crystallization during solidification of the mass is seriously interfered with.

The writer makes some interesting remarks on the subject of the colors of the crystals which appear to be subject to surrounding influences. For instance, yellow alpha crystals appear as the vicinity of 71 per cent of copper is approached and the alloy is rapidly cooled. When the copper content is from 64 to 58 per cent and the alloy is cooled at 470 deg. cent., alpha crystals with the yellow tinge are exuded from the red beta crystals.

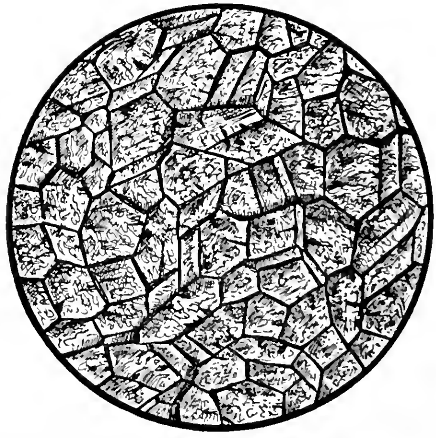


FIG. 4 CRYSTALLINE STRUCTURE OF AEROPLANE NAIL BRASS IN NORMAL STATE

A brass containing from 71 to 64 per cent of copper is, when just solidifying, made up of a mixture of alpha and beta crystals. After slow cooling, however, at 400 deg. cent. or annealing at this temperature the beta crystals become absorbed by the alpha crystals and the latter largely predominate. But further changes are possible. Beta crystals may be restored and then again vanish, especially if increase of temperature accompanies the physical action. This is why alloys con-

taining down to 60 per cent copper can only be cold-worked, while those for hot-working have to be composed of 63 to 50 per cent copper.

Commercial white brass is almost all of the gamma stage, there always being less than 45 per cent of copper present.

Rapid cooling may suppress a certain state in brass, but this is capable of prominently reasserting itself at atmospheric temperatures, the reversion being accelerated should the metal be struck or vibrated.

The writer gives illustrations taken from an etched surface (with chromic acid) of an aeroplane brass nail head. Fig. 4 shows the normal state of the metal. The grains are small and compact. Fig. 5 shows the same metal after distortion by hammering. The original grains have been forced together to form larger ones and the structure is decidedly weaker. Fig. 6 shows the same with the grains split up irregularly and crevices appear between them. This latter is due to the fact that mechanical strains and temperature variations have first caused the particles to momentarily squeeze together and after relief from the modified action to reform as much larger angular grains. The straining consequent upon such changes loosens the grains, some of which by concentration or shrinking leave crevices around their boundaries, while others gradually cleave crosswise.

This may explain the frequent dropping off of aeroplane nail heads. (*The Metal Industry,* vol. 16, no. 7, July 1918, pp. 319-320, 3 figs., *pt*)

Forge Shop

Development of Flaws in Hollow Forgings, A. S. Hesse. Discussion of mistakes sometimes made in the production of hollow forgings which will cause serious flaws to develop in the piece of steel being worked.

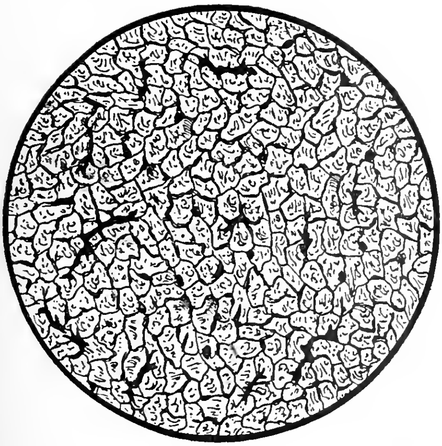


Fig. 5 Crystalline Structure of the Same Material as in Fig. 4 After Distortion by Hammering

There are three such mistakes: namely, using too small a mandrel, using flat dies in the hydraulic press or hammer, and working the metal too cold. The first of these three is by far the most serious.

The writer shows and illustrates how the use of an excessively small mandrel may develop a fissure. The worst of it is that it is possible that this fissure may not be seen at first in the interior of a long, hollow forging until its sides are crushed together. Whether the seam so formed extends deeply into the material or not, the stress which has been developed will be a vital factor in the ultimate strength of the piece.

The flaw caused by a mandrel which is too small can hardly be avoided even where the long axis of the oval hole is placed exactly vertical, for the forging is squeezed down with a tendency to form seams on both sides.

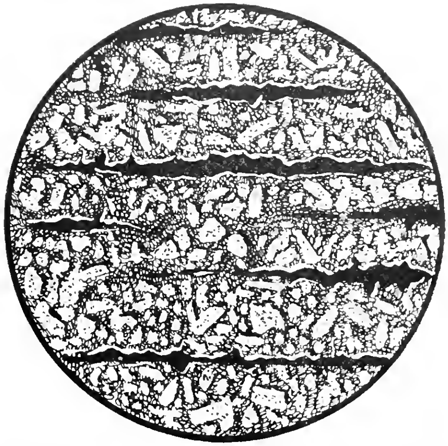


Fig. 6 Crystalline Structure of Same Material as in Fig. 4 After Being Subjected to Mechanical Stresses and Temperature Variations, Showing Cracks and Crevices

The writer also points out that seams which were formed as very minor affairs at the start will work or "travel" along and grow deeper should the smith start going over the forging a couple of times to round it up. The best practice is to draw and finish a section and stop when it no longer draws on account of the low heat and only bends from one oval axis to another. (*American Machinist,* vol. 49, no. 4, July 25, 1918, pp. 153-154, 3 figs., *p*)

Question of Quenching Oils for Forgings, Geo. W. Pressell. The writer discusses under the basis of experiments the results in quenching with different oils. He claims that the quenching speed of an oil depends on its heat-conducting properties and also on its fluidity or viscosity. Decomposition of the oil entails a reduction of the quenching speed and, in general, the more viscous an oil the slower will be its quenching speed.

The most interesting part of the paper is that illustrated by Fig. 7, showing the hardening power of distilled wool grease.

Wool grease has been known for several years and is claimed to have unusual powers of heat circulation and heat absorption. It is also claimed that it does not decompose after repeated use or show indications of further fractional distillation.

Tests were made for quenching speed at different temperatures. The test piece was made from low-carbon chrome-vanadium steel 17 in. long and $3\frac{1}{4}$ in. wide. All heating was done in lead and the test piece was heated to 1200 deg. fahr., then quickly immersed to a constant depth in 25 gal. of the quenching fluid, the immersion being such that the quenched mass was equally surrounded on all sides by the same depth of quenching fluid. A stop watch was used to measure the

time required to cool the test from 1200 to 600 deg. fahr. The following data were obtained with distilled wool-grease oil:

Temperature of quenching bath, deg. fahr.	Seconds.	Temperature of quenching bath, deg. fahr.	Seconds.
82	97	190	102
97	99	202	102
112	102	215	105
125	104	222	106
138	103	230	104
149	102	238	105
160	101	247	103
170	101	249	102

The average quenching speed was 102 sec. The total variation was 9 sec.

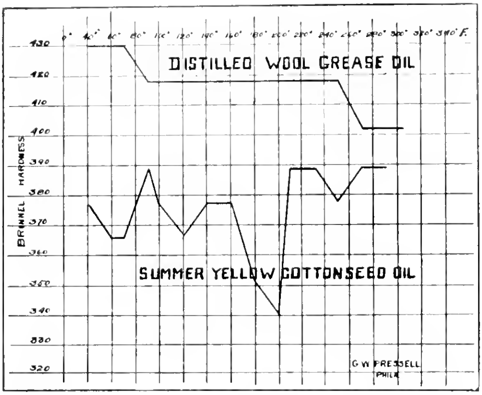


Fig. 7 Curves Showing Hardening Power of Distilled Wool Grease and Yellow Cottonseed Oil

Tests were also run on heat conductivity, oxidation and volatilization of various oils, as well as a test to determine the life of oil distilled from wool grease and the effect of constant use.

The system of quenching with its appliances, such as quenching tanks, cooling of the oil, etc., are discussed in brief. (Paper presented at the Fifth Annual Convention of the American Drop Forge Association, abstracted through the *American Drop Forger*, vol. 4, no. 7, July 1918, pp. 273-277, *ep*)

Fuel and Firing

Coal Saving by the Scientific Control of Steam-Boiler Plants, D. Brownlie. The first of a series of articles promising to be of quite unusual interest.

It is proposed to give the average figures for 250 typical steam-boiler plants covering the period from 1910 to the present time with the object of supplying accurate data on possibly conservation of fuel through the adoption of scientific methods in the boiler house.

The present article describes the method of carrying out the tests and begins the detailed analysis of the results of the 250 tests. (*Engineering*, vol. 106, no. 2741, July 12, 1918, pp. 25-27, *ep* 1. To be continued)

Fuel Conservation on the Santa Fe, Charles E. Parks. Description of the methods used in the past ten years for fuel conservation on the Santa Fe system.

In 1909 over 3½ billion lb. of coal were consumed in producing approximately 16 billion gross ton-miles; in 1917 the gross ton-miles had increased 55.9 per cent, while the pounds of coal used had only increased 17.8 per cent. The pounds of coal consumed per 1000 gross ton-miles was 227 lb. in 1909 and 171 lb. in 1917, or a decrease of 24.7 per cent.

It is recognized that this decrease in fuel consumption was due to many factors outside of the activities of the fuel department of the individual railroad system: such as the proper design and maintenance of locomotives; the use of larger power plants; construction of second tracks; reduction of grades; elimination of curves and general improvements in the line; lengthening passing tracks and greater efficiency in train handling.

The Santa Fe fuel department works along two general lines: first by educating the actual users of the fuel in its economic use, and second by an inspection and supervision of the physical factors in fuel consumption.

The education of the enginemen and the firemen has been materially assisted by a system of fuel accounting which not only discloses the conditions as they exist at the fuel stations daily, but also shows the amount of fuel consumed by each individual engine on each trip. In addition to the engine crews, much effort has been made in educating the fire builders, fire cleaners, hostlers and helpers in roundhouses. Further, the fuel question on the Santa Fe is recognized as something in which the transportation department is interested as well as the mechanical department. Dispatchers are constantly impressed with the importance of economic fuel consumption in handling trains and it is also forcibly brought to the attention of conductors, trainmen and other operating employees. The inspection department sees to it that the coal is free from slate both at the mines and at the fuel stations. The operation of coal chutes is under the supervision of the department and all coal-chute foremen and laborers are carried on the department roll. Attention is also given to the unloading of coal and the loading of engine tanks to prevent waste in yards and along the right of way.

The article describes in detail the system of accounting, and, in particular, the individual fuel records.

The writer sums up the whole situation by saying that waste in fuel like loss and damage claims cannot be reduced to zero, but the record of the Santa Fe shows that it can be materially reduced when a systematic effort is made. (*Railway Review*, vol. 63, no. 4, July 27, 1918, pp. 124-127, *p*)

Internal-Combustion Engineering

Four-Cycle Versus Two-Cycle Diesel Engines. Discussion of the relative merits of these two principles as applied to Diesel engines.

It is generally admitted that the larger the power the better is the case for the two-cycle principle; and furthermore, the Diesel engine is free from some of the most severe objections to the two-cycle principle. Thus, scavenging with Diesel engines is carried out by air alone and not by a mixture of air and gas, which eliminates the danger of ignition of the incoming gas or of the loss through the exhaust ports of part of the charge.

Franco Tosi, of Milan, Italy, have recently built two similar engines; one a two-cycle and one a four-cycle, which they have tested one against the other with a view to comprehensive comparison.

The two-cycle engine has six working cylinders in the center with a scavenging pump and a compressor at each end. The four-cycle engine has eight working cylinders with two compressors at the forward end. There are also other differences required by the respective cycles of operation.

Both engines are of the same b.hp., namely, 1300, which is the standard submarine-engine size of the makers.

Lengthy tests were carried out, 145-hour continuous non-stop runs being made and both engines developed their designed power of 1300 b.hp. at 300 r.p.m. It was found, however, that the two-cycle engine was not capable of developing higher than this figure, whereas the four-cycle engine at the same speed gave 1450 b.hp. and as a maximum power at higher revolutions developed 1585 b.hp. for a short period. As regards fuel and lubricating oil consumption, the advantage lies greatly in favor of the four-cycle engine. At full load the four-cycle figure was 0.41 lb. of fuel and lubricating oil per b.hp. hour, whereas the two-cycle consumption was 0.573 lb. per b.hp. hour.

It is of interest to note that with the two-cycle engine at 300 r.p.m. the compression was 460 lb. per sq. in., whereas at 120 r.p.m. the compression fell to 315 lb. per sq. in., at which pressure the temperature would be insufficient to support combustion of heavy fuel oil and so the engine would stop. With the four-cycle engine at 300 r.p.m. the compression pressure was 490 lb. per sq. in. and at 100 r.p.m. had fallen only to 445 lb. per sq. in.

Messrs. Franco Tosi have decided, in future, to abandon the two-cycle principle, and to confine themselves to the four-cycle for reasons substantially as stated, which may finally be recapitulated: 1. Elimination of the scavenging air pumps with their receivers, diminishing thus the size of the engine and decreasing the noise. The four-cycle engine of equal power is, approximately, the same size and weight as the two-cycle. 2. Lesser amount of heat units abstracted by the cooling water and the four-cycle engine contributing to the lower-fuel consumption with the four-cycle engine. 3. The inefficiency of scavenging with two-cycle engines, as compared with the four-cycle. 4. The possibility of using higher piston speeds with the four-cycle engine. 5. Greater flexibility of the four-cycle engine. 6. Simpler mechanical parts of the four-cycle engine. 7. The fuel pumps and valve gear of the four-cycle engine only ran at half the engine speed, making thus for easy running conditions. (*Engineering*, vol. 105, no. 2739, June 28, 1918, pp. 727-728, editorial)

"Gasteam" Plant at Ford City, Ontario. Description of the combination gas and steam plant now being erected by the Ford Motor Company of Canada, Ltd., on the Canadian side of the Detroit River at Ford City, Ontario.

On the whole the plant follows closely in design the general arrangement of the well-known Highland Park Plant in Detroit, where boiler feedwater is employed to recover waste heat from gas-engine cylinder jackets.

One of the most interesting features of the plant is in the gas-producer installation where tar separated from the gas is returned to the producer and gasified. It is stated that this method of tar disposal proved to be preferable to the old system of burning the tar under the boilers, as the heat value of the gas is increased considerably when the tar is gasified.

At present there are two Smith gas producers and a third is being installed. Each producer is built up in six sections. The rate of driving in each section can be separately controlled so as to prevent channelling and unequal blast distribution in the fuel bed.

As regards the operation of the producer plant, the following information is given: On leaving the fire the gas passes through a brick-lined hot pipe to a primary cooling tower where its temperature is reduced from about 1100 deg. fahr. to 120 deg. fahr., or to a temperature that will insure efficient operation of the tar extractors. It then passes through a low-pressure header into the exhauster, which delivers the gas under 3 lb. pressure to the tar extractors. After the tar is removed the gas enters the secondary cooling tower where the temperature is reduced to approximately that of the atmosphere before being delivered to the gas engines and to furnaces in the shop.

The fuel bed in the producers lies at an angle of 35 deg. and when the grates are shaken the fuel moves obliquely along the inclined bed. Three firemen on top of each producer watch closely for holes, channels and ridges in the fuel bed, particularly along the wall. The depth of the fuel bed averages about 5 ft. on the high side of the grade and 7 ft. along the back wall.

Exhaust steam is used to saturate the air blast to the producers. A thermostatic valve automatically controls the steam supply so as to maintain the temperature of the blast at 140 to 150 deg. fahr.

In the operation of the thermostatic valve a curious phenomenon was discovered. The valve had been adjusted to open and close slowly, gradually changing the quantity of steam being admitted to the producer. By regulating it so that it would open and close at the rate of two times per minute, admitting the steam in puffs, the proportion of carbon monoxide could be maintained at 25 per cent and the carbon dioxide cut down to 3½ per cent. The probable explanation for this is that in the first place steam coming in contact with incandescent carbon forms water gas high in carbon monoxide. As the motor-operated valve closes the decomposition zone increases rapidly in temperature, as only dry air is entering the combustion zone. When the valve opens it allows a considerable quantity of steam to enter and strike the incandescent carbon, which again forms water gas, with the result that the producer gas is made high in carbon monoxide.

Some trouble was at first experienced with tar delivery. At first the tar pipe was jacketed, but this was found to be unnecessary, for when the tar is recirculated it becomes as fluid as machine oil. A 2-in. line without steam jacketing is now used and the pumps have been replaced by a steam-pressure tank with steam at 880 lb. pressure. At first tar from the sprays tended to saturate the fuel bed, but this trouble was overcome by increasing the number of spray nozzles from three to five and thus distributing the tar more evenly over the fire. The gain in thermal efficiency by gasifying the tar averages from 8 to 9 per cent. (*Power*, vol. 48, no. 6, August 6, 1918, pp. 186-193, 13 figs., *d*)

Lubrication

The Lubrication of Michell Blocks. A mathematical discussion of the problem. In the applications which have hitherto been made of Osborne Reynolds' theory of lubrication, it has been customary to assume that the viscosity of the lubricant does not vary as it passes through the bearing. On this assumption it follows that for efficient lubrication a Michell block must be supported behind its center of figure in order to secure the necessary film of oil between the opposing surfaces; and, moreover, such a block, if centrally supported, should have no load-carrying properties whatever. By actual experiment it was found, however, that a centrally pivoted block could carry quite a high load and it was pointed out by H. T. Newbigin, in 1914, that this was due to the fact that in applying Reynolds' theory the variation of the viscosity of

the oil as it rose in temperature during its passage through the bearing was neglected, and that when this factor was taken into account the experimental facts were quite in accord with theory.

For a block infinitely wide as compared with its length, measured in the direction of motion, Osborne Reynolds gave the equation:

$$\frac{dp}{dx} = 6\lambda \frac{h - h'}{h^3} \quad \ldots\ldots\ldots\ldots\ldots [1]$$

where p denotes the pressure of the oil, x the distance of any point of the block from the origin, λ the viscosity of the lubricant, while h denotes the distance separating the opposing surfaces at any point x, and h' is the value of h at the point where the pressure is a maximum.

In integrating this equation Osborne Reynolds assumed λ to be constant, although it is known that the temperature of the oil may be increased by its passage under the block. Some time ago this subject was investigated theoretically and experimentally in the laboratories of Brown, Boveri & Co., of

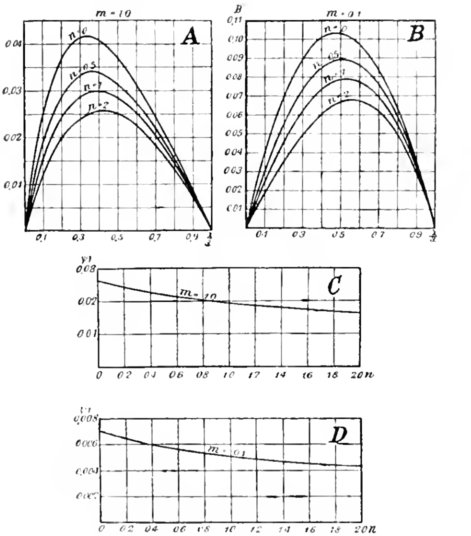


Fig. 8 Curves from Tests on Lubrication of a Michell Block

Baden, Switzerland. In this investigation the assumption was made that the viscosity λ may be expressed in the form

$$\lambda = \lambda_0\left(1 + \frac{n}{a}x\right)$$

Here λ denotes the viscosity of the oil as it *leaves* the block, while a denotes the length of the block and n is a coefficient. The viscosity of the oil as it enters the block is therefore $(1 + n)\lambda_0$.

With this substitution Equation [1] can still be easily integrated and the results for practical values of the constants m and n are given in Fig. 8, *A* and *B*, taken from the house organ of Brown, Boveri & Co. called *Revue B.B.C.* In these figures m is defined by the relation $h = h_0\left(1 + \frac{mx}{a}\right)$ where a is, as before, the length of the block taken in the direction of motion and m represents the inclination of the block to the other bearing surfaces.

It appears from Fig. 8-*A* that when $n = 0$, that is to say, when the viscosity is constant, the maximum pressure and the line of action of the resultant pressure lie distinctly behind the center of the block.

Fig. 8-*B* corresponds to a much smaller angle between the opposing bearing surfaces and in this case the change in viscosity has a much greater influence on the position of the center of pressure. This becomes nearly coincident with the center of the block when the viscosity is only 50 per cent more at the leading edge than at the trailing edge, while with $n = 2$ the center of pressure is well forward of the leading edge.

The two curves appear to indicate that to carry a given load the oil film will be thinner with a centrally pivoted block than with one which is pivoted behind the center line. This thinner film will be subject to a more severe shearing action and the development of heat should be greater than with the center of pressure behind the center of the figure.

The Swiss investigators have also determined the total load carried per unit width of an infinitely wide block when the viscosity varies according to the law already assumed above. Denoting this total load by $\frac{P}{b}$, they find that:

$$\frac{P}{b} = \frac{6\lambda_1 U a^2}{h_0^2} \cdot \varphi_1$$

where $\lambda_1 = \lambda_0(1 + n)$ denotes the viscosity of the oil at the leading edge, λ_0 being the viscosity at the trailing edge. U is velocity of motion, h_0 the least thickness of the film and a the length of the block measured in the direction of motion. The function φ_1 depends on n and m only. Its value for different values of n when $m = 1$ is given by Fig. 8-*C*, and when $m = 0.1$ is given by Fig. 8-*D*. Fig. 8-*C* shows that if the viscosity is three times as much at the leading edge as at the trailing edge the load carried is only about eight-thirteenths as much as if the viscosity were constant at its highest value. With $m = 0.1$ the relative carrying power diminishes with varying viscosity in approximately the same degree as with $m = 1$.

The original article describes tests made to determine the truth of the above conclusion and also experiments on the coefficient of friction.

In conclusion, the writer in the *Revue B.B.C.* points out that Michell's calculations show that when a block is of finite dimensions the displacement of the center of pressure from the center of figure becomes greater the narrower the block is as compared with its length in the direction of motion. The effect of side leakage is therefore to increase the eccentricity of the resultant pressure on the block, while on the other hand the rise in the temperature of the oil tends to decrease this eccentricity. (*Engineering*, vol. 105, no. 2739, June 28, 1918, pp. 714-715, 4 figs., *et*)

Machine Shop

Fusion-Welding Fallacies, S. W. Miller. Continuation of an article the first installment of which appeared in the July number of *Machinery*. The writer discusses here several of the commonly accepted but erroneous opinions about fusion welding. He points out that a weld which has not been heat-treated is not suitable for all engineering structures; that thermal changes in structures are neither negligible nor easily corrected: that coarsening of the grain reduces the ductility and resistance to shock of the metal, and these conditions cannot be entirely overcome by heat treatment although a material improvement can be made.

The structure of weld cannot be made as good as that of the original material, because the finest grain and therefore the

best physical qualities can only be obtained by using both heat treatment and some mechanical treatment like forging. As forging cannot be done in most welds it is evident that the best results cannot be secured. An electric weld in the opinion of the writer is not superior to an oxy-acetylene weld. (*Machinery*, vol. 24, no. 12, August 1918, pp. 1082-1084, 11 figs., *cp*)

Machine Tools

Milling Machine with New Type of Drive. Description of a constant-speed driven type of milling machine in which 16 changes of spindle speed and the same number of feed rates are available, all of which changes are obtained through sliding gears controlled by two ball-joint levers, the tumbler gear in the feed-change mechanism having been eliminated. The power is transmitted through a single driving pulley operating at a constant speed and all the shifting of gears is done on secondary shafts underneath. (*The Iron Age*, vol. 102, no. 4, July 25, 1918, p. 207, 1 fig., *d*)

Mechanics

Critical Loading of Struts and Structures, W. L. Cowley and H. Levy. Many interesting questions of practical importance relating to the failure of structures under compression have been brought up by a study of the problems of the strength of aeroplane framework. The present paper is an attempt to solve problems relating to the strength of such a construction as a beam under end thrusts, supported at intermediate points.

The writers believe that there are two types of failure of a structure. On the one hand, the material of a member may rupture on account of the yield stress having been exceeded during the course of the loading; while, on the other hand, the loading may be such that the geometrical configuration previously existing can no longer be maintained even approximately. It is the second type of failure which forms the chief subject of discussion in this paper. The writers start with the discussion of an elementary case such as, for example, when a prismatic homogeneous rectilinear uniform strut with simple supports at the end is loaded both laterally and longitudinally, as in Fig. 9.

AB is the strut simply supported at the ends A and B. Let w (pounds per unit length) be the intensity of lateral loading at P of coördinates x and y. Let M_1 and M_2 be externally applied bending moments at the ends. The writers consider the equilibrium of the beam taking the origin at A and AB as the axis of x.

The bending moment at P is given by

$$F.y - M_2 + (M_2 - M_1)\,(l - x)/l + H(x)$$

where $H(x)$ is the bending moment at P due to the lateral loading alone. Equating this to the resisting moment, viz., $-EI$ (curvature), and assuming the deflections small, we find that

$$-EI\frac{d^2y}{dx^2} = F.y - M_1 + (M_1 - M_2)x/l + H(x)\ldots\ldots[1]$$

where $H(x)$ does not involve M_1 and M_2.
This equation may be written

$$\frac{d^2y}{dx^2} + \lambda^2 y = M_2\lambda^2/F - x\lambda^2(M_2 - M_1)/Fl - \lambda^2 H(x)/F\,.\,.[2]$$

where $\lambda^2 = F/EI\ldots\ldots\ldots\ldots\ldots\ldots\ldots[3]$

From this the writers proceed to show that the bending moment at any point can only become infinite when

$$\sin \lambda l = 0\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots[8]$$

unless at the same time

$$M_1 \cos \lambda l - M_2 + F\{X(0)\cos \lambda l - X(l)\} \rightarrow 0\ldots.[9]$$

Equation [8] indicates that when the length of the strut is given by

$$\lambda l = \pi$$

that is, $l = \pi\sqrt{(EI/F)}\ldots\ldots\ldots\ldots[10]$

bending moments and deflections become excessively large compared with those allowable by the analysis. Equation [10] is the commonly recognized expression for "Euler's strut."

It should be particularly noted that under these conditions Equation [9] reducing to

$$M_1 - M_2 = -F\{X(0) + X(l)\}\ldots\ldots[11]$$

furnishes a relation between the externally applied bending moment which may prevent the struts failing in the Eulerian sense. It is suggested that in a structure in which M_1 and M_2 are determined by the loading and configuration of the system, it may be possible to have present a strut of Euler's length without failure resulting.

It appears then that in the simple case treated above, a

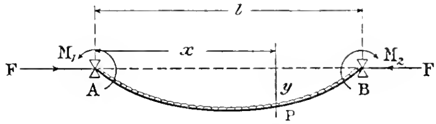


Fig. 9 Prismatic Homogeneous Rectilinear Uniform Struts With Simple Supports at the Ends Loaded Both Laterally and Longitudinally

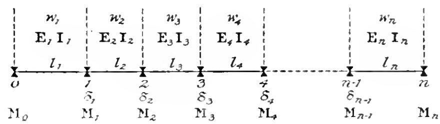


Fig. 10 Beam with $n + 1$ Supports

critical loading of the beam is essentially associated with the production at all points of bending moments and deflections excessively large in comparison with those allowable by the assumption upon which the analysis is based.

This immediately suggests that failure, in a corresponding sense, may take place in a more complicated structure and that these criticals will be furnished from the expressions determining the bending moments on the assumption of small deflections by inserting the condition that the former become infinite.

The next case discussed is that of a uniform beam under end thrusts, where the central axis is constrained to pass through $n + 1$ fixed points. For this case formulæ are derived, by means of which the loads on each bay are defined in terms of the dimensions of the bays, their flexural rigidities and the longitudinal loading in addition to the lateral loading. Thus is given an extended form for the equation of three moments, or Clapeyron's theory, when the axis of the beam is constrained to pass through given points and when both lateral and longitudinal loading exist.

Next is considered the case of $n + 1$ supports and n bays figured in such a manner that the rth bay appears to the left of the support numbered r as in Fig. 10. For this case a system

of equations is obtained from which if the bending moments at any two supports (usually zero and ∞) be known the remaining bending moments are uniquely determined, and once the bending moments at all supports have been evaluated the determination of the bending moment in each bay becomes a simple matter.

The next matter inquired into is the suggestion that the presence of a bay of Euler's critical length would not of itself involve failure of the type here considered. In common engineering practice failure is often assumed to be the case.

The writers sum up this case in the following manner: A beam supported at any given number of simple supports will not fail in general through the bending moments becoming excessive, even if some of the bays are of Euler's critical length, provided one bay, at least, is not of this length. Whether or not this will correspond with the stable loading of the structure will depend on whether or not the actual longitudinal load, if any, that would produce infinite bending moments is greater or less than Euler's load for the bays in question. It appears , therefore, that the presence of bays of Euler's length is not in itself either a necessary or sufficient criterion for instability.

On the other hand, where one of the bays is twice Euler's length, the writers find that the equation giving the relation between the bending moments contains an infinite term, and since the coefficients of these bending moments and the remaining terms are all finite, it follows that one, at least, of the bending moments must become infinite and the structure must fail. This is, however, not the lowest critical loading.

The following statement is made as to the conditions of failure of a supported system:

The criterion of failure which will be utilized in the present discussion is, as already explained, the production of infinite binding moments at the supports. Associated with this will be the assumption already known to be valid in the case of a single strut, that for values of the longitudinal force greater than the least that will produce these infinite bending moments, the geometry of the structure will not be maintained, the failure, in this sense, thus corresponding with instability. It remains, therefore, to write down the mathematical expression which must be satisfied when the bending moments are infinite and to determine the least root, regarding it as an equation in F, the longitudinal force.

The case of clamping supports is considered in detail, two cases being specially inquired into, namely, where the beam is clamped at either or at both ends, and determinational conditions corresponding with critical loading are given. On the whole, the writers believe that clamping one or both ends is equivalent to a direct addition of strength, the exact magnitude of this increased safety being dependent upon the smallest root of the determinant regarded as an equation in F, the longitudinal force. (Paper read before the Royal Society, January 2, 1918, abstracted through the *Proceedings of the Royal Society*, Series A, vol. 94, no. a662, pp. 405-422, 7 figs., *t* A)

A DOCTRINE OF MATERIAL STRESSES, R. F. Gwyther. The purpose of the paper is to provide a reasoned basis for a theory of stresses applicable in the first case to a body which satisfies the geometric conditions for acting as a rigid body (not being in a state of constraint), but which shalt be capable of extension to elastic bodies or to other approximations to material bodies without introducing the fiction of an "undisturbed" condition in whic the body is assumed to be free from stress.

The body contemplated is not supposed to be crystalline, fibrous or annealed and not to be subject to any special conditions either locally or at the surface.

The general reasoning is expressed by the writer in the following manner:

(1) The nine elements of mechanical stress obey well-known laws of resolution. By introducing the notion of infinitesimal rotations of the coördinate axes about their own positions, we can, for our present purposes, replace these relations by the three differential operators, acting upon the elements of stress, the determination of which follows from the laws of their resolution; that is, these operators are based on mechanical considerations.

(2) If we now consider any arbitrary vector (which we shall speak of conveniently as a virtual or potential displacement), we may look upon the nine first differential coefficients of its components as being replaced by the nine elements of virtual or potential strain (including among them the three rotations).

These nine virtual strains may now be affected by the same infinitesimal rotation of the axes as is employed in (1), and the three consequent differential operators acting upon the elements of strain may be deduced: in this case on geometrical grounds. It will be noticed that the forms of the two sets of operators are similar, and may easily be made identical.

(3) I shall now introduce the fundamental assumption on which the theory is based: namely, that the elements of a material stress are functions of the first differential coefficients of the components of some vector quantity; in other words, functions of some set of nine virtual strains.

(4) If we now turn to the two sets of differential operators concerning elements of stress and of virtual strain, we are able, in consequence of assumption (3), to express each element of stress in terms of the nine elements of virtual strain; or conversely, each element of strain in terms of the nine elements of stress, by means of sets of simple partial differential equations.

In obtaining these solutions constants will be regarded as uniform and isotropic, and, consequently, we shall exclude, among other things, the possibility of a crystalline structure. We shall also suppose the body not to be in a state of constraint, or otherwise that that state has been eased. I shall, further, limit the solutions to relations of a linear form. From this it will follow that the relations between the elements of stress and of virtual strain agree, in form, with the corresponding relations familiar to us in the Theory of Elasticity.

(5) Supposing the elements of virtual strain to be expressed in terms of the elements of stress, we may eliminate the former by differentiation, and obtain a set of relations involving only the elements of stress (stress relations).

(6) I shall now suppose the set of three mechanical stress equations to be introduced which correspond to the state of rest or motion of the body as a rigid body. With these equations I shall suppose the stress relations of the preceding paragraph to be combined. From this combination we may obtain stress relations, by which we may regard the elements of stress to be defined: as far as they are capable of being defined as long as the surface-traction conditions have not been considered.

(7) Up to this point I have been contemplating such cases as a cube of metal on a rough inclined plane, or a connecting rod moving in a prescribed manner, the geometrical conditions for rigidity being preserved. The stresses are not to be regarded as undefined, but as being determinate.

(8) The Theory of Elasticity is now introduced by the definition of an elastic body as a body such that the strain, hitherto considered as a virtual or potential strain, is the actual strain

experienced by the parts of the body. The stresses being definite, the strains become definite, and the displacement may be deducted.

The acceptance of the principles involved in this doctrine would have the effect of removing the subject of stresses from its accepted place in the Theory of Elasticity, and of making it an integral part of the Statics and Dynamics of a Rigid Body. (*The London, Edinburgh, and Dublin Philosophical Magazine and Journal of Science*, vol. 35, no. 210, June 1917, pp. 490-492, *tA*)

Motor-Car Engineering

Utilization of Heavy Fuels. As a result of some experiments which he conducted, the author believes the concentration of effort toward the most suitable application of additional heat to vaporize the fuel, to be undesirable. In his estimation it is necessary to endeavor to atomize the fuel more thoroughly than is generally the case in modern carbureting devices. The specializing upon the provision of heat may give satisfactory results if the problem be looked upon only from one aspect, merely to secure the complete vaporization of the fuel, but where excessive heat is solely depended upon, the end in view is attained at the expense of the volumetric efficiency of the engine.

From the particulars which have been published of certain American vaporizing systems, it appears that in the United States efforts are being directed toward the application of heat to the heavier elements only of the fuel which may be passing in unvaporized form from the carburetor to the cylinder ("hot spot" devices).

If a certain temperature is necessary to vaporize the fuel in the form in which it issues from the carburetor jet, it is obvious that more complete vaporization would occur if the same heat were applied to a more thoroughly atomized fuel. Experiments which the author made led him to believe that in the case of fuels which are not excessively heavy, judged by the present standards, it is possible to obtain better results in the way of power production and economy by thoroughly atomizing the fuel, even without the provision of hot air or hot-water jackets, than by depending upon heat alone to vaporize it. (Editorial in *The Autocar*, vol. 41, no. 1185, July 6, 1918, pp. 1-2, *g*)

A New Chassis Lubrication System. Description of a scheme by which oil in a motor car is fed to bearings by wicks. The wicks are suspended in a reservoir of oil through a conical-shaped hole. At the small diameter of the conical hole a sharp edge is provided which acts as a barb, gripping the wicks tightly and making it impossible to pull them out from the outside.

The oil is fed to the surfaces to be lubricated by means of capillary attraction and can be regulated in the following manner: The point where the sharp edge of the small diameter of the conical hole grips the wick compresses it and this compression is varied in accordance with the amount of lubricant required for a bearing surface. When there is no relative motion between the bearing and its journal there is no flow of lubricant, as it is the movement of one surface relative to another that causes the oil that has saturated the wick to be wiped off and become distributed over the bearing surface.

In Fig. 11 a brake-countershaft assembly is shown in which oil is employed for lubrication though not on the system above described. The trunnion bearings shown eliminate any chance of the brake countershaft and tube binding from frame weave when the truck is passing over irregular road surfaces. (*Automotive Industries*, vol. 39, no. 3, July 18, 1918, pp. 95-96, 5 figs., *d*)

24-Valve Automobile Engine. It is stated that the Pierce Arrow Motor Car Company is going to place on the market an automobile equipped with a 6-cylinder 24-valve engine. While four valves to an engine is not new, and both the Stutz and the White companies are using them as standard equipment, a 6-cylinder engine with four valves to a cylinder is new commercially. (*Automobile Topics*, vol. 50, no. 12, July 27, 1918, p. 1193, *a*)

Munitions

The Stokes Gun and Shell and Their Development. Sir Wilfred Stokes. Third Gustave Canet lecture delivered

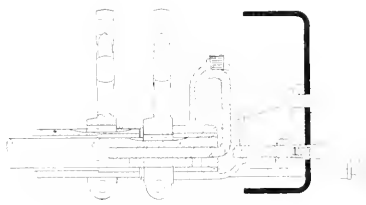


Fig. 11 Brake-Countershaft Assembly in Which Oil is Employed as a Lubricant

before the Junior Institution of Engineers on Monday, June 24, 1918, giving the history of the Stokes trench mortar. The article is of considerable interest as it explains not only the actual construction of the various parts, but also the ideas underlying their design in connection with this novel application. The paper is illustrated by halftones. (*Engineering*, vol. 105, no. 2739, June 28, 1918, pp. 719-723, 20 figs., *d*)

The 3-In. Anti-Aircraft Gun, Model 1918. The first description of this interesting apparatus. The gun is built up of nickel-steel forgings consisting of a tube, jacket and bridge ring assembled by shrinkage.

The gun weighs 1948 lb., has a total length of 129.69 in. and a length of bore of 4 calibers, equivalent to 120.04 in.

The weight of the projectile, shrapnel type, is 15.95 lb. and the muzzle velocity is 2400 ft. per sec. (*The American Machinist*, vol. 49, no. 5, August 1, 1918, pp. 185-190, 5 figs., *d*)

Physical Chemistry

The Solubility of Ammonia, M. J. Eichhorn. An extensive article reviewing in detail the previous work done on the subject.

The numerical data previously obtained have been plotted on a Cartesian diagram, Fig. 12, which illustrates the outstanding discrepancies in the values collected from various sources and permits the estimation of the magnitude of the probable errors.

From this diagram it appears that at ordinary room temperatures the agreement between the values for atmospheric pressures is fairly good, but for temperatures near the freezing or boiling point, or for pressures considerably above or below the atmospheric, the few data available are far from being in harmony.

The lines of equal pressure in the right half of the diagram

seem to converge toward a point located below the lower right-hand corner, and in order to investigate this matter further the diagram was anamorphosed and the scale for t recalculated, so as to make the line for $p = 1.0333$. The end points were taken at $t = 0$; $N = 1202.8$; and $t = 102$; $N = 0$; the scale for N was left as a regular scale. Now, calling x the distance, measured on a regular scale, from the point $t = 0$ to the point t, it follows from the proportionality of the sides in the two right-angled triangles, that

$$1202.8 \div 102 = (1202.8 - N) \div x; \text{ from which}$$

$$x = 102\,[1 - (N \div 1202.8)]$$

With the scale for t determined by the last equation, and the

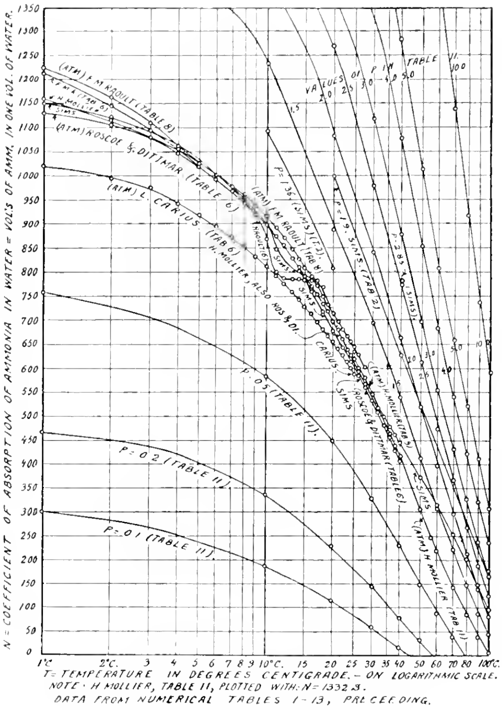


FIG. 12 DIAGRAM FOR SOLUBILITY OF AMMONIA

same regular scale for N, a new Cartesian diagram is constructed and the lines of equal pressure, plotted on such a system of coördinates, prove to be reasonably close approximation to straight lines and meet in one point, diagonally below the lower right-hand corner.

The diagram was further anamorphosed into one with three groups of intersecting parallel lines by a method which the author believes to be original with him. It is a method of perspective geometry and consists essentially in rejecting the point of radiation to infinity. If we consider the eye located in the plane of the last-mentioned diagram, and in the point in which the equal-pressure lines coincide, and further that the plane of the diagram is intersected by another plane, at right angles to the same and also at right angles to the line connecting the eye with the zero point of the diagram, and beyond the latter, then each numbered point on the coördinate axis may be considered as having a perspective image on the new plane. These image points, taken together, form two scales for N and t, and when the eye point is considered as receding to infinity, then of course all the lines, connecting each image point with the same, become parallel. When the new scales for N and t thus obtained, are taken as the coördinate axes in another Cartesian diagram, the lines of equal pressure, plotted on same, will be straight parallel lines. In this diagram the scale for N is a linear scale, the general equation for which is

$$x = (ma + n) \div (pa + q)$$

In order to convert the last-mentioned Cartesian diagram into a nomogram of aligned points, Fig. 13, the equation of the N-scale, obtained by the method outlined above, was figured out by taking four arbitrary points and forming four equations with m, n, p, q as the unknown quantities and solving for the same. The resulting formula for the N-scale is

$$x = 26\,a \div (a + 2100)$$

Again utilizing the relation $N = 1332\,S$, the equation of the S-scale becomes

$$x = 51.8\,a \div (a + 1.568)$$

in which

a = number of the point

x = distance of the point from zero

S = fraction of a pound of ammonia to one pound of water.

The writer constructed a second nomogram for solubility of ammonia in which the Mollier equation of condition is laid as a basis, with the results given in both the customary and the metric units. (*Ice and Refrigeration*, vol. 55, no. 2, August 1918, pp. 41-47, 6 figs. of which 3 are tables, *tA*)

Power-Plant Engineering

DETERMINATION OF HEAT GIVEN OFF BY ENGINES AND POWER PIPING, Dr. E. V. Hill and W. J. Mauer. Some time ago the Engineering Department of the City of Chicago requested the Ventilation Division of the Health Department to conduct tests with the view of determining the amount of heat supplied to the engine rooms of pumping stations by the engines and power piping in the building.

In order to determine the net heat supplied by the equipment it is necessary to determine the air change in the building under average winter conditions, and one must also know the heat loss from the building due to temperature differences on the inside and outside of engine-room walls.

The article describes in detail the method of carrying out the tests. The air change in the engine room was determined by the reduction of the carbon dioxide content shown by hourly readings. In this way the air change curve shown in Fig. 14 was obtained.

As regards heat losses, the question was somewhat complicated by the fact that the materials of construction in the building varied at different elevations. Further, on account of the height of the room there was a difference in temperature of 40 deg. between the air at the floor level and the peak of the roof. Hence in computing the heat transmission through the wall the temperatures to be used must be those corresponding to that part of the wall in question. For this reason temperatures were taken at various points and the temperature curve (Fig. 15) drawn, this curve being approximately a straight line. The original article gives a detailed calculation of heat losses through the windows in one of the walls in which use is made of this temperature curve.

On the whole it was found that one complete air change required about 56½ min., and results were obtained showing the total heat losses through the floor, roof, edge of the walls and

through the air change, respectively. (*The Heating and Ventilating Magazine*, vol. 15, no. 7, July 1918, pp. 18-24, 9 figs., *e*)

Railroad Engineering

First of the U. S. Standard Locomotives. Description of the first of the standard locomotives, namely, a light Mikado type built by the Baldwin Locomotive Works for service on the Baltimore & Ohio.

There is nothing of an unusual character either in the general design or the details of construction. The boiler is of the conical wagon-top type, 78 in. in diameter over the first course, increasing to 90 in. in outside diameter at the dome course, Fig. 16. The longitudinal seam of the dome course is on the left-hand side of the center line, and the reinforcing pad on the inside of the shell under the dome is extended to form the inside welt strip of this seam. The longitudinal seams of the conical and front courses are at the right and on the top center line of the boiler, respectively. These seams are all welded at the ends.

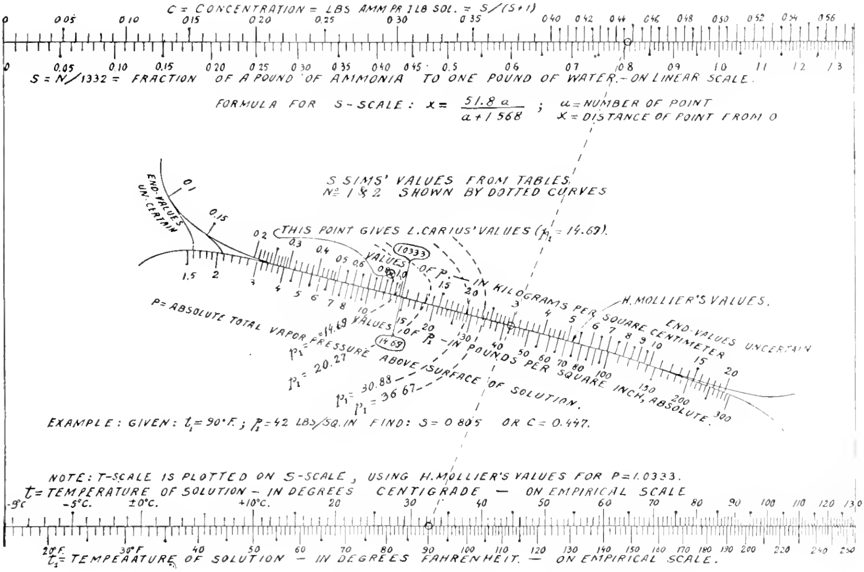


Fig. 13 Nomogram for Solubility of Ammonia

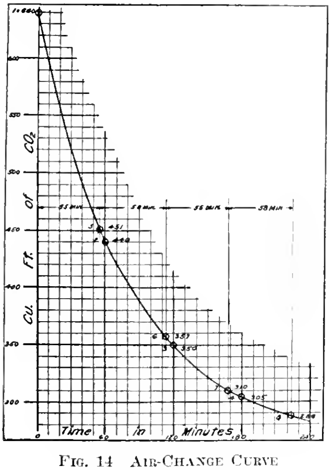


Fig. 14 Air-Change Curve

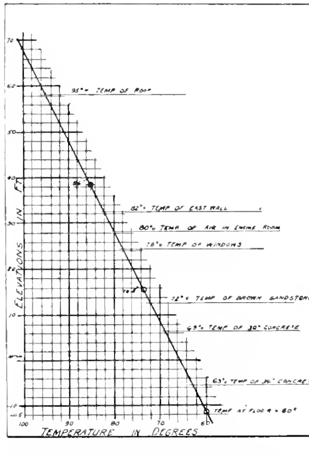


Fig. 15 Curve for Determining Temperature at Various Elevations in Engine Room

On the basis of Cole's ratios, the boiler capacity rating is practically 96 per cent of the cylinder requirements in respect to the heating surfaces, and slightly over 100 per cent in respect to the grate area. The tubes are 2¼ in. in diameter and

19 [illegible] over the tube flues, the ratio of the diameter to the length of tubes being about one to 100. The firebox includes a combustion chamber 24 in. long and is fitted with a security arch. The boiler includes a 40-unit Schmidt top header superheater with 5½ in. superheated flues, and is fired by a Duplex stoker. It is fitted with a Shoemaker fire door.

The ashpan has three center hoppers with swinging drop bottoms. The opening under the mud ring is 5½ in. wide. The grates are operated by a Franklin grate shaker. (*Railway Age*, vol. 65, no. 3, July 19, 1918, pp. 131 to 133, 5 figs., e)

Refrigeration (See Physical Chemistry)

Steam Engineering (See also Internal-Combustion Engineering)

A NEW THEORY OF THE STEAM TURBINE, Harold Medway Martin. Presentation of a new theory of the steam turbine in which the leading idea is that steam is not in thermal equilibrium where it was hitherto supposed to be.

In the investigation of the performance of steam turbines some notable discrepancies between theory and apparent practice were discovered, one of these being that under certain conditions the weight of steam discharged from a nozzle was actually greater than what was physically possible according to the then accepted theory. At first it was attributed to the moisture in the steam, but this explanation was discarded when it was found that to bring this theory into accord with experiment would involve the presence of anywhere between 10 and 20 per cent of moisture in the steam. Later on this anomaly was attributed to a fundamental error in the then accepted theory of the efflux of steam; namely, that the expansion of wet steam did not proceed under conditions of thermal equilibrium as was previously assumed.

The present theory is based on an assumption claimed to be proved by actual experience with steam turbines; namely, that not only is steam not in thermal equilibrium in the "saturated field" of the Mollier diagram, but it is never in thermal equilibrium until the condenser is attained. The relation between volume and pressure during the expansion of wet steam is accordingly never the same as if thermal equilibrium were established.

In opening a turbine it is easy to see the difference in the appearance of the blading which has been exposed only to superheated steam and that which, on the ordinary theory, has been subjected to the action of wet steam. In the region where the steam was supersaturated a film of moisture is deposited on the blading and it is this very phenomenon that for a long time interfered with the detection of undercooling in steam turbines and steam engines. In any attempt to take the temperature of the steam by means of a thermometer a film of moisture was immediately deposited on the bulb or on the exterior of the thermometer pocket if the steam were supersaturated, and the thermometer recorded the temperature of this film and not that of the surrounding vapor. Hence, for many years it has been noted that the temperature of the steam as indicated by a thermometer placed in a turbine exhaust pipe was sensibly below that corresponding to its pressure. These low readings are all the more remarkable in that experiment has shown that a thermoscope immersed in a current of a permanent gas tends to give too high a reading, owing to adiabatic compression of the fluid against the obstacle.

The writer mentions a possible objection against the idea that there is any large degree of undercooling in the turbine exhaust, viz., the fact that in experiments with nozzles discharging into open air Dr. Stodola showed that once condensation commenced it proceeded with extreme rapidity. However, he calls attention to the fact that the occurrence of condensation or even its completion does not necessarily imply the simultaneous establishment of thermal equilibrium. In fact, there is evidence in favor of the view that there is a sensible lag between the two.

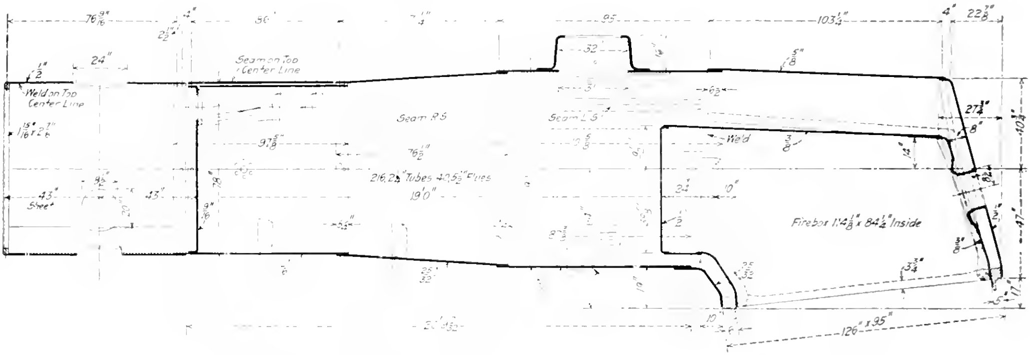


FIG. 16 BOILER OF THE RAILROAD ADMINISTRATION STANDARD LIGHT MIKADO TYPE LOCOMOTIVE

In the experiments of Stodola the droplets observed by him in his jets of undercooled steam were formed in a period of time of the order of one ten-thousandth of a second, while the time occupied by steam in flowing through the low-pressure end of a turbine is some hundred times as great. Were it not for the lag between condensation and thermal equilibrium, it is difficult to see how these droplets could be built up with such rapidity. Each molecule as it condenses liberates energy sufficient to raise its own temperature by some 500 or 600 deg. cent. and were this energy immediately and wholly transformed into heat, it is difficult to see how the temperature of the surface could be kept low enough to permit of the building up by further condensation of droplets observed by Dr. Stodola.

The author also brings forward the following interesting reasoning to prove that the instantaneous conversion into heat of the energy liberated on condensation is unlikely. He claims that the forces responsible for the attraction between the molecules of the same substance to which the phenomenon

of liquefaction is due, are essentially of the same nature as the forces holding together a chemical compound, i.e., electrical. There are thus good grounds for believing that the energy liberated on the condensation of a vapor is at the outset represented by electrical disturbances and is only somewhat gradually converted into the form of heat. In support of this view the writer cites the paper of Wilson in the *Philosophical Transactions* for 1897, where the latter states that if the expansion of dust-free vapor was just sufficient to produce condensation the number of droplets formed was of the order of 10^8 per cu. cm., but that this number increased very rapidly if the range of expansion was increased. This affords direct proof that the additional condensation took on new nuclei and the temperature of the vapor must accordingly have been far below the equilibrium value during the whole range of expansion. The time taken for the expansion in Wilson's experiments was estimated at something over 1/50 of a second and was thus of the same order as the total time taken for steam to pass completely through a modern steam turbine, the inference being that the steam as finally discharged from such a turbine is used in a greatly undercooled and supersaturated condition.

The author in his present paper attempts to show that if his interpretation of Wilson's results be accepted (*i. e.*, that the expansion continues with the vapor temperature far below that which would be indicated by any thermometer immersed in it) both superheat and vacuum corrections can be rationalized, while a contrary view involves wide discrepancies between theory and practice.

For this purpose the author gives a somewhat modified Callendar steam table (Fig. 17).

Until Professor Callendar took up the matter, the formulæ used to represent the properties of steam were wholly empirical and were very commonly mutually inconsistent. Thus the values deduced for the specific heat of superheated steam from the experiments of Knoblauch and Jakob and adopted as the basis of certain well-known tables are quite inconsistent with the specific volumes of the steam also given in the same tables, the discrepancy being as much as 20 per cent. Callendar's formulæ have, on the other hand, been deduced from considerations of the physical nature of steam and the known laws of thermodynamics. Their form has been fixed by theoretical considerations, and the coefficients only determined by experiment. All the formulæ are mutually consistent with each other and agree with the only reliable experimental data so far available. In preparing the chart Callendar's formula for the isentropic expansion of steam was employed, viz.:

$$p^{-3/13}\,T = \text{constant}$$

where p denotes the absolute pressure of the steam and T the absolute temperature. Starting with high-pressure steam at a given entropy, the absolute temperature attained on expansion to a lower pressure was then determined by Callendar's equation for the total heat of steam, which in pound-centrigrade units is:

$$H = 0.47719\ T + 464 - \frac{144}{1400}\cdot p\left(\frac{13}{3}\times 0.4213\left(\frac{373.1}{T}\right)^{10/3} - 0.01602\right)$$

At least seven points were calculated for each curve represented on the diagram. The computations were made with five-figure logarithms and checked by examining the differences. This test led to the detection of a few small isolated errors, which were duly corrected. The calculation was made to five figures and the plot to four figures.

One innovation which is thought to be of importance is that the abscissæ values are not values of the total heat H but of $2.2436\ (H - 464)$. As a result, specific volumes can be obtained from the diagram with great accuracy.

It is merely necessary to divide the abscissa reading by the pressure, and to add the constant 0.0123. For example, the abscissa reading corresponding to 90 lb. and 240 deg. cent. is 536.65. Hence the specific volume is:

$$(536.65/90) + 0.0123 = 5.962 + 0.012 = 5.974$$

The value given in Callendar's tables is 5.9741.

The adiabatic heat drop is measured in the same way as with the ordinary Mollier diagram. The Wilson line shown in the diagram represents the limit to which steam originally dry or superheated can expand without condensation occurring. The method used in deriving it will be set forth in a later issue, to which also will be deferred a description of the two diagrams of reheat factors.

Full lines on the diagram refer to superheated or supersaturated steam. Dotted lines and heavy figures refer to wet steam in a state of thermal equilibrium, a state which is never attained when wet steam expands inside a turbine or an engine cylinder.

Pressures are absolute, and temperatures in centigrade degrees. The entropy is constant along horizontal lines, and the total heat is constant along vertical lines. The numbers affixed to these verticals are, however, not values of H but values of $2.2436\ (H - 464)$.

Heat Drop. To find the isentropic heat drop, mark on the diagram the initial state point of the steam, and from this point draw a horizontal to the final pressure line. The length of this line measured on the scale provided is equal to the heat drop. There are two scales, one of which gives the heat drop in B.t.u. and the other in pound-centigrade units.

Specific Volumes. To find the specific volume of superheated steam, note the value of the abscissa corresponding to this state point. Divide this value by the absolute pressure of the steam and add 0.0123. To find the specific volume of wet steam in thermal equilibrium multiply the volume at saturation by the dryness fraction, which is represented on the chart by the dotted curves.

The Wilson Line. Save for the deposit of a thin film of moisture on adjacent surfaces, no condensation occurs when the saturation line is crossed during the expansion of steam (J. Aitken, 1880). The steam merely becomes supersaturated and continues in this condition until by further expansion the Wilson line is reached. Up to this limit the law of expansion and the relation between volume, temperature and pressure is exactly the same as for superheated steam. The Wilson line on the diagram has been plotted from the equation: $\log_{10} p - \log_{10} p_s = 3:76\ \sigma/T$, where p denotes the pressure of the steam and T its actual temperature; σ is the surface tension of water at this temperature, while p_s denotes the saturation pressure at T deg. absolute. The end portions of this curve have been extrapolated.

Reheat Factor. In multistage turbines the effective thermodynamic head is not the isentropic heat drop u, but is equal to u, multiplied by the reheat factor, R, which varies with the range of expansion, and with the hydraulic efficiency of the turbine. The less the efficiency the greater is the reheat factor. The useful work done in a multistage turbine having a hydraulic efficiency η_h is equal to $\eta_h Ru$.

To find the specific volume of steam after expansion from p_1 to p_2 in a multistage turbine of hydraulic efficiency η_h, determine the heat drop u, using the full-line curves of the

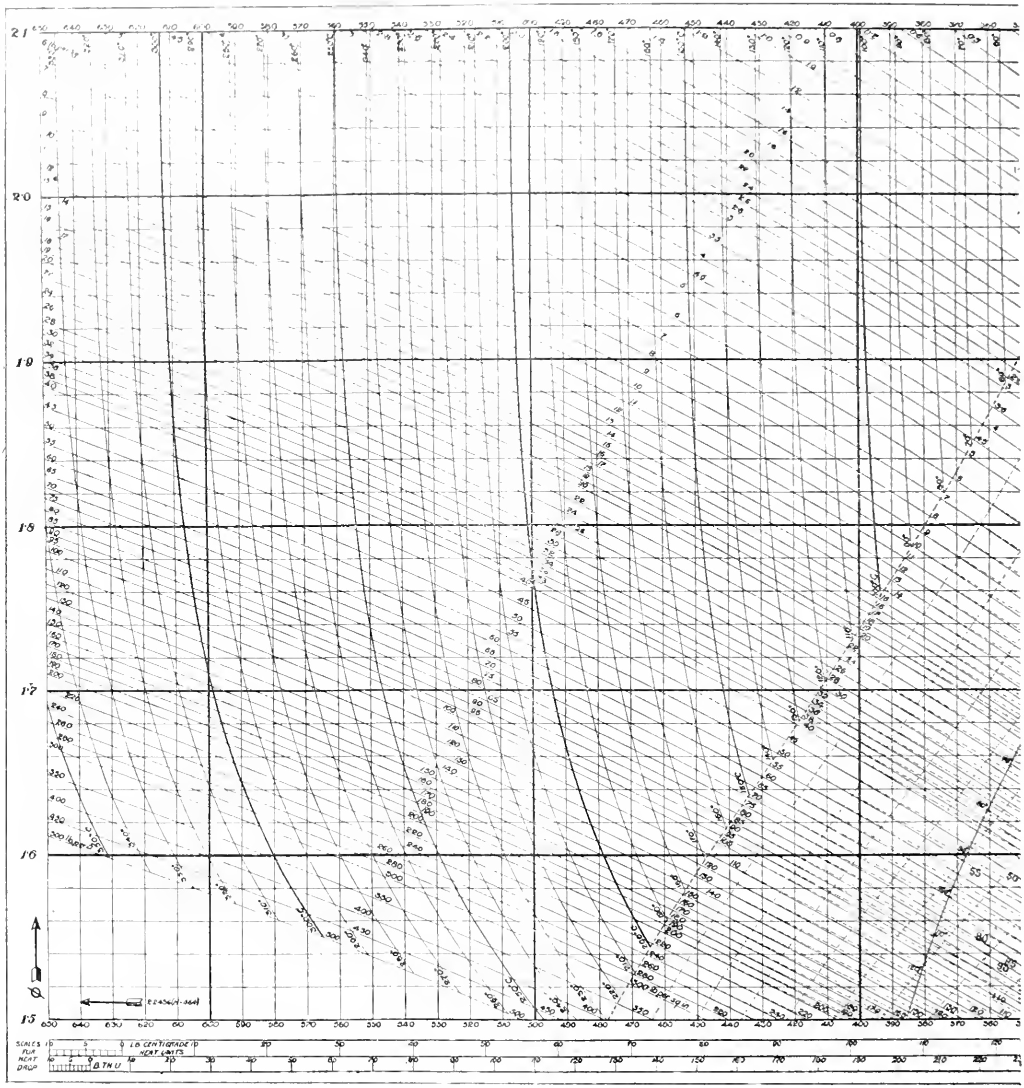
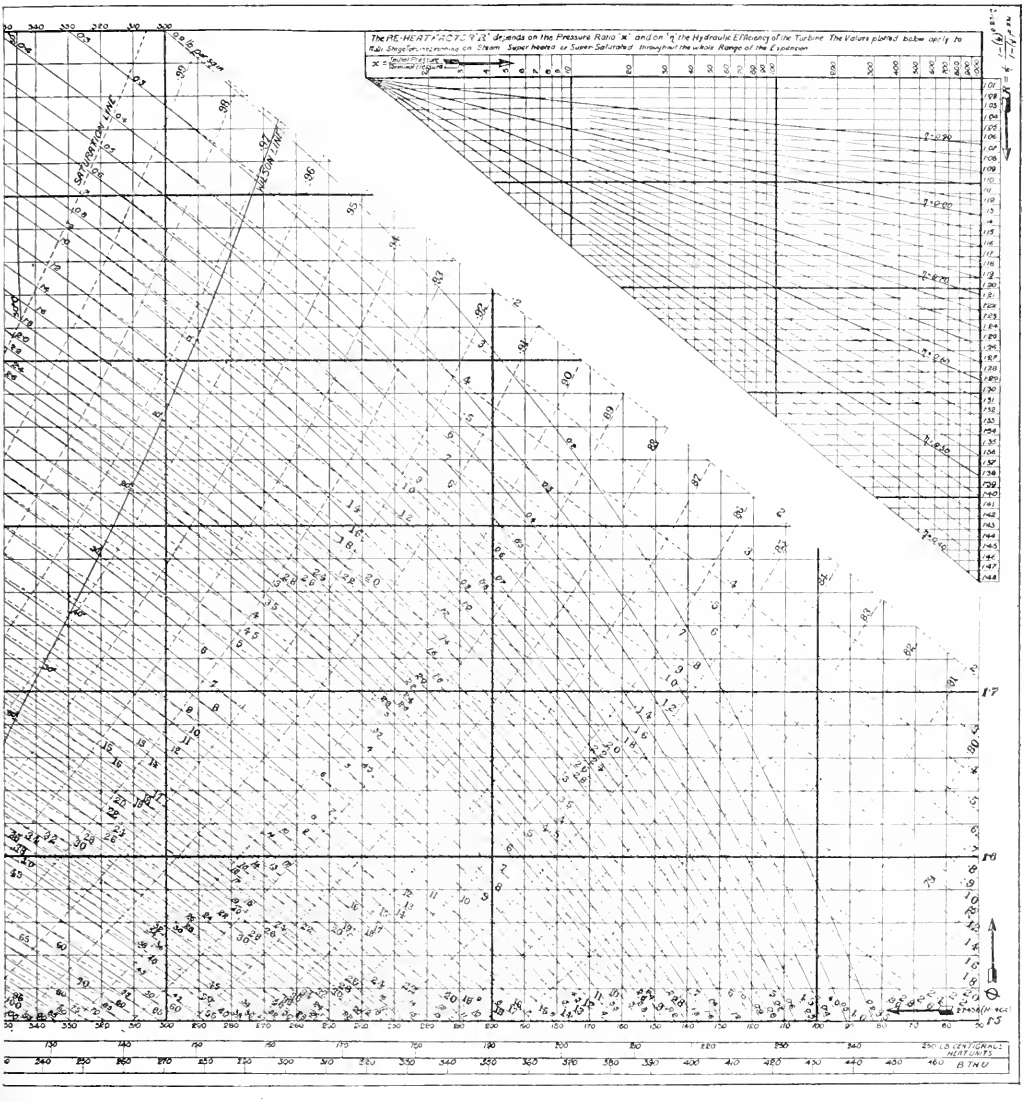


FIG. 17 HAROLD MEDWAY MARTIN'S STEAM CHART

chart; next take out the reheat factor corresponding to η and to $x = p_1/p_2$. Set off horizontally from the initial-state point a distance equal to Ru^1 as measured on the heat-drop scale. From the point thus found, raise a perpendicular to cut the (full-line) curve corresponding to p_2. This intersection represents the state point of the steam after its expansion, accurately if it lies to the left of the Wilson line and roughly in the contrary case. The volume V^1 corresponding to this state point is given by Equation [2].

If the expansion be stopped at the Wilson line approximate thermal equilibrium is rapidly attained and the final state point of the steam can be found by drawing a vertical from the Wilson state point to cut the dotted line for steam at the same pressure. If the expansion be continued past the Wilson line fresh condensation occurs, but on new nuclei. The temperature during this further expansion remains therefore far below the equilibrium value and the specific volume of the steam and the work done by it are much below the values corresponding to the expansion of wet steam in thermal equilibrium.

From the superheat correction it appears that the specific volume V_w during this stage of the expansion is given approximately by the relation $V_w = 0.8V^1 - 0.2V_s$, where V^1 represents the volume calculated as above and V_s the corresponding volume and the expansion beyond the Wilson line been effected in thermal equilibrium. The value of V_s for



BASED ON CALLENDAR'S TABLES AND FORMULÆ

different hydraulic efficiencies can be found by using reheat factors taken from the dotted lines in the annexed factors.

Since the steam in expanding beyond the Wilson line is in a "dynamic" condition, it is probable that these curves of equivalent reheat factors should be bands rather than lines.

1 kilowatt-hour = 1895.5 ft-lb. centigrade units (F. P. C.)
= 3411.9 B.t.u.

1 horsepower hour = 1414.3 ft-lb. centigrade units
= 2545.6 B.t.u.

Theoretical velocity of efflux = $300.2 \sqrt{u}$ (F. P. C.)
= $223.8 \sqrt{u}$ (B.t.u.)

(First of a series of articles: *Engineering*, vol. 106, no. 2740, July 5, 1918, pp. 1-3, and a 2-page plate, t.1)

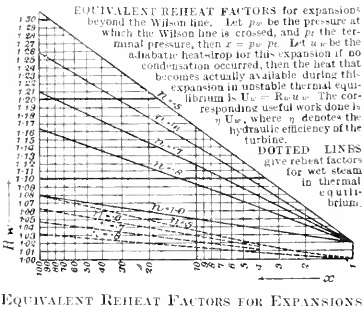


FIG. 18 EQUIVALENT REHEAT FACTORS FOR EXPANSIONS BEYOND THE WILSON LINE

Testing

Testing of Aluminum Sheets, Robert J. Anderson. In a previous article (The Journal, June 1918, p. 506) an account was given of Erichsen tests made on annealed 18-gage aluminum sheets and it was shown how the effects would become apparent earlier on cold-rolled aluminum sheets with increasing percentages of reduction. In the present article the writer discusses the use of exceedingly short time exposures at various temperatures.

It is claimed that more prolonged exposure results in over annealing, which latter produces a weakened condition of the metal and makes it unfit for drawing.

In order to demonstrate roughly how much time is required for annealing, a number of samples of cold-rolled 14-gage aluminum sheets reduced 72 per cent were exposed for two hours at 400 deg. cent. Forty blanks so annealed were drawn

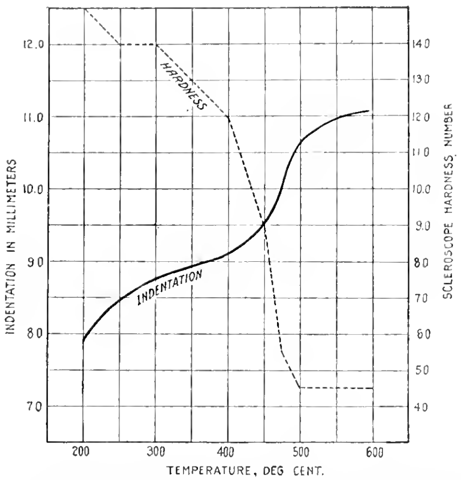


Fig. 19 Temperature-Indentation and Temperature-Hardness Curves for 14-gage Aluminum Sheets Exposed for 3 Min.

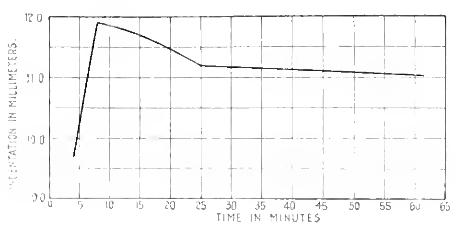


Fig. 20 Time-Indentation Curve for 14-gage Aluminum Sheets at 450 Deg. Cent.

in the draw press and all of them successfully withstood the draw.

Then some annealing experiments were performed with the view to softening the 14-gage cold rolled sheets by means of relatively short exposures at various temperatures. These annealing experiments were performed in a laboratory electric furnace of the resistance type and the temperatures given are accurate within ± 10 deg. cent. The time of exposure was 3 min. Fig. 19 gives the temperature-indentation and temperature-hardness curves for these tests and shows that the scleroscopic hardness falls off rapidly with increasing temperature and the indentation increases gradually to a maximum attained at the exposure at the highest temperature employed.

The preliminary short-time annealing experiments showed that 14-gage cold-rolled aluminum sheets could be softened at 4.5 Shore scleroscope hardness numbers by 3-min. exposures at temperatures of 500 deg. cent. and above. In the next series of tests 80 cold-rolled blanks with accompanying smaller samples for test purposes were annealed at constant temperature and variable time, as shown in Fig. 20. It was found that softening, so far as required by practice, can be effected for cold-rolled 14-gage aluminum sheets by an exposure of as little as 8 min. at 450 deg. cent.

The writer called attention to the fact that the deepest indentation value secured by the annealing tests was for sample 13, which had been exposed for 8 min. With longer exposures at the same temperatures the indentations are less deep, a fact which accords very well with the time-indentation curve of Fig. 20. (*The Iron Age*, vol. 102, no. 3, July 18, 1918, pp. 148-149, 2 figs., *e*)

Varia

The Rising Cost of Machine Building, Ludwig W. Schmidt. The writer discusses the rising cost of the elements entering into machine construction, such as labor, material and what he summarizes under the name of factory costs. A chart is given showing the variation in the margin of profit, cost of materials and cost of labor during the year 1917, which reveals a reduction in the margin of profit of noticeable magnitude.

The writer comes to the conclusion that doubt exists whether under present conditions a machine manufacturer acts wisely to cut his profit margin too narrow, and it is questionable whether even 30 per cent of the factory sales price can be called a safe margin. (*American Machinist*, vol. 49, no. 5, August 1, 1918, pp. 209-211, 1 fig., *g*)

On the Critical Absorption and Characteristic Emission X-Ray Frequencies, W. Duane and Kang-Fuh Hu. Results of an experimental measurement of the critical absorption wave-length (λ_a) and the wave-length ($\lambda\,\gamma$) of the γ line in the emission spectrum by means of a Coolidge X-ray tube with a rhodium target, the current through it coming from a high-potential storage battery. From a paper presented before the American Physical Society. (*Physical Review*, vol. 11, no. 6, June 1918, pp. 489-491)

The Relation Between the General X-Radiation and the Atomic Number of the Target, W. Duane and T. Shimizu. Investigation of the general X-radiation from the four elements iron (26), cobalt (27), nickel (28) and copper (29), to decide whether or not its intensity increases with the atomic number of the elements. Abstract of a paper presented before the American Physical Society. (*Physical Review*, vol. 11, no. 6, June 1918, pp. 491-492)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Survey.

CORRESPONDENCE

CONTRIBUTIONS to the Correspondence Departments of The Journal by members of The American Society of Mechanical Engineers are solicited by the Publication Committee. Contributions particularly welcomed are suggestions on Society Affairs, discussions of papers published in The Journal, or brief articles of current interest to mechanical engineers.

Fuel Conservation in the Petroleum Industry

To the Editor:

In few industrial fields is there a greater lack of engineering talent, coupled with a more favorable opportunity for engineers, than exists in the petroleum industry.

The drilling and pumping methods in the production of petroleum are substantially the same as they were forty years ago, and in the refineries the vast majority of distilling apparatus is identical in type with that of the earliest development, and, most significant of all, nearly all patents on distilling processes and apparatus have been granted to other than technical men.

Necessity, the mother of invention, has developed for both the driller and the refiner equipment that performs, in a measure, satisfactorily, even if inefficiently; therefore the efforts to increase efficiency have received no impetus except through the stimulating effect of large profits, and such efforts have been in the direction of increasing the production in the field and the yield in the refinery, rather than in attempting to secure increased revenue through operating refinements.

The subject of heat transfer receives little attention, the fuel used being considered merely a means to an end, yet the success of the numerous "cracking" processes hinges largely on this very question.

In the Rittman process, tubes with excessive wall thicknesses are employed to enable the use of the desired internal pressures at the temperatures necessary for "cracking," and flame temperatures, under forced draft, are allowed to impinge on a relatively small portion of the heating area.

In the Burton and other cracking processes, horizontally inclined tubes are subject to temperatures causing inevitable sagging and, only too often, rupture.

In the ordinary fire still, the desired temperatures are attained at a fuel and still-bottom-maintenance cost out of all proportion to the results obtained, and the derived vapors are condensed and the residuum cooled, at an additional expense of energy for pumping water.

The production of steam accounts for the use of nearly 50 per cent of the total fuel used in refineries, yet in the selection, installation and operation of boilers and auxiliaries little attention is paid to economy or efficiency. Feedwater temperatures in excess of 140 deg. fahr. are the exception, even with exhaust steam wasting to the atmosphere; flue-gas temperatures above 1000 deg. are common, and below 750 deg. very rare.

About fifty per cent of the steam generated is for use in the sills, the rest being used for pumping, etc. As the duty for steam in the stills is merely that of a medium for heat transfer, the exhaust from the pumps, engines, etc., is practically as valuable as live steam, but this fact is in many refineries unknown or ignored.

By the use of steam-driven electric generating equipment operating at 20 to 30 lb. back pressure (serving simply as a reducing valve), and the superheating of the exhaust steam for use in the stills, it is safe to say that 35 to 40 per cent of the present boiler fuel can be saved, and that the investment will pay for itself in twelve months in the average refinery.

In the Mid-Continent field the type of boiler commonly used is the portable locomotive-firebox boiler. Being simply a means to an end, no consideration is given it other than its portability, cost and steaming capacity, the latter requirement being according to the actual drilling need; when pulling tools and cleaning, the boiler is only half large enough, the firebox area being too small for high ratings. At these periods much time is wasted "waiting for steam."

In an article which I recently contributed to the *Doherty News* (April, 1918), it was stated that a series of tests run on both natural-gas and crude-oil fuels under 35-hp. locomotive-firebox boilers showed the average drilling boiler used 90,000 cu. ft. of gas a day or 16 bbl. of crude oil. These tests, with

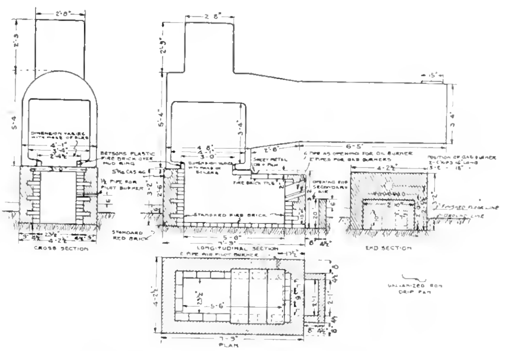


Fig. 1 Brick Sub-Furnace Used with Locomotive-Firebox Boiler

others, coupled with various experiments, have led to the development of methods and equipment which today are effecting savings in fuel consumption amounting roughly to 25 per cent.

The most notable development is that of the brick subfurnace shown in Fig. 1, which not only effects the savings shown in Table 1, but also allows double rating of the boiler when necessary.

The boiler covering consists of No. 28 gage $\frac{3}{8}$-in. "hy-rib" fitted around the boiler and securely wired on. To this is applied $\frac{3}{8}$ in. of 85 per cent magnesia, which is then coated with $\frac{1}{8}$ in. of waterproof dressing such as the combination of asbestos, gilsonite, asphaltum, etc. This covering costs about 30 cents per sq. ft., and is not only weatherproof, but will with reasonable care stand moving many times.

The portable boiler-cleaning outfit consists of a gasoline-engine-driven air compressor mounted on a suitable truck with a boiler-tube "air-hammer" scale remover, and with two experienced operators will effectually clean a boiler of all scale adhering to the tubes in two to three hours.

The price of crude oil is fixed by the pipe-line companies and is based on the average known specific gravity of oil pro-

TABLE 1 SAVINGS POSSIBLE IN OIL-FIELD BOILER OPERATION

Nature of Improvement	Installation cost per boiler	Saving per boiler per year of 365 days	
		Gas fuel	Oil fuel
Boiler Covering:			
Inside boilers	$50	$192	$480
Outside boilers	50	470	1175
Sub-Furnaces complete with Gas and Oil Burners:			
Steaming-plant boilers	60	900	2550
Drilling boilers	60	1150	3000
Feedwater Heater and Piping:			
For 4 boilers	175	275	780
For 8 boilers	125	275	780
Boiler-Cleaning Equipment with Air Compressor:			
Steaming-plant boilers	25	400	750
Drilling boilers	25	275	600

duced. Weathering and dehydration methods are responsible for the loss of 3 to 11 per cent of the total production (actual test data), yet the pipe-line companies place no restrictions upon the producer tending to discourage practices responsible for these wastes. As a matter of fact, they encourage the waste by refusing to run oil containing greater than a given percentage of water, knowing as they must that the removal of this water is almost invariably attended with considerable losses of the more volatile, and therefore more valuable, hydrocarbons.

Many of the larger producers control their own pipe lines and refineries. One of these used in the past twelve months for fuel in the fields over 300,000 bbl. of crude oil worth, at the market price, over $600,000. Forty per cent of this was entirely too valuable for use as fuel. A $100,000 topping plant would have saved this, and the investment would have paid out in a year at the outside.

I am speaking only of the operations I have witnessed in the Mid-Continent fields, but because of the investment involved they are doubtless typical.

A careful review of the professional cards appearing in the periodicals devoted to the oil industry shows that the mechanical engineering profession is very inadequately represented as compared with the geologists, mining engineers and chemists.

The U. S. Bureau of Mines is probably doing more constructive work in the petroleum industry than any other body, but there is an immense amount of work of the most valuable character awaiting the engineer in this field.

W. G. Williams.

Bartlesville, Okla.

Crippled Employees Are Able to Make Good

To the Editor:

Contrary to the general rule, our plant was in favor of older men, and had for a number of years hired the man of mature years in preference to the youth, other things being equal. We had found them steadier and to require less supervision: three-fourths of our work was manufacturing of an exact nature where these qualities counted more than semi-frequent bursts of speed. Located in a manufacturing center where piece work was general except in machine shops, it was hard to get and retain all the able-bodied men we needed, so almost unconsciously we formed the habit of arranging working operations to accommodate the infirmities of the men who generally find it difficult to obtain employment and who appreciate efforts made to enable them to earn a living, apply themselves, work steadily, and stick.

A few instances will show how we got along, and may suggest ideas for greater development in the same field. A visitor, a superintendent from a distant machine shop, was going through the plant one day, and remarked, "Where did you get all the cripples?" A year later, when the draft had cut deep into his ranks and the inducements of profiteers still deeper, he doubtless would have been glad to obtain the services of many of those cripples who had become valued employees by that time.

Several men who applied were ruptured and could not do lifting and were put to work on milling machines and punch presses. At this light labor they were perfectly safe and content. One man had lost all but the stump of a foot in a railroad accident and had worked in factory after factory, always, however, having to quit because he could not bear his weight all day on the injured foot; but on a power press he could work in comfort, and he turned out a large amount of work. This same man had picked up considerable knowledge in the operation of automatic machinery in various factories, and when a vacancy occurred he was put on a battery of screw machines; in a month's time he could set any of the automatics in the shop, and did so well that he kept five going and still found time to sit and rest the lame foot all it needed.

Another of these piece workers—a middle-aged man of known integrity and no little manual skill—had been in the shop but a short time when he asked to be allowed to bid on the "spring job"—a job of "setting" small leaf springs to a gage, an operation that kept two and three busy all the time and that could not be done accurately enough by machine. He argued that he could do the work at home, could save the hour night and morning that he spent on the way, and could work an hour or two at night. At first we didn't altogether like the idea, but after he had tried out a number and quoted us a price that would double his wages and lower our cost nearly a half, we gave in, and he has relieved us of a really troublesome job.

A telegrapher, a hunchback, who had tired of being shunted to lonely stations because of his appearance, applied for work. We had plenty of small assembling and to this his nimble fingers were fitted by long training; the work was as physically easy as his own trade and paid as much—but what was to the point, he was settled and lived at home. One of our younger men, a good lathe hand but always restless, stole a ride on a freight train on a Saturday night and came back three months later minus a foot and with a desire to settle down if we could "give him a job at something," which we did by rigging up a seat and transferring him to one of the small lathes, where he has become a genuine standby. A lad with a withered hand and a desire to work made good on a sensitive drill which was fitted up with a foot feeding attachment.

Other physical defects such as poor eyesight, susceptibility to heat and cold and dust, etc., etc., were encountered, and, if found genuine, an effort was made to supply the possessor with work that he could do in comfort. One deaf and dumb person and one who had an impediment that practically deprived him of speech were carefully instructed and in time became very speedy, reliable workmen.

The instruction of crippled men is one of the things we will undoubtedly be called upon to do in the not distant future, and the foregoing examples may serve to show what can be accomplished with a little patience and exercise of thought.

Donald A. Hampson.

Middletown, N. Y.

SOCIETY AFFAIRS

A Record of the Current Activities of the Society, Its Members, Council, Committees, Sections and Student Branches; and an Account of Professional Affairs of Interest to the Membership

THESE monthly letters which the Secretary has had the privilege of writing to the membership have endeavored to bring out the decided change of thought on the part of engineers as to their obligations on the one hand and the objects and aims of professional societies on the other. Our Society has felt that we were peculiarly sensitive to these thoughts and ambitions of members, particularly those who live at a distance from headquarters, and through its Sections movement and through visits of its officers has tried to keep in touch with them. The American Society of Civil Engineers, similarly recognizing the necessity for "stock taking," has called for a conference at its annual meeting in January to consider whether or not the aims and objects of that society should be restated. As this is such an excellent suggestion, our Sections Committee has actively taken up the matter of a similar conference for the purpose of carrying out its undeveloped plans, and the President has requested Mr. L. C. Marburg of the Committee to secure preliminary suggestions.

All those interested in making the Society useful in every sense, not only to the engineer himself in the advancement of his work, but to the municipality and state in which he lives and to the nation as a whole, are invited to correspond with Mr. Marburg, in care of the Society, and at a conference to be called the latter part of October in Indianapolis and again during the Annual Meeting all suggestions will be most gratefully received. Here, therefore, is an opportunity not only for suggestions of a specific character pertaining to the proper and higher aim of the Society in its work, but for any other suggestions which a member has for the improvement of any phase of that work. The conscientious devotion of the officers of the Society can best be rewarded by the interested participation of every member in a truly democratic manner in the government and guidance of the Society in all of its activities.

Technical Men and the War

The Society very early appreciated the necessity of conserving the technically trained men, including the students in the technical schools. Officers of the Society felt this so deeply that they encouraged the authorities in Washington that it would be consistent with democracy to assign trained men according to the service for which they are best fitted, and, although considerable damage had been done before action was taken, were finally successful in staying the waste of irreplaceable material, essential not only in the firing line and in the military preparations back of the line for officers, but in the industries where many times the number of men are required as are in the actual military establishment.

Consequently this Society is to be congratulated upon its success in calling the attention of the Nation to this, and securing action on what it considered was a prime requisite. The recognition of the Administration of this necessity is now complete and it has developed an important department, namely, that of education and special training, with Dr. Maclaurin at the head of all college training and Mr. C. R. Dooley at the head of special training. The indications are that all of the educational institutions of the United States in which there are over 100 pupils will come under the direction of the War Department.

It must be recognized that the problems of the draft have been complex in the extreme, and it is the duty of every individual to credit those responsible with the same devotion to ideals as oneself.

Training of Women

Our nominee for President, Dean Mortimer E. Cooley, similarly emphasized the necessity of training women for technical pursuits at a meeting of our Detroit Section with the Detroit Engineering Society, this spring. The departments of health and several of the leading educational institutions have also emphasized the opportunities for women, but in chemistry especially, as well as in public health, there is a wonderful field for women. It really becomes a patriotic duty for parents to make sacrifices to give their daughters a technical education.

In the Service

In a brochure entitled In the Service which the members will shortly receive will be stated the degree to which the engineers, as a profession, have taken up active work in the war. The medical profession, all of whom are registered and for that reason are capable of more definite analysis, is reputed to have about 24,000 men in the service, or about 25 per cent. It is no reflection upon our medical friends to state that the engineering profession, both relatively and absolutely, has a much greater percentage.

Permanent Camp for Engineers

All engineers will naturally follow with interest the development of Camp Humphreys, at Belvoir, Virginia, about twenty miles south of Washington and just below the town of Accotink. The Camp embraces the large Fairfax tract adjacent to Mount Vernon and to Gunston Hall, the former plantation home of George Mason, the author of the Bill of Rights. Camp Humphreys has been designated by the War Department as a permanent engineers' camp of the United States and by the first of August it was expected to have about 17,000 men there; later this number will be increased to about 30,000. Officers of the Camp have called at the Society's rooms, and there may later be a proposal to the members of the engineering societies to participate in some form of headquarters for the officers of this permanent engineering camp. In the act of Congress creating the camp and its equipment, no provision for such a building is made, so this building, essential to the welfare of the Camp from a human point of view, will have to be provided through the interest and generosity of the members of the engineering profession.

Calvin W. Rice,
Secretary.

PROGRESS OF THE SOCIETY'S TECHNICAL COMMITTEES

ONE of the fundamental objects of the Society, as outlined in the Constitution is to undertake specific investigation in the field of research through the appointment of committees for this purpose. Below are given a few brief notes on the work which has been done by some of our committees during the past year.

A word of appreciation is due all the members of these committees because their work is a labor which they have undertaken for the honor and advancement of the engineering profession, and it often means to them a considerable loss of time which might be devoted to more personal aims, in addition to a financial outlay to cover traveling expenses.

Joint Conference Committee on American Engineering Standards. Due to war conditions, standardization has been brought to the front line of attention, but the final arrangements of the Joint Committee representing the most prominent engineering societies have not yet been completed. Major Barba, one of the representatives of this Society, having accepted a commission in the United States Army, Mr. Henry H. Vaughan, Vice-President of the Dominion Bridge Co., Ltd., Montreal, Canada, and President, this year, of the Canadian Institute of Engineers (formerly the Canadian Society of Civil Engineers), has accepted appointment as the third representative of the Society on this Joint Committee. The other two representatives of the Society on this Committee are Mr. Henry Hess and Mr. Wm. F. Kiesel, Jr.

By means of this Joint Committee it is expected that the activities in standardization of all engineering societies will be coördinated so as to proceed with coöperated effort for progress in the engineering profession. It is also expected that it will provide a means of coöperating with the various bureaus of the Government through its Bureau of Standards.

This Committee, it is expected, will also be the advisory body in the conduct of international standardization activities. This branch of the work, during the war, has shown a need of special attention and will be one of the activities of the Committee when they start work in the near future.

Government Commission to Standardize Screw Threads. In the May JOURNAL announcement was made that a bill was before the Congress to standardize screw threads. This bill is now a law, and it provides that this Society and the Society of Automotive Engineers are to participate in the work. Never before has the United States Government undertaken national standardization to the degree that is specified by this bill.

The Commission will consist of two representatives from The American Society of Mechanical Engineers, two from the Society of Automotive Engineers, one from the Army and one from the Navy, and a representative from the Bureau of Standards. Secretary Redfield has already invited the Society to advise him of its nominations for membership on the Commission, and the matter is now before the Council and announcement will soon be made.

It is expected that the Commission will begin its activities very shortly and that its work will be completed within the time allowed by the bill, which is six months.

Committee on Screw Threads and Threaded Parts. In order to secure coördinated effort in standardization of all parts having screw threads, it has been decided that an inclusive committee should be formed of the several committees of the Society who consider the various branches of screw-thread standardization. Efforts in this direction have been successful and the following members have accepted appointments: E. M. Herr, *Chairman*; E. H. Ehrman, *Vice-Chairman*; Stanley G. Flagg, James Hartness, A. M. Houser, Frank O. Wells.

In general, the duties of this Committee will be advisory, and it will assign work to sub-committees who in turn will formulate details. The members of this Committee will be *ex officio* members of all of the existing committees considering screw-thread standards, and such existing committees automatically become sub-committees of the Screw Threads and Threaded Parts Committee. One of the functions of this Committee will also be to follow the activities of other societies and governments in the work of screw-thread standardization and avoid duplication, and an effort will be made to bring together all interests and obtain results generally acceptable.

Joint Committee for Standardization of Machine Screw Nuts. In this work the Society is coöperating with the American Society of Automotive Engineers. This Joint Committee has prepared a tentative specification which is acceptable to the majority of machine-screw nut manufacturers. On account of the absence of the chairman, who was called by the Government for duty in Europe and was away for a period of two months in the spring, the work of the Committee has been delayed, but they are now proceeding and hope in the near future to present a report.

Committee on Pipe Flanges and Fittings. The American Society of Mechanical Engineers in appointing a committee to consider the standardization of pipe flanges and fittings, recognized the need of an industry affecting in a vital manner almost every other branch of industry in the United States.

In 1914 the Committee on the Standardization of Flanges made a report[1] on flanges from 1 in. to 100 in. in diameter for 125 lb. per sq. in. working pressure, and for flanges and fittings from 1 in. to 48 in. in diameter for a working pressure of 250 lb. per sq. in. The value of this report was immediately recognized and led to a request that the subject be further investigated, with the result that at the Spring Meeting at Worcester Report No. 3 of this Committee was presented. This report, which is in addition to the 1914 Standard, covers standard flanges for pipe from 12 in. to 54 in. in diameter with a working pressure of 50 lb. per sq. in. and flanges and fittings for $\frac{1}{2}$ in. up to 12 in. in diameter for a hydraulic working pressure of 800 lb. per sq. in. and, within the same limiting sizes, for 1200 lb. per sq. in.

The Committee further investigated and has recommended standards for hydraulic pressure of 3,000 lb. per sq. in. for flanges and fittings varying in sizes for pipe from $\frac{1}{2}$ in. in diameter up to 12 in. in diameter. This report will be published in an early issue of THE JOURNAL, as well as in pamphlet form.[2]

Committee on Limits and Tolerances in Screw Thread Fits. In the August issue of THE JOURNAL a valuable progress report of this Committee was published which it is believed has been greatly appreciated by the engineering profession. This Committee is still energetically pursuing its deliberations and is now working on formulæ for tolerances for refined, medium and rough work, and will doubtless in the near future have a still more valuable report to make.

Gage Committee. Gages are one of the things which vitally affect production, as without them the manufactured goods would not conform within the prescribed limits and the final production would fall behind the requirements. This is the condition which confronted the Ordnance, Quartermaster and

[1] Paper No. 1430, Trans.Am.Soc.M.E., vol. 36, pp. 29-57.

[2] For previous reports on flange standardization, see Papers Nos. 481, 504 and 826.

Signal Corps Departments of the United States Army, and the Engineering Division of the United States Navy, and led to the formation of a committee. It was formerly the custom—and to our regret it is still continued to a certain extent—to have various authorities for the certification of gages. This Committee recommended that there be but one place to certify gages and that these master gages be located in one or more of the important industrial centers. This recommendation has been quite generally accepted and the U. S. Bureau of Standards has been agreed upon by the several bureaus as such a place. Its practice is to certify to master gages. As announced in a previous issue of The Journal, this plan was accepted by several of the bureaus of the United States Government and has already been of great benefit in assisting in the production of munitions and all other engineering requirements for the auxiliary branches of the Army and Navy services. Our Committee, in general, has been of an advisory character and the members have traveled at their own expense to Washington and to a number of munition- and ordnance-producing centers of the United States.

War Industries Readjustment Committee. This Committee, as the name indicates, is another of those committees produced by the war and since its creation, in June this year, has been in correspondence with manufacturers and organizations in a position to render technical service of various kinds. It has brought together engineers and manufacturers and furnished names of concerns able to render technical services or to manufacture articles as sub-contractors. It has notified the regional representatives, and in many cases the War Industries Board, of the offers of services and plants. It has also directed these offers of services and plants to the War Industries Board in the various regions. The Committee is doing everything possible to effectively assist the War Industries Board.

Tin Conservation (Bearing Metals Committee). Our Bearing Metals Committee, with the approval of the President, have increased the scope of their work so as to include the consideration of Conservation of Tin, and to coöperate with the Tin Section of the War Industries Board, Washington. It is not generally known that one of the most serious shortages at this time is that of tin. In the transportation of food to our troops in Europe, tin coating of the container where in contact with the food is absolutely necessary, and the war has produced such a tremendous shortage of this metal that tin conservation is perhaps just as important as fuel, wheat and sugar conservation. Tin has been used extensively in connection with bearing-metal alloys and when the question of its conservation was brought to the attention of our Committee on Bearing Metals, they immediately accepted the work of making a careful study of the matter. Bearing metals may be made with a much reduced percentage of tin, but in the case of food containers it cannot be reduced without endangering the quality of the food.

Our Committee is now carefully considering this problem of finding substitutes for tin and the Society awaits with interest the result of their deliberations. Mr. T. G. Cranwell, Assistant to Chief in Charge of Tin, War Industries Board, Washington, D. C., and president of the Consolidated Can Co., is directly handling this work and a letter has been received from him recommending that all our members and other engineers and people who have the interests of the United States and its Allies at heart use tin with extreme care and if possible do without it, so that the necessary requirements of the Government may be met.

Power Test Code. The necessity of there being a standard code for the measurement of all power and a standard method by which such measurements will be taken has long been a recognized necessity. Our Committee was formed with the object of satisfying that requirement and it is expected to offer a progress report in the very near future. The members of the Society will await with interest news of their report.

Refrigeration Committee. This Committee has been in existence for some time and is coöperating with other interested societies.

Boiler Code Committee. The Boiler Code Committee has during the early half of the year been active in pursuing its research and investigations in connection with the work of revising the Boiler Code which was begun early in 1917. At the same time, the Committee has continued the regular monthly meetings at which interpretations have been formulated for all cases presented to it for consideration, a total, up to the present time, of 199 cases having been brought before the Committee for formal action. At the present time, the revision work on the Code can be said to be practically completed, with the expectation that the new Edition of 1918 will be published in September. Also the new locomotive-boiler section of the Code has now been placed in definite form by the Locomotive Sub-Committee, and will receive the consideration of the Committee early in the fall. The Committee is also actively at work on the proposed boiler-inspection rules.

Committee on Steel Roller Chains. This is a Joint Committee with the Society of Automotive Engineers.

Proposed Committee for the Standardization of Shafting. This proposed Committee is an outgrowth of our Committee on War Readjustment and is in process of formation. Several engineers have advised us that steel shafting manufactured only in sixteenth sizes, and with the odd sizes eliminated, would save a considerable amount of material each year.

Committee on Small Hose Couplings. This is a new Committee which is being formed and which has been in contemplation for several years. It has been found that manufacturers of small hose couplings have different standards of threads, which produce difficulties where a user has purchased couplings from different manufacturers.

Further, it has been freely stated by engineers that the small hose couplings which are used for fire and water purposes should be totally different from those which are used for gasoline and other inflammable oils. The Committee will take up the consideration of couplings, having in mind the above points for standardization of hose couplings of about $\frac{1}{2}$ in. up to about $1\frac{3}{4}$ in.

Research Committee. The Research Committee has prepared a comprehensive program and is seeking coöperation with other national bodies. Research work is perhaps at this time one of the most important activities in engineering, because the war has produced shortages of various kinds of material, some of which it has been found necessary to do without and find substitutes and others of which have had their consumption curtailed. The Council has been urged to grant an increased appropriation for this work.

Committee on Machine Shop Practice. This Committee reports that at the request of the Ordnance Department it has undertaken work on the heavy-machine-tool problem and that the Department has accepted and is carrying out many of its suggestions. For instance, an order for forty-seven 102-in. gun boring lathes is being placed with the firm that developed the reinforced-concrete machine tool, and a very large number of 87-in. lathes have been contracted to the Southwark Foundry & Machine Co., who are planning in building them to make use of all the available heavy-machine-tool capacity of the eastern district. The work is still in progress.

Big Meeting at Indianapolis

The Council of the Society will hold its October meeting in Indianapolis, and the Committee on Local Sections has decided to take advantage of this and to call a meeting of the mid-western Sections to be held October 25 to 26. Cincinnati, St. Louis, Chicago, Milwaukee, Detroit, Birmingham and Indianapolis will be the chief Sections represented officially, although the invitation to the meeting will be sent to every member of the Society in the mid-western territory, and to members of local sections of other national societies, and to members of local societies.

It is expected that the Indiana Engineering Society and the Indianapolis-Lafayette Section of the American Institute of Electrical Engineers will join in with the arrangements.

A tentative program has been prepared, which calls for a two-day meeting to be held on Friday and Saturday, enabling members to leave home on Thursday night, and to stay over at Indianapolis until Sunday night if they desire. On the first day the program contemplates the Council meeting as the first event, followed by a meeting of the Committee on Local Sections, and a conference of delegates from local committees.

An informal lunch will be held at midday, and in the afternoon there will be a symposium on the mid-western fuel situation, and it is hoped to secure Mr. David Moffat Myers, the Advisory Engineer of the United States Fuel Administration as the chief speaker, and to supplement the program with addresses from the state fuel engineers of the Middle West, and from notable speakers upon the fuel question.

In the evening of the first day an informal dinner is contemplated, and an address by President Main, and by prominent local speakers.

On the Saturday the meeting will begin with a symposium on war education, including several phases of this timely subject, with addresses by Dr. C. R. Mann, Chairman of the Committee on Education and Special Training of the War Department, if he can attend, and by Dean Cooley, President-Elect of the Society, and by a number of prominent educators in the Middle West.

It is hoped that the luncheon on the second day will be held at one of the war plants of Indianapolis, and that in the afternoon visits to points of interest will be arranged, including a visit to Fort Benjamin Harrison, which is the headquarters of the Army engineers of the state of Indiana.

The arrangements are tentative, but full particulars will be published in the next issue of THE JOURNAL.

This meeting was intended to be the first of a series of joint Local Section meetings which the Committee on Local Sections hopes to hold as a desirable means of strengthening the Local Section organization and of reciprocally benefiting local members who do not often get to general meetings.

It is easily seen that such a joint meeting as the one to be held at Indianapolis may assume the proportions of a general meeting and may secure for members all the advantages of the regular convention.

War Activities in Chicago

As announced in the August issue of THE JOURNAL (page 712) the Technical Societies of Chicago have organized for war work and for placing at the disposal of the Government and other various agencies, the combined strength and resources of the engineers of that city. The organization is called the War Committee, Technical Societies of Chicago, and coöperates with the United States Employment Service.

The headquarters of the Committee is in the office of the Western Society of Engineers, 1735 Monadnock Block, Chicago.

A general meeting of the members of the Committee was held on Thursday, August 1. It was addressed by Mr. S. J. Duncan Clark, war analyst of the Chicago *Evening Post*, on the subject Recent Developments on the War Front. The address was a popular one, summarizing war conditions as given in the daily press but going more into detail in regard to the progress of the present drive and counter-attacks.

Following the address, Mr. W. F. Abbott made a brief statement of the purpose of the War Committee which is a union organization composed of two representatives from each local society and local section to coöperate in assisting the Government. The meeting was the first of the combined Committee and the attendance was about 600.

So far the activities of the Committee have been directed to sending out employment bulletins and calling attention of engineers to opportunities in the uniformed and civilian services of the Government. Further activities will be entered upon as requests from the Government departments, which have been notified of the readiness of the Committee to serve, come in.

Committee on Development of the A. S. M. E.

Initial steps have been taken for the appointment of a Committee on Development, which was suggested in the recent letter of Louis C. Marburg of the Section's Committee, reprinted in these columns (see page 694 of the August JOURNAL). The following letter, which is self-explanatory, has been sent to all Chairmen of Local Sections:

The attached letter to the Chairman of the Local Sections Committee, Mr. D. Robert Yarnall, was discussed at a recent meeting of the Local Sections Committee which was attended by the President and Secretary of the Society.

It was the feeling of all that a committee of our Society composed mainly of representatives from all the Sections as outlined in the resolutions of the A. S. C. E. might prove of great benefit.

Many have had for years the ambition for the Society to enlarge its scope of activity to include fields allied to engineering. They have also hoped for a restatement of ideals expressing a broader conception of the engineer's duty to the community and of the position of the expert in public life. No finished program of organization can be offered, but a crystallization of ideas is needed and it is hoped that a plan of liberal coöperation between all engineering organizations may result therefrom.

The writer was instructed by President Main to communicate with all Sections and to request that each Section suggest a representative to serve on a Committee of our Society similar in form and scope to that of the A. S. C. E. Will you, therefore, please take up this matter with your Section and make an early recommendation. It is advisable that each Section be represented by a member particularly interested in this undertaking as it is expected to have far-reaching effects upon the development of our Society. In addition to one representative from each Section the President will appoint a number of members at large and if you have any names to suggest they will be appreciated.

It is proposed that an early meeting in the fall will be called at some central point to discuss the work, and while not yet authorized to guarantee the payment of mileage to delegates, the writer feels confident that sufficient funds will be available for this purpose.

Hoping to hear from you at an early date, I am,

Very truly yours,

L. C. MARBURG.

In this connection it will be of interest to learn that the American Institute of Mining Engineers has also decided to appoint a similar committee. Three of the four Founder Societies have now taken action in this matter. It is to be hoped that other societies of national character and also local societies will provide for similar discussions, as only in this manner can the best results of this important movement be secured.

Captain May Forfeited Life in Testing Oils

The notice of the death of Capt. O. J. May of Chicago, Mem.Am.Soc.M.E., an officer of the Equipment Division of the Signal Corps, which appeared on p. 573 of The Journal for July 1918, is supplemented by the following news item, which states that in consequence of the severe strain to which he was subjected while conducting a 65-hour test of a new oil for lubricating air engines, his death is held officially to be in the line of duty.

The new oil is the result of a problem worked out with great care by officers of the Signal Corps in connection with the development of the Liberty engine. At first it was believed that castor oil must be used, or at least a blend of castor oil and some mineral oil. There seems to have been no definite determination among the aircraft organizations of the Allies as to what kind of oil should be used.

The character of the lubricating oil of the air engine is of the greatest importance, as the efficiency of the engine underlies the work of the airman, and his life often depends on its quality.

It was figured out that 5,000,000 gallons of castor oil at $3 a gallon would be required for our air service, and that quantity was not in existence. The Signal Corps then went to work on a blended mineral oil to cost 75 cents a gallon.

Captain May was set to the task of testing this oil and others on running engines. In 25 days he made 37 tests on as many engines, where five tests a week was regarded as all that any one could do. Every oil was analyzed, weighed and measured before and after the run of each engine.

Captain May was exhausted when he had completed these tests. He then set to work to make an altitude test in an air-tight building with the air in it partly exhausted and kept in that state to simulate the atmosphere at high altitudes. The Captain ran several of these tests and made one of 65 hours' duration. He stood at watch without leaving the work all that time and duly recorded his data.

The strain on Captain May's vitality was too great, and when a few days later he went on an inspection trip he caught cold in a heavy storm. He died at Takoma Park, Md., near Washington, on May 22. His work has provided the Army and Navy aviation services with a lubricating oil of the best quality at a cost one-fourth of what was estimated, and it is calculated he saved the Government fully $11,000,000. One feature of the tests of this oil is the fact that half of the quantity used may be cleaned and used over again. (*New York Times,* August 14, 1918, p. 18)

A.S.M.E. Member Cited for Bravery

Captain Horace L. Smith, Jr., Mem.Am.Soc.M.E., has been cited for bravery in action, along with his entire company. Captain Smith is in command of Co. D, First Engineers, and distinguished himself in battle at Cantigny which the Americans captured and held against superior enemy forces. Captain Smith's company lost 45 men and two officers, killed during the action.

The First Engineers is a part of the First Division, Regular Army, commanded by Major General Bullard. The citation of bravery read as follows:

"Although handicapped at the beginning of the action by the loss of two officers killed and one wounded, nevertheless, it carried out its mission in a highly efficient and satisfactory manner; in addition to its duties as an engineer company, it acted as an infantry reinforcement, and during the three days suffered severely in killed and wounded."

Captain Smith was recommended for the citation for bravery in battle by the non-commissioned officers of his command, who declared that they were proud to serve under him.

Lieutenant-Colonel Parsons Now in Command of the Eleventh Engineers

Lieut-Col. Wm. Barclay Parsons has recently been placed in command of the Eleventh Regiment of Engineers, now in France for over a year. Previous to entering the war Colonel Parsons had held the rank of brigadier general and chief of engineers with the New York National Guard. He was chief engineer of the Rapid Transit Commission of New York from 1894 to 1905; a member of the Isthmian Canal Commission, 1904; advisory engineer of the Royal Commission on London Traffic, 1904; member of the Board of Consulting Engineers, Panama Canal, 1905. He has been a trustee of Columbia University since 1897, having been graduated in 1879, and is the holder of several degrees. He is a member of the American Society of Civil Engineers, the Institution of Civil Engineers, Great Britain, Société des Ingénieurs Civils de France, and has written several books and papers on engineering subjects.

In May 1917 Mr. Parsons received a commision as major and on the 14th of the same month sailed for France on a special mission for the Government to look over the railroads of that country.

Navy Factory's Year Record in Building Flying Boats

It is a pleasure to publish the following information relative to the accomplishments of one of the members of the Society:

On July 27, the anniversary of the date on which the building of the naval aircraft factory at Philadelphia was authorized, Rear Admiral Taylor, Chief of the Bureau of Construction and Repair, which built and operates the plant, reported to Secretary Daniels the satisfactory record made in its erection and operation, under the direction of its manager, Naval Constructor F. G. Coburn, Mem.Am.Soc.M.E. In recognition of this, the Secretary addressed a letter to Naval Constructor Coburn, as follows:

"The department desires to express its appreciation of your ability shown in organizing the naval aircraft factory and bringing it, as its manager, to its present state of efficiency. One year ago the construction of the naval aircraft factory was authorized by the department, and you were detailed as its manager. This factory has been built in accordance with plans prepared by you, and the records show that forms for the first flying boat were laid October 12, while the building was not completed until November 28. The first flying boat was given its successful trial flights on March 27, 1918, and since that date a steadily increasing rate of production has been observed. It is noted that the first order for 50 large flying boats has been completed and the greater part are now flying over British waters.

"It is believed that the creation in the space of one year of one of the largest aircraft factories in the country stands as a conspicuously successful example of the Navy's preparation for war."

The contract for the aircraft factory was awarded August 6, 1917, and work was begun on the same day. The original factory had a floor space of 160,000 sq. ft. An extension, which will give an added space of 55,400 sq. ft., was begun on February 26, 1918, and is now practically completed. (*Official Bulletin,* July 27, 1918, p. 5)

AMONG THE LOCAL SECTIONS

THE four years' work of the Committee on Local Sections, first as a special committee of the Society and now recently as a standing committee of administration and one of the six fundamental committees of our organization, demonstrates the value of Local Sections as an agency for furthering the several phases of the Society's work and for reaching the individual member and rendering him effective service.

However, there has been one limiting factor—the number of the Sections which have been established. In certain centers, such as Boston, Chicago and St. Louis, Local Sections of our members have been operating for some years, and members residing in these centers have secured all the advantages which come from the Local Sections organization, whereas members in other large centers where Sections have not yet been established, such as Pittsburgh and Cleveland, have not secured these advantages. In no two local centers has there been similarity of conditions, so that the matter of establishing a Local Section has been a problem unto itself in each place, and organization of local members has only come about when all concerned have been convinced of the advantages and when the local members themselves have decided upon utilizing their initiative in requesting organization.

This latter is the determining factor in the progress of the local sections movement in all societies and precludes any undue stimulation of the movement on the part of the governing bodies or any committees at headquarters of the national societies. Therefore, if the progress of organization into local groups has been slow in some desirable territories, it has been on account of the fact that the local members have for some reason or other deemed it wise to defer organization.

Now, however, comes a turning point in the history of the Local Sections and a new factor is introduced into the equation which requires local members to review their local conditions, especially in relation to the existing local societies and to determine upon a manner of organization. The Committee on Local Sections becomes one of the six main committees of the Society; the Local Sections organization therefore becomes constitutionally one of the supporting pillars of the Society. It is no longer a question of whether or not it is desirable for the Society to encourage Local Sections; it becomes imperative that the Society have Local Sections to continue to function.

This condition of things has not been brought about suddenly by constitutional amendment produced autocratically, but is merely the outcome of a number of tendencies extending over as many years as the Local Sections organization has been in existence; and, furthermore, these tendencies have not all been proposed by the Local Sections themselves—they have been originated by the central committee of the Society which has long since recognized the coming of the new order of things.

For five years decentralization in government has been under discussion in the councils of our organization, with such success that the latest proposed amendment to the Constitution means a marked step in this direction. It will be but a short while before such decentralization is completely accomplished and the power of government placed in the hands of the entire membership forever.

If the constitutional amendment securing this decentralized government goes into effect next spring, and its execution should be placed in the hands of the Local Sections, the elements in the Local Sections organization heretofore not at all similar by virtue of the unique set of conditions in each Section center will need coördination. And, as already mentioned, some of the centers where Sections do not exist, but where the local membership is strong, must be brought into committee relations and the whole Local Sections organization must be well rounded out so that all disparities are removed and the new machinery of government can be started up smoothly.

Incidentally, for some time there has been discussion regarding the desirability of completely coördinating all organized groups of engineers of whatever kind for the purpose of securing for engineers the voice in the community to which they are entitled. A rounding out of the local sections organization of the national societies such as we are about to accomplish in our own Society will go a long way toward rendering such a unification of engineering society activities effective.

The Committee on Local Sections foresees a large amount of work in bringing its organization to a condition of inclusion of all localities, but this can be very much simplified if the full coöperation of the local center is secured in each case. A certain amount of uniformity is necessary in the organization of Sections, but the difference of local conditions must of course be realized. The following thoughts regarding Local Sections and local societies might be advanced at this time:

The basis of social relations is the community, in which the engineer is one of the elements. The fundamental organization of engineers in the community is the local engineering society which includes in its membership all engineers of whatever training or experience, or in whatever field of work. Through this organized local society the engineers have their voice in the affairs of the community. The local society may be large enough to render it desirable to sectionalize its activities into civil, mining, mechanical, electrical or other engineering. However that may be, the local society still remains the unit and so long as the engineer continues to reside in the community he secures his voice in its engineering affairs through the medium of his local society. That is all he requires and that secures for him his recognized standing. Therefore, the local society must be regarded as paramount in engineering organizations.

The limit of usefulness of the local society to the individual member is reached, however, when he removes from the community and establishes himself in another territory. He must make entirely new connections and must bide his time for his standing in a new community to be recognized. There is also another limit of usefulness of the local society in its relation to the engineer at large and to the public: the local society specializes in local conditions and confines its interest to such conditions. Its meetings are usually limited in attendance and its publications have only a small circulation, and, except in a few special cases, its influence does not extend very far beyond its center of operations.

Here is where the utility of the national society comes in. It secures for its members a national and sometimes international connection, so that the limitation of community residence is entirely removed. Its meetings and publications are national and international in scope, so that its influence through these media is practically universal.

The connection between the local and national societies is established in the following manner: The activities of the national society are supported entirely by individual members, who are, in turn, usually members of local societies; and so, while the fields of operations of local societies and national societies are entirely separate and distinct, the agents perform-

ing these operations are one and the same. The two kinds of organizations therefore become inseparable and interdependent.

It is not necessary to justify further the existence of both organizations and the above comparison has been made merely to introduce the idea by which our own Local Sections organization and the local societies may be brought up to the point of active coöperation and complete coördination.

In practically every center in which we have a Local Section there is a local society, and it is the business of our section to preach the gospel that that society is the authority in the community.

In centers where we have no Local Sections there is usually, likewise, a local society and, bearing in mind that in all such centers we need organization and government, our local members should take the initiative and open up negotiations with the local society with a view to determining how our members may organize and work for the government of the national society without detracting from the autonomy of the local society.

Behind the whole organization movement of which, of course, our Society is but a small part, there is the great incentive that there remains an army of engineers in this country who have not yet responded to any calls for organization to secure for the engineer the recognition in public life which he merits. The engineering profession is lacking in missionaries—the men who will emerge from the natural conservatism which is inherent to their professional training and who will blaze the way into the halls of community government in which the engineer has so far been conspicuous by his absence.

SECTIONS REPORTS AND PROGRESS FOR THE YEAR

Although in a few cases the war seriously upset the plans of the executive committees for the season just closed, nevertheless on the whole the committees were able to maintain the development of the Sections organization and to carry out a progressive year's work. Naturally the meetings have changed in character somewhat and in a number of instances committees were called upon to fill programs quickly; many war subjects and war speakers have been introduced and much valuable information upon war topics brought out at the meetings.

In the last issue of The Journal were listed the more important papers contributed by the Sections. Some of these papers have already been published and others appear in this issue. While it is not yet possible to publish all the papers received and while it is likewise not yet possible to publish material immediately upon receipt, still the Publication and Papers Committee is alive to this condition and is considering ways and means of remedying it, so that the Sections may receive the prominence in the publications which their large contributions to the activities of the Society merit. Many of the papers presented before Sections are given in collaboration with local societies, and if the local society issues a publication, the paper appears in good season in the local journal. What we want is some arrangement whereby simultaneous publication of Local Sections papers may be made in the local journal and in the national journal, and then the interests of both societies will be best served.

The new executive committees, which, under the present method of government of Sections, assume office on July 1, are taking the opportunity afforded by the out-of-season period to familiarize themselves with the duties of their office and of laying their plans for the next year's work. In many cases the committees have already had their organization meetings. The transfer of records from the old to the new officers is now made in a very simple manner through the medium of what are called Section record books—loose-leaf binders with standard sheets which have been issued to each Section by the Committee on Local Sections and which contain just the information the chairmen and secretaries require in discharging their duties of office. This simple method saves a great deal of time when the personnel of the committee changes.

The thanks of the Society and of the members at large should be duly extended to the executive committees whose terms of office have just expired for the personal time they have devoted and the labor they have spent in continuing and fostering this fundamental activity. The amicable relations with local societies and with local groups of other national societies which were universally enjoyed by our Society are the subject of comment by all, and these relations are entirely due to the fine spirit with which the local committees have carried on their voluntary work.

As in previous years, the committees going out of office have been requested for brief reports of their activities for the year for publication in The Journal. Not all of these reports have yet come to hand, which is natural considering the heavy calls upon the time of every one. Those which have been received, however, are published in abstract below.

ATLANTA

The Section has continued to meet with the Affiliated Technical Societies of the City of Atlanta.

It was decided early in the year to hold meetings monthly and have a paper upon an appropriate subject presented at each meeting. This program was not quite carried out, however, owing to the war conditions.

The engineering paper of the year was entitled, The Effect of Fuel Economy of Different Arrangements of Baffles in Boiler Tubes, by Mr. W. G. Eager.

Oscar Elsas,
Section Chairman.

BALTIMORE

Six meetings were held this season, one being of the nature of a symposium of engineering problems of the canning industry.

At the November meeting a notable paper was read by Mr. W. L. De Baufre of the U. S. Naval Engineering Experiment Station on the subject of Evaporation. Professor Christie, at the same meeting, discussed the question of Municipal Ownership of Public Utilities.

At the May 22, 1918, meeting M. W. H. Blood, of the American International Shipbuilding Corporation, read a paper entitled Hog Island Shipyard; the Greatest in the World.

Wm. W. Varney,
Section Chairman.

BIRMINGHAM

The Section retained its affiliation with the Alabama Technical Association, which includes all members of the national engineering societies residing in the state of Alabama.

Five meetings were held, at three of which phases of the war situation were discussed. The May 16, 1918, meeting was an all-day joint meeting, at which Secretary Rice was present.

J. H. Klinck,
Section Chairman.

BOSTON

During the year the Boston Section held six regular meetings in addition to the Annual Dinner and a joint meeting with the A.I.E.E. Section. All these meetings were duly reported in THE JOURNAL.

The Annual Dinner of the combined engineering societies was held on April 30, and among the gentlemen who spoke were: Alfred D. Flinn, Secretary of the Engineering Council, who dealt with the Work of the Council; and W. H. Blood, Jr., of the American International Shipbuilding Corp., who delivered a lecture on Hog Island, the Greatest Shipyard in the World. Short addresses on subjects of the day were given by Major-General H. F. Hodges, in command at Camp Devens, and Major Andrew J. Peters, of Boston. Motion pictures were also shown illustrating the adaptability of a new rudder which has been perfected by H. O. Westendarp, of the General Electric Company.

The Annual Meeting of the Section took place at the Engineers' Club on the evening of May 29. Dr. Charles H. Eaton of the Shipping Board, Emergency Fleet Corp., delivered an address on America at the Gateway of Destiny.

No meetings have been planned for the summer months.

A. C. ASHTON,
Section Chairman.

BUFFALO

The Section has continued as an affiliated branch of the Engineering Society of Buffalo and has passed through its seventh season successfully.

The local society held a large number of meetings, many upon mechanical engineering subjects, all of which have been recorded in THE JOURNAL from time to time.

The new committee is a very active one and prospects for the coming year are exceedingly good. The committee already has some good papers in prospect.

F. E. CARDULLO,
Section Chairman.

CHICAGO

On October 24 a meeting of the executive committee was held with the Sections Committee who were visiting Chicago, and the question of coöperation with other societies in Chicago was discussed, which resulted in a movement to hold joint meetings with the Western Society of Engineers and the Chicago Section of the American Institute of Electrical Engineers.

The first regular meeting was held on November 16 in connection with the Council Meeting, and was attended by some 180 members and guests. The address was given by Lieut.-Col. Peter Junkersfeld on Cantonment Construction.

Three such meetings have been held, two in the rooms of the Western Society and one in connection with the meeting of the National Society for the Promotion of Engineering Education, at Northwestern University. At the first, Mr. C. F. Kettering spoke on the Development of the Internal-Combustion Engine, and at the second, Messrs. Berg and Morgan presented papers, the first on The Future Possibilities of Steam Economy, the second on Modern Condenser Practice.

The meeting at Northwestern University was on the subject of Technical Training for the War and After, and included short addresses on Present Needs of Industry, The Future Outlook, The Nature of Training Which Should Be Given, and The Employment of Women Workers in War Industries.

The March meeting of the Section took up the question of the fuel situation and addresses were given by Joseph Harrington and by Prof. H. H. Stock. Prof. Stock spoke on the question of Fuel Storage, and Mr. Harrington outlined the fuel situation and advocated a system of power-plant regulation such as is now being put in force by the Fuel Administration.

A short meeting held in May was addressed by John Erickson, City Engineer, who presented a paper on the New North-Side Tunnel and the Mayfair Pumping Station of the City Water Works.

Auxiliary activities of the Section during the year have been coöperation in the sending out of notices for the Government of requirements of engineers for Signal Corps Service, for the Refrigeration Regiment, for Submarine Service, and for the Ordnance Department.

The Section has also coöperated in the sale of the bonds of the Third Liberty Loan, and has joined with the other local sections and local societies of Chicago in establishing the War Committee of Technical Societies which is now issuing bulletins on Government needs, is coöperating with the State Fuel Administration in the power-plant census, and has held one popular summer meeting at which some 600 were present, addressed by S. J. Duncan Clarke on The Present War Situation in France.

A. D. BAILEY,
Section Chairman.

CINCINNATI

On October 18, 1917, Mr. F. O. Clements addressed a joint meeting of this Section with the Engineers' Club of Cincinnati on the Research Laboratory Applied to Industry. A brief abstract of this paper appeared in the December 1917 issue of THE JOURNAL.

Mr. J. E. Freeman was the speaker at the February 21 meeting and had for his subject the Construction of Concrete Ships and Barges.

A joint meeting with the Engineers' Club was held on the afternoon and evening of March 21, 1918. The afternoon session began at 2:30 and was presided over by George W. Galbraith. Mr. Henry Ritter, general superintendent of the Lunkenheimer Co., spoke on Shop Kinks, and the paper was discussed by A. Wood of the Niles Tool Works Co., Hamilton, and George Langen of the Cincinnati Planer Co. The second paper, on The Economic Use of Coal by Communities, was delivered by Prof. John T. Faig and was illustrated by lantern slides.

The evening session was presided over by the president of the Engineers' Club. Mr. C. U. Carpenter, vice-president and manager of works of the Recording & Computing Machines Co., Dayton, O., spoke of the training of some thousands of women, who had had no previous training in mechanical lines, for the manufacture of time fuses for Russian shrapnel.

At the meeting on May 11 the guest of honor was Secretary Calvin W. Rice, who delivered an inspiring address on the activities of the Society. Mr. F. A. Geier and Mr. George W. Galbraith also gave short talks.

An automobile trip to Dayton, O., was arranged for the members of the Section on May 25 and the party was given special permission to visit the famous Wilbur Wright Aviation Field near Dayton. During the afternoon, members were given an opportunity to inspect the plants of the Dayton-Wright Aeroplane Co. and the Recording & Computing Machines Co., the latter of which firms has accomplished much in its rapid and efficient method of training women for industry.

In response to a resolution offered by Dean M. E. Cooley of the University of Michigan before the Detroit Section, a committee was appointed by the chairman of the Cincinnati Section on the intensive training of women for industry, consisting of the following: George Langen, J. B. Doan and R. T. Hazleton. Through the efforts of this committee an intensive course in mechanical drawing was begun at the Ohio Mechanics' Institute, Cincinnati, on June 24. About forty young women presented themselves for this work and a number of them are now taking the places of men who have been called to the Service. It is the intention of the committee to continue its work.

G. W. GALBRAITH,
Section Chairman.

CONNECTICUT

The Connecticut Section, which was organized last year with five Branches at New Haven, Hartford, Bridgeport, Waterbury and Meriden, respectively, has passed through a successful season although all Branches have not been uniformly active.

It is felt that the work of the Section has been of service to engineers of the state and that as the organization develops this work will be enhanced in value.

The Connecticut plan provides for fall and spring meetings at New Haven and additional meetings at each of the Branches from time to time. Such meetings have been held this year.

Reports from all Branches have not yet come to hand, but the following typical report has been received from the Bridgeport Branch:

The Bridgeport Branch of the Connecticut Section has been coöperating with the other Branches in the state, copies of the

minutes of all executive meetings having been exchanged. They have also worked jointly with the New York Section and have been represented in the United Engineers' Sessions in New York City, and also on the Mayor of New York's special sessions for the Allied Engineering Societies, which had mainly to do with labor problems appertaining to mechanical engineering work. The Branch was also represented at a banquet given in honor of the British Labor Commission in New York.

The general meeting held on April 24, 1918, was most successful. This being a banner occasion, almost the entire membership was present. The combined meeting held on June 21 with the Bridgeport Manufacturers' Association and Chamber of Commerce was a particularly happy thought on the part of President Bilton, of the Manufacturers' Association. This last general meeting was a most successful affair and the papers read on the Conservation of Fuel will become a guide for carrying on this work.

Papers have not been as numerous as had been hoped possible but have been valuable, bearing on the subject of gages.

Henry B. Sargent,
Executive Committee Chairman.

DETROIT

Meetings of the Section are now being held in coöperation with the local sections of other societies and with the Detroit Engineers' Society in the rooms of the Chamber of Commerce.

The National Committee on Local Sections visited Detroit on October 25, 1917, when a few select brief papers were presented on primary topics.

The annual meeting was held on May 5, 1918, in conjunction with the Detroit Engineering Society. Important resolutions by Dean Cooley on the training of women for drafting-room work were adopted and transmitted to all engineering organizations.

The Detroit Section is looking forward with a great deal of anticipation to the coming of the Society to the city in the spring of next year and is already beginning to make arrangements for the distinguished guests.

G. W. Bissell,
Section Chairman.

ERIE

The Erie Section has continued its coöperation with the Engineers' Society of Northwestern Pennsylvania and held a joint meeting with the society on November 13, 1917. On May 3, 1918, Mr. James Burke presented a paper on The Conservation of Fuel.

The Section is still a young one, having only just passed through its second year of operation and that under the exceptional conditions of war.

J. F. Wadsworth,
Section Chairman.

INDIANAPOLIS

The Indianapolis Section has been coöperating with the Indiana Engineering Society, the local section of the A. I. E. E., and the local Chamber of Commerce.

An important joint meeting was held on June 25 of this year at which a number of papers of local and general interest were presented.

One other meeting was held on November 7, 1917, and was duly reported in The Journal.

A symposium on Fuel Conservation was held on May 10, 1918. Secretary Rice gave an address on The Relation of the National Society to the Section and the Relation of the Engineer to the War.

W. H. Insley,
Section Chairman.

LOS ANGELES

The Section has been coöperating with the joint technical societies of Los Angeles, which have been holding luncheon meetings throughout the year at which short talks have been given by speakers furnished by the various societies, in accordance with a program laid out in advance.

On November 24, 1917, an interesting visit by the societies was made to the top of Mt. Wilson and the Mt. Wilson Solar Observatory.

President Hollis visited the Section early in the year and also addressed the Student Branch at Throop Polytechnic Institute.

F. G. Pease,
Section Chairman.

MILWAUKEE

Milwaukee has just completed another good year, its meetings being largely attended. The meetings are still being held at the City Club.

The first meeting of the season was held on October 23, 1917, when the Section entertained the National Committee on Local Sections. Luncheon was served at the Milwaukee Club and a visit paid to the Allis-Chalmers plant. In the evening a large number of local engineers attended a dinner and took part in a discussion of Society affairs.

On November 14, Mr. B. E. Fernow gave an illustrated talk on the Design and Application of Magnetic Clutches. On January 16, 1918, Mr. W. Alexander spoke on Electric Locomotives on the Chicago, Milwaukee and St. Paul Railway. On February 13, 1918, Mr. E. S. H. Baars addressed the section on Cold Accumulators and Their Application to the Refrigerating Industry. A joint meeting with the Electricals was held on March 13 when Prof. C. M. Jansky spoke on Science in War. A successful meeting was held on April 10 under the auspices of the American Society of Refrigerating Engineers, and C. L. Portier gave an illustrated lecture on Automatic Control Apparatus for Temperature. On May 8 Mr. N. J. Whelan addressed the Section on The White Coals of Wisconsin.

W. M. White,
Section Chairman.

MINNESOTA

A very cordial feeling exists between the Minnesota Section and the other engineering interests and societies of the state. The Minnesota Joint Engineering Board is becoming a factor in society affairs in the Northwest. The Board has headquarters in the Twin Cities and practically all the engineering associations in the state have applied for membership in it.

The Board recently appointed a committee to draw up a permanent plan of organization of an engineering club. Four alternatives are under consideration: (1) An all-inclusive organization for professional engineers, juniors and associates, with a different status for each, (2) an organization of members of the four national societies, (3) an organization of national society members with a limited number of associate members, (4) an organization of professional engineers only.

Three elements are considered as essential to the organization: professional, social and civic; and it has been suggested that affiliation be made with a civic body so that the entire community may be bettered.

A joint meeting of the sections of the national societies was held in Duluth on May 20.

H. LeRoy Brink,
Section Chairman.

NEW ORLEANS

The second year's work of the New Orleans Section has been a successful one. As before, meetings have been held in entire coöperation with the Louisiana Engineering Society.

Five meetings were held during the season. On September 7 Mr. F. J. French read a paper on Shipbuilding which was published later in The Journal. The January 12, 1918, meeting was a smoker with the Louisiana Engineering Society. On February 11, 1918, Mr. P. E. Lehde gave an address entitled, Some Notes on Wireless Telegraphy, and on March 11 Mr. A. M. Lockett described the New Orleans Industrial Canal. On May 13 Secretary Rice visited the Section, and Hon. T. F. Carlisle, British Consul, spoke on Britain and the War during the last twelve months.

H. L. Hutson,
Section Chairman.

NEW YORK

During the first half of the season the plans of the Section were somewhat disorganized on account of the almost complete dismem-

[illegible] E. [illegible] Ar[illegible] considerable effort [illegible] organized and aggressive program [illegible] [illegible].

Report [illegible] meeting held has been published in full in THE JOURNAL, the discussion at the meeting on Non-Essential Industries on February 21, 1918, being given place by the Publication Committee in the technical section.

On April 9, 1918, a unique gathering was held in the form of a joint meeting of the Metropolitan Student Branches and the New York Section. The Branches were responsible for the conduct of the meeting and carried the program through in a very creditable manner.

JOHN H. NORRIS,
Section Chairman.

ONTARIO

This section was established in May of last year.

On January 29, 1918, Mr. F. B. Ward addressed the Section on the Influence of Munition Manufacture and Other War Work on Machine-Shop Practice. On March 25 a meeting of the Joint Committee of Technical Organizations was held and several speakers addressed the Section on war subjects. On April 18, 1918, Mr. W. M. Wilkie spoke on Heat Treatment of Low-Carbon Steels.

A well-attended meeting of the A.S.M.E. Ontario Section and the Toronto Branch of the Engineering Institute of Canada was held in the lecture room of the Engineers' Club on July 3, at which two subjects were presented.

The first was a very interesting paper by Edward Maybee on Patents of Invention which covered particularly that part of the patent field of interest to engineers, and a number of points which are generally not well understood were explained very clearly.

The second subject was an address by Mr. Holmes, of the Invalid Soldiers' Commission, on The Training of Disabled Soldiers in the Industries. The training of returned soldiers falls into three periods: that in the hospitals, then in the reëducation schools, and lastly in the shops of the industries themselves. Mr. Holmes dealt with this last department and explained the organization and methods of handling the work. It is with this industrial phase of the training that the engineers and employers should be most closely in touch, because here they can help most.

Mr. Holmes explained how the preliminary survey is made of each plant before men are placed there and that a careful supervision is kept over the men and their work by the government commission during the period of their instruction. The men receive pay from the government and instruction from the firm. Over 90 per cent of the men so placed have made good and are now earning or making good progress toward earning, a comfortable income.

The principal point brought out was that the returned men should not be dumped upon the industrial field and left to shift for themselves, but that their cases must be studied individually and the men allotted to positions suiting not only each man's natural capacity but also the nature of his wounds or physical deficiency.

R. W. ANGUS,
Section Chairman.

PHILADELPHIA

Early in the fall of 1917, the Executive Committee met and arranged the entire program for the year, completing all arrangements by the middle of September. In spite of the pressure of war work, none of the speakers failed to keep his appointment, much to the gratification of the committee and the membership.

On October 16 the first meeting of the year was held jointly with the Philadelphia Engineers' Club in Witherspoon Hall. President Vogelson of the Engineers' Club presided. Mr. Homer L. Ferguson, President and General Manager of The Newport News Shipbuilding & Dry Dock Co., gave an excellent address upon The War's Effect on Merchant Shipbuilding. At the time of this meeting the country had just become awakened to the necessity and importance of the shipping program; his address, therefore, was a very timely one. About six hundred engineers from Philadelphia and vicinity attended the meeting.

The meeting of November 2 was given over to a discussion of the activities of the Local Sections of the Society. Mr. D. Robert Yarnall, the chairman of the National Committee on Sections, opened the meeting with a statement in which he emphasized the fact that some of the newer western Sections have been extremely active and progressive, and that Philadelphia would have to use every possible means to equal the pace set by the western Sections. The Local Section had the pleasure of meeting at this time Ernest Hartford, Secretary of the Committee on Sections, and William Bullock, Assistant Secretary of the Society. Professor Walter Rautenstrauch, of Columbia University, gave the leading paper of the evening, entitled Manufacturing in Relation to Banking, Research and Management.

On December 11 a paper entitled Offensive Against the Submarine was presented by Joseph A. Steinmetz at a joint meeting of the Franklin Institute and the A. S. M. E., held in the Franklin Institute Auditorium. The lecture was fully illustrated with lantern slides and moving pictures.

On January 22 The War on Land and Sea was discussed at the Engineers' Club by Professor Cathcart, who is a retired officer of the United States Navy and has studied the situation closely. In introducing the subject, Professor Cathcart said:

"It may be safely said that the present war has had no parallel since the darkest days of barbarism. Prussian autocracy is the enemy of no one nation or group of nations, but of all free peoples the world over. For forty years that savage government has made deliberately planned war for world-dominating aims the chief industry of its subjects. To further these aims, in their political and financial bearing, sinister German intrigue has been active everywhere. From Bagdad to Buenos Aires there is no land now which is not stained by the slime of German plotting, of German money lavishly spent for basely treacherous ends."

A lecture that was quite new in its field was given by Carl G. Barth on February 26. Mr. Barth took as his subject The Income Tax, an Engineering Analysis, in which by a thorough mathematical analysis of the Federal Income Tax law, represented graphically in several ways, he clearly set forth the defects of this law. Mr. Barth has promised at a later date to give to the Philadelphia Section a supplement to The Art of Cutting Metals. This work of the late Dr. Frederick W. Taylor is well known as a masterpiece on the subject. A revision of the work by a man of Mr. Barth's experience is looked forward to eagerly by the engineering fraternity.

Few men realize the very important part that the Bureau of Standards has taken in the war. Dr. S. W. Stratton, director of the Bureau, stopped his work long enough to visit Philadelphia and deliver to a very large audience in Witherspoon Hall on March 27 a paper on The Relation of the Bureau of Standards to the War. Views and descriptions of very delicate measuring instruments used by Dr. Stratton in his work were shown.

On April 23 the Section had the pleasure of entertaining the Council of the National Society at a dinner meeting held in the Adelphia Hotel, Philadelphia. The following members of the Council attended: Messrs. Rice, Benjamin, Plunkett, Orrok, Marburg, Thomas, Green, Rautenstrauch, Hartness, Wiley, Alford, Stevens, Main and Barr.

George Satterthwaite, vice-president and general manager of the Tacony Ordnance Corporation, spoke on May 28 to a large audience in the Engineers' Club auditorium. Mr. Satterthwaite's subject was the Manufacture of Ordnance Forgings. Supplementing Mr. Satterthwaite's paper a moving-picture film giving in detail the manufacture of 9.2 high-explosive projectiles was shown. These films were loaned through the courtesy of *Machinery* and the Industrial Press.

The following were elected officers for the year beginning July 1, 1918: C. N. Lauer, chairman; John P. Mudd, secretary; H. B. Taylor, L. F. Moody, W. B. Murphy and L. H. Kenney for executive committee.

During the year 1917-1918 four joint meetings were held with other engineering societies in Philadelphia. The joint-meeting idea is a good one, and it is the hope of the Local Section that there will be more of the "get together" among the numerous engineering societies in Philadelphia.

Three papers presented at meetings of the Philadelphia Section this year have been published in THE JOURNAL of the Society, and four have been published in the *Journal* of the Engineers' Club. The paper presented by Homer L. Ferguson on The War's Effect on Merchant Shipbuilding was also published in the *Marine Review*, and extracts of it were printed in several other trade journals.

L. F. MOODY,
Section Chairman.

PROVIDENCE

As heretofore, the functions of the Local Section at Providence are accomplished through an affiliation with the Providence Engineering Society. The local society has made uniform progress during the past year and is now well established in its adequate and permanent quarters. The activities of the local committee have been continued under the fire-insurance, designers' and draftsmen's section, machine-shop, efficiency, structural engineering, chemical, power, municipal, highway and water supply, industrial and technical education, student, and municipal engineering sections. Each section held meetings monthly at which papers on suitable technical topics were presented and discussed.

The annual outing of the Providence Engineering Society together with the American Chemical Society was held at the Oakland Beach Yacht Club on June 29. Many attractions and sports were arranged and all in attendance had a very enjoyable time.

Robert W. Adams, *President,*
Providence Engineering Society.

ST. LOUIS

There has been a growing feeling in St. Louis that considerable attention should be paid in the Section to subjects touching upon the human side of engineering work. Accordingly, at the first meeting this year, September 21, a number of vital-interest questions to mechanical engineers in St. Louis were discussed by prominent members, all of whom indicated very clearly that there was a large amount of work laid out for the coming year and that it was to be carried forward with great earnestness. This idea was confirmed by the visit of President Hollis the next month, who emphasized this policy as the first and foremost one of service to the engineering profession.

Six regular meetings of the Section were held during the year. The November 23 meeting was in the form of a testimonial dinner tendered to Mr. John Hunter by the Associated Engineering Societies of St. Louis, which was reported in The Journal.

An exceedingly timely meeting was that held on March 29, 1918, when Dr. Isaac Lippincott addressed the Section on Economic Reconstruction After the War.

R. L. Radcliffe,
Section Chairman.

SAN FRANCISCO

The meetings have taken the form of joint meetings of the sections of the Mechanical, Civil, Mining and Electrical Engineers, and the American Chemical Society. At the first of these joint meetings, on October 25, 1917, a dinner was tendered to President Hollis on the occasion of his visit to the Pacific Coast. The general subject for the evening was the Relation of Engineering to the War and speakers from each society took up the particular branch of engineering represented by his society. Doctor Hollis responded with an inspiring address on the Moral Influence of Engineering and Efficiency.

A similar joint meeting with four speakers on war topics was held on March 20, 1918.

B. F. Raber,
Section Chairman.

WORCESTER

The biggest event in the Worcester Section this year was the Spring Meeting of the Society held there from June 4 to 7, 1918. This has been fully reported in The Journal. Most of the activities for the year were taken up in the preparation of plans for this meeting and their execution.

On November 22, 1917, President Hollis and Prof. L. P. Breckenridge opened a discussion upon Fuel Conservation.

George I. Rockwood,
Section Chairman.

ROLL OF HONOR

Appelquest, J. A., Second Lieutenant, Aviation Section, N. A.

Bassett, Cyrus W., Corporal, Headquarters Co., 305th Ammunition Train, American Expeditionary Forces, France.

Bayne, George H., Captain, Ordnance Officers' Reserve Corps, Ordnance Department, U. S. Army.

Bickley, C. D., Second Lieutenant, Utility, Quartermaster Corps, U. S. Army, Camp Dix, N. J.

Blee, H. H., Captain, Air Service, U. S. Army, Airplane Engineering Department, Bureau of Aircraft Production, McCook Field, Dayton, O.

Bolton, Wright, Jr., Chief Machinist's Mate, U. S. Naval Aviation Station, France.

Bryce, Richard M., Ordnance Corps, U. S. N. A., American Expeditionary Forces, France.

Corp, Charles I., Captain, Sanitary Corps, U. S. Army, assigned to Fort Oglethorpe, Ga.

Deeds, Edward A., Colonel, Signal Corps, U. S. Army, assigned to Washington, D. C.

Doar, E. Marion, Machinist's Mate, U. S. Navy, Candidate Steam Engineers' School for Officers, Stevens Institute of Technology, Hoboken, N. J.

Donaldson, Harold R., Flying Cadet, Barracks No. 54, Kelly Field No. 2, San Antonio, Tex.

Dunton, Philip R., Sergeant, Tank Corps, Headquarters Co., 326 Battalion, Camp Colt, Gettysburg, Pa.

Durgee, Andrew B., First Lieutenant, Air Service Department, Military Aeronautics, Taliaferro Field, Hicks, Tex.

Eager, W. G., Lieutenant, Senior Grade, U. S. Naval Reserve Force.

Flad, Albert E., Marine Reserve Flying Corps, Navy Yard, Philadelphia, Pa.

Flanigan, Edwin B., First Lieutenant, Quartermaster Corps, U. S. Army, commanding M. S. T. U. 405, American Expeditionary Forces, France.

French, E. V., Major, Quartermaster Corps, N. A., American Expeditionary Forces, France.

Gill, Murray F., 5th Officers' Training Camp, Fort Monroe, Va.

Grady, William H., Candidate, Officers' Training Camp, Camp Zachary Taylor, Ky.

Grisbaum, L. D., U. S. Naval Reserve Force, Marine Engineers' Training School, Hoboken, N. J.

Harrison, H. L., Ensign, U. S. Naval Reserve Force, Navy Department, Bureau of Ordnance, Washington, D. C.

Hood, Warren B., Captain, Ordnance Officers' Reserve Corps, Ordnance Department, U. S. Army, assigned to Watertown Arsenal, Watertown, Mass.

Hoover, A. Pearson, Major, Quartermaster Corps, N. A., assigned to Boston Quartermaster Terminal, Boston, Mass.

Hyde, G. C., Captain, Utility Detachment, Camp Beauregard, Alexandria, La.

Karr, Alfred D., Second Lieutenant (military aeronautics), Signal Corps, N. A., Air Service Flying School, Chanute Field, Rantoul, Ill.

Klinck, J. H., Major, Quartermaster Corps, N. A.

Kossif, N., Cadet, U. S. School of Military Aeronautics, Mass. Inst. Tech., Cambridge, Mass.

Lafore, John A., Major, Ordnance Officers' Reserve Corps, Ordnance Department, U. S. Army, assigned to Washington, D. C.

Langstroth, C. B., Captain, Ordnance Officers' Reserve Corps, Ordnance Department, U. S. Army.

McLundie, Archibald S., First Lieutenant, Ordnance Officers' Reserve Corps, Rock Island Arsenal, Rock Island, Ill.

Miller, H. W., Captain, Railway Artillery Section, Ordnance Department, U. S. Army, American Expeditionary Forces, France.

Murphy, E. A., Second Lieutenant, Aviation Section, N. A., Bureau of Aircraft Production, Purchase Division.

Nichols, George B., Captain, 56th Engineers, Washington Barracks, District of Columbia.

Ruddy, William, First Lieutenant, Ordnance Officers' Reserve Corps, Ordnance Department, U. S. Army.

Terry, Carlyle M., Chief Machinist's Mate, U. S. Naval Reserve Force, Steam Engineering School, Pelham Bay, N. Y.

Thompson, Herbert L., Ensign, U. S. Naval Reserve Force.

Turner, Robert T., Corporal, 52d Pioneer Infantry, U. S. Army, Camp Wadsworth, Spartanburg, S. C.

Tuttle, W. B., Major, Construction Division, Quartermaster Corps, N. A.

NECROLOGY

EDWARD R. ARCHER

Edward R. Archer was born on March 9, 1834, at Old Point Comfort, Va. He received his early education in the private schools of Hampton and Richmond, Va., and at the age of 17 entered the employ of the Tredegar Iron Works of the latter city, where he served an apprenticeship of four years in the shops and drafting room of that company. On June 26, 1856, he was appointed third assistant engineer in the U. S. Navy and served in that capacity on the U. S. Frigates *Roanoke* and *Powhatan*, making a two and a half years' cruise around the world. At the close of the cruise he returned again to the Tredegar Iron Works and remained in their employ until the outbreak of the Civil War, when he entered the service of the Confederate Navy. When peace was declared he again reëntered the employ of the Tredegar Iron Works, and at the time of his death was chief engineer of the company.

In addition to being a member of our Society since 1890, Mr. Archer was one of the founders of the Virginia Mechanics Institute. He died at his résidence in Richmond on March 13, 1918.

EDWARD CARRINGTON BATES

Edward C. Bates was born in Boston, Mass., in 1848. He was educated in the private schools of that city, preparatory to attending Brattleboro Academy, after which he went to the Massachusetts Institute of Technology where he was graduated with the first class sent forth, that of 1868.

He then began work in his chosen profession as civil and railroad engineer and on going West was active in the earliest days of the Union Pacific Railway. During his career he held the position of superintendent of works of the Union Electric Sign Signal Co., Boston, and the same later with the Union Switch & Signal Co., Pittsburgh. He was for five years superintendent with the Hall Typewriter Co. and for eleven years railroad representative for the Crosby Steam Gauge & Valve Co., Boston. He was also associated for a period with the Ewald Iron Co., St. Louis.

Mr. Bates was an inventor of note and his later years were devoted to inventing although in a less active way than formerly. He became a member of our Society in 1899. He died very suddenly on July 23.

CHARLES HARVEY HILE

Charles H. Hile was born at Bellefonte, Pa., in March 1864. He was graduated from Pennsylvania State College in 1892 with the degree B.S. and in 1893 he received the degree of M.E. from the University of Wisconsin.

He then entered the employ of the Philadelphia Traction Co., first as electrical assistant, then as engineer and inspector of underground conduit construction and later as operator in the power station. In July 1894 he entered the employ of the West End Street Railway Co., Boston, Mass., and served continuously with that company and its successor, the Boston Elevated Railway Co., for twenty-two years. During his long career with the two Boston companies, he won rapid promotions, being successively assistant superintendent of wires, superintendent of wires, assistant to the vice-president and chief of maintenance. In the last-named position he was in charge of the departments of mechanical and electrical engineering, maintenance of way, rolling stock and shops, building, stores, wires and conduits and power maintenance. Impairment of health finally required him to relinquish these heavy responsibilities and the company gave him an indefinite leave of absence with the privilege of engaging in lighter and less nerve-racking duties. In 1916 he became the secretary of the New England Street Railway Club, Boston, Mass. He was also editor of the publications of the club, *The Street Railway Bulletin* and the *Trolley Wayfinder*.

He became a member of our Society in 1916. He died on June 4.

HARRY C. HOLCK

Harry C. Holck was born in June 1887 in New York City. He received his technical education in the Carnegie Technical School, after which he entered the employ of the Keuffel & Esser Co., Hoboken, N. J., as assistant to the chief engineer. In 1908 he became connected with the George A. Ohl Co., Woodside, N. J., where he installed a drafting-room system and took charge of the design of their power presses and embossing machines. The following year he entered the employ of the Niles-Bement-Pond Co., Plainfield, N. J., as a designer, and while with this firm successfully designed a car-wheel lathe to turn car wheels at the rate of two in four minutes. In 1910 he became associated with the General Electric Co., Schenectady, N. Y., as engineer and designer of A. T. B. generators and synchronous and induction motors.

For the next three years he was employed successively by the Otis Elevator Co., New York City, as construction engineer for freight and passenger elevators; by the Regina Co., Rahway, N. J., as assistant to chief draftsman in systematizing and developing the design of a multi-process printing press; and by the Westinghouse Electric & Manufacturing Co., Pittsburgh, Pa., as engineer on control apparatus, rheostat, switchboards and oil switches. In 1913 Mr. Holck became connected with the Public Service Electric Co., Newark, N. J., where he was engaged in the design and engineering of sub-stations and central stations, system of railways and lighting distribution, and developed one of the largest and most modern stations in the East.

At the time of his death, June 13, he was employed as engineer and electric designer in the engineering department of the company. Mr. Holck became a junior member of the Society in 19[illegible].

JOHN DOLAN GABOURY

John D. Gaboury was born in Knoxville, Tenn., on June 3, 1879. Upon the completion of his collegiate education be took two years' special course in mathematics at St. Charles Barrome College, Sherbrooke, Quebec, Canada, and followed this in 1895 with a six months' special course in applied electricity at McGill University, Montreal.

Until about 1897 he was associated with his father who was one of the pioneer electric contractors and power-plant operators in the South. His next position was with the Greenville Light & Power Co., Greenville, Miss., as engineer, where he remained until 1905, holding successively the positions of electrician and superintendent. In 1905 he became connected with the Alabama City, Gadsden & Attalla Railway Light & Power Co., Attalla, Ala., as general manager and remained with them for a little over two years, during which time he designed and built a modern condensing steam-turbine power plant for lighting and railway service. In 1907 he entered the employ of the Woodward Iron Co., Woodward, Ala., as electrician, later becoming chief electrical engineer and finally superintendent of power, which position he had been holding for the last four years. The company makes approximately 1500 tons of pig iron per day, furnishing all of its own raw material. This involves the operation of several coal mines, red-ore mines, coal washers, by-product coke plants and a steam railroad for the transportation of raw material to the furnace plant. Mr. Gaboury was entirely responsible for the design, construction and operation of all the power-plant equipment, steam and electric hoists, haulage, rolling stock, steam and electric, as well as all of the repair work involved.

Mr. Gaboury became an associate-member of the Society in 1917 and was particularly active in the affairs of the Birmingham Section. He was also an associate-member of the American Institute of Electrical Engineers. He died very suddenly on May 17.

GEORGE E. WHITEHEAD

George E. Whitehead was born on September 6, 1846, at Ashton-under-Lyne, Lancashire, England. He was brought to this country when but a child and was educated in the public schools of Providence, later taking a special course in mathematics at the Jenks Morey School of that city.

During the period of the Civil War Mr. Whitehead was employed by the Burnside Rifle Works Co., leaving at the close of the war to serve his apprenticeship as mechanic with the Brown & Sharpe Manufacturing Co., Providence, R. I., at the same time completing his studies in algebra, geometry and trigonometry. He was next employed by the Household Sewing Machine Co., as tool maker and die cutter. In 1874 he became associated with the Rhode Island Tool Co. as assistant superintendent and later became superintendent, serving in that capacity for thirty-one years.

Mr. Whitehead became a member of the Society in 1887. He died on March 4, 1918.

LIBRARY NOTES AND BOOK REVIEWS

ARTICLES of interest from the Library of the four Founder Societies, selected list of accessions during the month, and reviews of books of special importance prepared by members of the A.S.M.E. and others particularly qualified.

BOOK NOTES

Elements of Fuel Oil and Steam Engineering: A Practical Treatise Dealing with Fuel Oil, for the Central Station Man, the Power Plant Operator, the Mechanical Engineer and the Student. By Robert Sibley, B. S., and Charles H. Delany, B. S., M. M. E., Members Am.Soc.M.E. Technical Publishing Company, San Francisco, 1918. First Edition. Cloth, 6 x 9 in., xiv + 320 pp., 127 illustrations, charts and figures. $3 net.

This book has as its underlying theme a study of fuel-oil power-plant operation and the use of evaporative tests in increasing the efficiency of oil-fired plants. The subject-matter has been treated in three main subdivisions: First, an exposition of the elementary laws of steam engineering; second, the processes involved in the utilization of fuel oil in the modern power plant; and third, the testing of boilers when oil-fired.

A new method has been used in treating the first subdivision, in that the viewpoint taken is that of the oil-fired instead of the coal-fired power-plant operator. This subdivision naturally requires the largest portion of the work.

The five chapters on Furnaces, Burner Classification, Gravity, Moisture Content, and Heating Value of Oils contain the gist of the information which will be of value to the inexperienced engineer whether he views the subject from a consulting or operating standpoint. The engineer who has had considerable experience in this line will be interested in the chapters on Suggestions for Fuel-Oil Tests and Their Tabulation, and the Use of Evaporative Tests in Increasing Efficiency of Oil-Fired Boilers, as these chapters, especially the latter, contain definite information worked out from practical experience in regard to furnace arrangement, oil burners, draft, flue-gas analysis and regulation.

The most interesting part to the experienced fuel-oil engineer is Appendix 2, which contains the report of conclusions in full of the Committee appointed by the Governor of California, in the latter part of 1917, to investigate the fuel-oil situation in that state and report their conclusions and recommendations. These conclusions cover utilization, production, consumption, storage, conservation and the remedy for the present shortage of oil in California. This is a remarkable report which should be read by every engineer interested in the future of fuel oil in this country.

We believe the authors have succeeded admirably in accomplishing the purposes which the book attempts to cover. It is unquestionably the best work of its kind for students of steam engineering who are interested in fuel oil. It is also of value to engineers, both consulting and operating, as it gives a large amount of information hitherto not covered by any work of this kind, and at the same time brings together much important matter which has appeared at various times in various forms. The subject-matter is clearly developed, and illustrated examples are worked out in great detail. The book is also profusely illustrated. To sum up, we believe this work occupies a field hitherto vacant in this particular branch of engineering.

B. R. T. Collins.

Edible Oils and Fats. By C. Ainsworth Mitchell. Longmans, Green and Co., New York, 1918. Cloth, 6 x 9 in., 159 pp. $2.

A concise outline of the chemical composition, and properties of the more important oils and fats, the methods of extracting them from the crude materials and of purifying and preparing them for food. Particular attention is given to the newer methods. A very full bibliography is appended to the text.

Concrete Engineers' Handbook. Data for the Design and Construction of Plain and Reinforced-Concrete Structures. By George A. Hool and Nathan C. Johnson, assisted by S. C. Hollister, with chapters by Harvey Whipple, Adelbert P. Mills, Walter S. Edge, A. G. Hillberg, and Leslie H. Allen. First edition. McGraw-Hill Book Co., Inc., New York. 1918. Flexible cloth. 6 x 9 in., 885 pp., illus., tables, diag. $5.

This work has been prepared to make available in concise form the best present knowledge concerning concrete and reinforced concrete, and to present complete data and details, as well as numerous tables and diagrams, for the design and construction of the principal types of concrete structures.

The Cyanide Process. Its Control and Operation. By A. W. Fahrenwald. First edition. John Wiley and Sons., Inc., New York, 1918. Flexible cloth, 4 x 7 in., 256 pp., 37 illus., 1 folded pl., 1 folded chart, 27 tables. $2.

The object of the book is to furnish a laboratory guide, both for investigating a new ore and for conducting the laboratory of a mill, which will include the latest developments of the process and be sufficiently complete for ordinary needs.

Diseases of Occupation and Vocational Hygiene. Edited by George M. Kober and William C. Hanson. P. Blackiston's Sons and Co., Philadelphia (copyright, 1916). Cloth, 6 x 10 in., 918 pp., 46 illus. $8.

With the assistance of a large number of experts, the editors have endeavored to present the basic facts concerning diseases of occupation in such a way as to form a safe, convenient guide for physicians, employers, workmen, legislators, public health officials and other interested persons.

Engineering for Masonry Dams. By William Pitcher Creager. First edition. John Wiley and Sons, Inc., New York, 1917. Cloth, 6 x 9 in., 237 pp., 88 illus., 1 pl., 25 tables. $2.50.

Contents: Investigations and Surveys, The Choice of Type of Dam, Forces Acting on Dams, Requirements for Stability of Gravity Dams, General Equations for Design of Gravity Dams, The Design of Solid, Non-overflow Gravity Dams, The Design of Solid Spillway Gravity Dams, The Design of Hollow Dams, The Design of Arch Dams, Preparation and Protection of the Foundation, Flood Flows, Details and Accessories. Presents the theory and the fundamental assumptions of design of dams of this kind, and gives a number of examples showing the application of theory to practical designing.

Glossaire, (Anglais-Français) des Termes et Locutions Electro-Techniques les Plus Usites. Compilé par Aristide Filiatreault. M. J. Filiatreault, Montreal, 1913. Paper, 4 x 7 in., 59 pp.

A moderate priced English-French electrical dictionary of pocket size.

How to Sell Electrical Labor-saving Appliances. One hundred and nineteen tested Plans for the Electric Store. Window Display. Show Cases, Shelves and Tables. Arrangement. Advertising. Prospects. Demonstrations. Training Clerks. Planning Sales. Management. Compiled by Electrical Merchandising. First edition. McGraw-Hill Book Co., Inc., New York, 1918. Cloth, 5 x 8 in., 115 pp., 15 illus., 13 pl. $1.

A manual for dealers in electrical supplies and fixtures,

suggesting methods for displaying stock, advertising, training clerks, etc.

Industrial Reconstruction. A Symposium on the Situation after the War and How to Meet It. Edited by Huntly Carter. E. P. Dutton and Co., New York, 1918. Cloth, 5 x 7 in., 295 pp. $2.

Contains the results of an inquiry undertaken to ascertain the opinions held by a large number of distinguished English men and women as to the probable industrial situation in Great Britain after the war and the best policy to be pursued by Labor, Capital and the State. The views of statesmen, capitalists, labor leaders, economists and others are included.

International Mining Law. By Theo. F. Van Wagenen. First edition. McGraw-Hill Co., Inc., 1918. Flexible cloth, 5 x 7 in., 342 pp. $3.50.

Starting with an account of ancient mining laws and customs, the author gives a digest of the present mining laws of the world. Statistics of production in the leading countries are given to show the effect of various laws on the industry, and there are discussions of different features of the laws. Confined to metal mining; the laws having to do with coal, iron and non-metals are omitted.

Organic Compounds of Arsenic and Antimony. By Gilbert T. Morgan. Longmans, Green and Co., New York, 1918. Cloth, 6 x 9 in., 376 pp., $4.80.

This volume in Messrs. Longmans' series of Monographs on Industrial Chemistry discusses the methods of preparation and the chemical properties of those compounds which have a practical application or theoretical interest. A useful bibliography is included.

War Adjustments in Railroad Regulations. Edited by C. H. Crennan. The American Academy of Political and Social Science, Philadelphia, 1918. (Annals of the American Academy of Political and Social Science, vol. 76. Whole number, 165. March, 1918.) Paper, 7 x 10 in., 333 pp., $1.

In this number of the Annals is presented a discussion, by a number of railroad men, political economists and lawyers, of various problems connected with railroad regulation.

The principal headings are: Railroad Regulation on Trial, War Pressure for Adequate Service, Present Effects of War Control of Railroads, Plans for Adjustment after the War, Continuing Problems of Public Policy, in addition to a chapter entitled Documents and Statistics Pertinent to Current Railroad Problems.

CANDIDATES FOR MEMBERSHIP

TO BE VOTED ON AFTER SEPTEMBER 21

Below is the list of candidates who have filed applications since the date of the last issue of The Journal. These are classified according to the grades for which their ages qualify them, and not with regard to professional qualifications, i.e., the ages of those under the first heading place them under either Member, Associate or Associate-Member, those in the next class under Associate or Associate-Member, those in the third class under Associate-Member or Junior, and those in the fourth under Junior grade only. Applications for change of grading are also posted. Total number of applications 198.

The Membership Committee, and in turn the Council, urge the members to scrutinize this list with care and advise the Secretary promptly of any objections to the candidates posted. All correspondence in this regard is strictly confidential. Unless objection is made to any of the candidates by Sept. 21, and provided satisfactory replies have been received from the required number of references, they will be balloted upon by the Council.

NOTE. The Council desires to impress upon applicants for membership that under the present national conditions the procedure of election of members may be slower than under normal conditions.

NEW APPLICATIONS

FOR CONSIDERATION AS MEMBER, ASSOCIATE OR ASSOCIATE-MEMBER

Alabama

BUBAR, Hudson H., Mechanical Superintendent, Air Nitrates Corp., Muscle Shoals

KENT, J. F., Manager, American Cast Iron Pipe Co., Birmingham

Arizona

HOFF, Edward A., Construction Engineer, United Verde Copper Co., Clarkdale

California

TURNER, Alfred J., Lubricating Oil Engineer, Standard Oil Co., San Francisco

Connecticut

ASHMUN, Bernard L., Vice-Pres., Pratt & Cady Co., Hartford

CAREY, H. Bissell, M. S. Little Mfg. Co., Hartford

LITTLE, Mitchell S., Manufacturer, M. S. Little Mfg. Co., Hartford

MORHARDT, Frank W., Mechanical Superintendent, Royal Typewriter Co., Inc., Hartford

PAINE, Walter S., Safety Engineer, Aetna Life Insurance Co., Hartford

QUINN, Lawrence R., Captain, Ord. R. C., U. S. A., Scovill Mfg. Co. Waterbury

VANDE PLANCKE, George, Superintendent, Turner Machine Co., Danbury

Delaware

LINDSAY, William J., Engineer, E. I. du Pont de Nemours & Co., Wilmington

District of Columbia

CHASE, Arthur H., Supervising Draftsman, U. S. Naval Gun Factory, Navy Yard

MARZOLF, Joseph M., Mechanical Expert, Aid Bureau of Yards & Docks, Navy Department

Florida

HAWKES, John D., Construction Work, Buckman & Pritchard, Pablo Beach

KENNEDY, Sidney G., General Foreman, Atlantic Coast Line R. R. Co., Lakeland

Georgia

CLIFFORD, Walter, General Supt., Atlantic Paper & Pulp Co., Savannah

Illinois

ADAMS, Ernest H., Mechanical Engineer, Continental Can Co., Chicago

CHANDLER, Albert R., Captain, Ordnance Reserve Corps, Rock Island Arsenal

DRATZ, Paul A., Chicago Representative, Whiting Foundry Equipment Co., Harvey

GALLUP, Rockwell L., Head of Engineering Dept., Torris Wold & Co., Chicago

KNAPP, Charles S., Assistant Chief Engineer, Pullman Co., Chicago

MILLER, Edward W., Chief Engineer, Fellows Gear Shaper Co., Springfield

Indiana

HUTCHCRAFT, D. L., Vice-Pres., Indiana Air Pump Co., Indianapolis

Kansas

SIMMERING, Siebelt L., Assistant Professor, Steam and Gas Engineering, Kansas State Agricultural College, Manhattan

Maine

FOWLES, Frank R., General Superintendent, York County Power Co., Biddeford

Maryland

WHITSITT, William B., Chief Draftsman, Baltimore & Ohio R.R., Motive Pwr. Dept., Baltimore

Massachusetts

BANFIELD, Frederick E., Jr., Superintendent, Saco-Lowell Shops, Newton Upper Falls

BATH, John, Owner, John Bath & Co., Inc., Worcester

BINNS, Frank, Draftsman, Hamblet Machine Co., Lawrence

DRAKE, Alden M., Chief Designer, Heald Machine Co., Worcester

EAMES, Jesse J., Instructor, M. E. Dept., Mass. Institute of Technology, Cambridge

KEEDY, Dyke V., Consulting and Metallurgical Engineer, Boston

KNIGHT, ARTHUR, Gage Design and Tolerance Engineer, Greenfield Tap & Die Corp., Springfield
LYLE, ERNEST T., New England Manager, Carrier Engineering Corp., Boston
ROOT, FRANCIS S., Power Engineer and Head of Pwr. Dept., Fall River Electric Light Co., Fall River
WITMER, ROY C., Secretary and General Manager, Blake Pump & Condenser Co., Fitchburg
ZSCHOKKE, ARTHUR J., Assistant Principal Draftsman, Watertown Arsenal, Watertown

Michigan

BAUS, RICHARD E., Assistant General Production Manager, Studebaker Corp., Detroit
BRITTSON, L. E., Major Ord. R. C., Inspector Ord., Ford Motor Car Co., Detroit
HARRIS, EMERY E., Vice-Pres., Pittelkow Heating & Engrg. Co., Detroit
HAWES, FRED W., Superintendent Wheel Dept., Detroit Pressed Steel Co., Detroit
LANE, HORACE H., Consulting and Designing Engineer, Detroit
McDONALD, William F., Heating Engineer, William F. McDonald Co., Detroit
PITTELKOW, ARTHUR G., President, Pittelkow Heating & Engrg. Co., Detroit

Missouri

FARNHAM, DWIGHT T., Consulting Industrial Engineer, St. Louis

Montana

PRUETT, GROVER C., City Engineer and Superintendent Water Works, Miles City

New Jersey

EPPENSTEIMER, WILLIAM F., Mechanical Engineer, United States Metals Refining Co., Chrome
FOX, AUBREY E., Industrial Engineer, Celluloid Co., Newark
McINTYRE, MALCOLM, Vice-Pres., Bergen Point Iron Works, Bayonne
MEIGS, WILLIAM P., Works Manager, Magor Car Corp., Passaic
RICHARDSON, HENRY, President, Richardson Scale Co., Passaic
SCHULHOFF, SAUL, Asst. Production Manager, Essex Rubber Co., Trenton
STENGER, JOHANNES G., Chief Draftsman, Marine Dept., Babcock & Wilcox Co., Bayonne
WOOD, HENRY E., Instructor of Special Mechanical Workers, Crocker-Wheeler Co., Ampere

New York

AXELSSON, GUSTAF S., Mechanical Engineer, Otis Elevator Co., New York
BLINN, EDWARD R., Superintendent of Construction and Maintenance, The Solvay Process Co., Syracuse
BRENNAN, JOHN E., Assistant Works Manager, The Remington Arms Union Metallic Cartridge Co., Inc., Ilion
CARMODY, JOHN P., Mechanical Engineer, Perin & Marshall, New York
CEBRAT, PAUL, Estimator and Purchasing Engineer, C. P. Perin & S. M. Marshall, New York
DISBROW, WILLIAM C., JR., Private Business, New York
ERB, EDMUND M., Manager, Merit Machine Mfg. Corp., New York
FLETCHER, HOWARD C., Chief Draftsman, Hull Div., Navy Yard, New York
GRIFFIN, GEORGE E., Mechanical Engineer, The Adder Machine Co., New York
GRUBER, MORRIS M., President and Engineer, Presto Machine Works, Brooklyn
HEIDELBAUGH, WILLIAM W., Secretary and Treasurer, Acme Cement Corp., Catskill
HOUGH, FREDERICK L., JR., Asst. Engineer, Edison Elec. Ill. Co., Brooklyn
McWILLIAMS, CLOYD C., Engineer of Machinery, American Loco. Co., Schenectady
MARSHALL, WALTER E., Buffalo Mgr., The Warner & Swasey Co., Buffalo
O'REILLY, PHILIP J., U. S. Inspector of Boilers, Steamboat Inspection Service, Custom House, New York
ROBLIN, WILMOT H., Inspector of Ordnance, U. S. Ord. Dept., Watervliet Arsenal, Watervliet

THOMAS, WILLIAM P., Chief Engineer, H. G. Vogel Co., New York
THOMPSON, CHARLES J., in charge Trench Warfare Section, Ord. Dept., New York
WHINERY, SAMUEL B., Sales Agent, Consulting Engineer, New York
WIBERG, HERBERT G., Chief Inspector, Compensation Inspection Ration Board, New York
WIDMER, JULES A., Designer, Confidential Experimental and Research Work, Sperry Gyroscope Co., Brooklyn

Ohio

BALBACH, EDWARD, Mechanical Engineer, James Leffel & Co., Springfield
BEAUMONT, JAY C., Chief Planner, Engrg Dept., B. R. Goodrich Co., Akron
GREENE, OSCAR V., General Manager, The Cleveland Stoker & Mfg. Co., Cleveland
LOCKHART, JAMES, Chief Engineer, The Lakewood Engineering Co., Cleveland
WEAVER, ROBERT R., Chief Engineer, Ralston Steel Car Co., East Columbus

Oregon

GILL, JOSEPH W., Associate Engineer and Chief Draftsman, Smith & Watson Iron Wks., Portland

Pennsylvania

BENZON, GEORGE H., JR., Chief Draftsman, William Sellers & Co., Inc., Jenkintown
BRODHEAD, ELBER H., Vice-Pres., Parkesburg Iron Co., Parkesburg
ECHOFF, WALTER H., Assistant General Master Mechanic, Midvale Steel & Ordnance Co., Coatesville
FUNK, NEVIN E., Operating Engineer, Philadelphia Elec. Co., Philadelphia
GILLETT, MERRIMAN C., Branch Manager, Spencer Heater Co., Philadelphia
HUMPTON, JOHN R., General Superintendent of Skelp Mill, Parkesburg Iron Co., Parkesburg
KEAL, GEORGE L., Resident Engineer, U. S. Shipping Board, Hog Island, Philadelphia
LOWELL, DWIGHT E., Assistant Machinery Fabrication Engineer, American International Shipbuilding Corp., Hog Island
MORRISON, LACEY H., Production Officer, Instrument Dept., Frankford Arsenal, Philadelphia
PORTER, ROY H., Asst. Mechanical Engineer, New Jersey Zinc Co., Palmerton
WILSON, BENJAMIN W., Designer and Superintendent of Constr. of Mech. Equipment, Ballinger & Perrot, New York and Philadelphia

Rhode Island

ANDERSON, ALEXANDER W., Inspector of Boilers, Fidelity & Casualty Co., of N. Y., Providence

Tennessee

FRYANT, HARRIS T., Specialty Salesman, Crane Co., Memphis
WORDEN, ARTHUR F., Fire Protection Engineer, Dupont Engineering Co., Jacksonville

Texas

PALMER, WILLIAM R., Mechanical Engineer, Cananea Consolidated Copper Co., El Paso

Utah

REDWINE, LEWIS S., Chief Draftsman, American Smelting & Refining Co., Garfield

Virginia

WILLARD, JAMES A., Chief Draftsman, Du Pont de Nemours Co., City Point

Washington

WATTS, ROBERT L., Mechanical Superintendent, St. Paul & Tacoma Lumber Co., Tacoma

Wisconsin

DE VLIEG, RAY A., Chief Engineer, Kearney & Trecker Co., Milwaukee
HYLAND, PATRICK H., Assistant Professor of Mech. Engrg., University of Wisconsin, Madison
KNIGHT, CLARK M., Inspector, United States Indian Service, Ashland

FOREIGN

Australia

LEWIS, EDWARD P., Designing and Construction Engineer, Partner Kelly & Lewis, Melbourne
RIGBY, EDWARD J., Consulting Engineer, Private Practice and for Northern Territory Federal Government, Melbourne

Canada

DICKSON, GEORGE H., Official Gauge Checker, U. S. Army Ord. Corps, Civilian Dominion, Arsenal, Quebec
GILES, GEORGE, General Manager, Vancouver Engineering Works, Ltd., Vancouver
JANSEN, WALTER A., Operating Manager, Canadian Steel Foundries, Ltd., Montreal

Costa Rica

PICADO, RAMON M., City Engineer, Cartago City Council, Cartago

England

MARSHALL, WILLIAM J., Managing Director, Richard Garrett & Sons, Ltd., Engineers, Westminster

France

BANKS, SAMUEL J., Director, Works Manager, Berlut Automobile Works, Lyons

Hawaii

NELL, EDWARD J., Manager, H. S. Gray Co., Honolulu

Japan

SCHENCK, W. EGBERT, Treasurer and General Manager, The F. W. Horne Co., Tokyo

Porto Rico

STOREY, NORMAN C., Mechanical Superintendent, Aguine Sugar Co., Aguine

FOR CONSIDERATION AS ASSOCIATE OR ASSOCIATE-MEMBER

District of Columbia

HARTFORD, ERNEST, Office Manager, Committee on Education and Special Training, War Department, Washington

Massachusetts

LLEWELLYN, ERNEST R., Assistant Chief Draftsman, American Steel & Wire Co., Worcester

Michigan

DIX, HORACE P., Secretary and General Manager, Wilmarth & Morman Co., Grand Rapids

Ohio

DETWILER, HOMER H., General Manager, The Enterprise Co., Columbiana

New Jersey

JACKSON, LEONARD D., Consulting Ballistic and Mechanical Engineer, American Standard Metal Products Corp., Paulsboro

New York

BROWN, ARTHUR J., President and Treasurer, B. A. B. Model Mfg. Co., New York
MONAHAN, THOMAS G., Assistant to Chief Engineer, The Donner Steel Co., Inc., Buffalo

Oklahoma

EMMETT, CARL P., Superintendent, Bell Oil & Gas Co., Stone Bluff

Pennsylvania

EVANS, HERBERT H., District Sales Manager, Coatesville Boiler Wks., Philadelphia
STRICKLER, HARRY K., Asst. Chief Engineer, Erie Forge & Steel Co., Erie

FOR CONSIDERATION AS ASSOCIATE-MEMBER OR JUNIOR

California

SHIPLEY, JACK B., Marine Engineer, Moore Shipbuilding Co., Oakland

Connecticut

ROOT, FREDERICK J., Major O. R. C., Army Inspector of Ordnance and Acting Quartermaster, Marlin Rockwell Corp., New Haven

District of Columbia

KNIGHT, BERNARD O., Aeronautical Mechanical Engineer, Production Engr. Dept., Bureau of Aircraft Production, Washington
ROSS, ROBERT M., 1st Lieut., Ordnance Dept. N. A. Mechanical Engineer, U. S. Chemical Plant No. 4, Washington

Georgia

BROOKS, EUGENE A., Sales Engineer, The Babcock and Wilcox Co., Atlanta

Illinois

ACCOLA, EDWARD C., Methods Engineer, Western Electric Co., Chicago
HACH, CLARENCE A., Mechanical Engineer, Western Electric Co., Chicago
SCHEEL, CHARLES F., Department Head, Western Electric Co., Inc., Hawthorne
MANLEY, LLOYD M., Section Head, Western Electric Co., Chicago

Maryland

EVANS, BOYD V., 1st Lieut., Ordnance Department, U. S. A., Aberdeen Proving Ground

Massachusetts

SPENGLER, RALPH A., Captain, Watertown Arsenal, Watertown

Michigan

ALDRICH, HENRY E., JR., Chief Draftsman, The Wickes Boiler Co., Saginaw

Minnesota

ROTHENBERGER, JAMES H., Asst. Supt., Minneapolis Steel & Machinery Co., Minneapolis

New Jersey

HARBESON, JAMES P., JR., Plant Engineer, Camden Forge Co., Camden
HARDING, ARTHUR B., Construction Engineer, U. S. Cast Iron Pipe & Foundry Co., Burlington
LENNOX, WESTON, Leading Draftsman, Babcock & Wilcox Co., Bayonne

New York

ADAMSON, ALLAN A., Chief Draftsman, Boucher Cork & Machine Co., New York
BROWN, ANTHONY F., Vice-President & General Manager, B. A. B. Model Mfg. Co., New York
HARDY, CHARLES, General Manager, Blair Tool & Machine Wks., New York
NORRIS, DONALD G., Experimental Motor Div., Curtiss Aeroplane & Motor Corp., Buffalo
PIERCE, HAROLD F., Lieut., In charge mechanical development, Medical Research Laboratory, Field No. 1, Mineola, Long Island
WELLS, ALBERT W., Engineer, General Electric Co., Schenectady

Ohio

BENJAMIN, MERRIL G., Power Plant Engineer, Youngstown Sheet & Tube Co., Youngstown

Pennsylvania

BRYANT, ROBERT E., Captain, Ordnance R. C., Inspecting Artillery Ammunition, c/o Worthington Pump & Mach. Corp., Hazelton
ROTHERY, LUDWIG W., Erecting Engineer, Westinghouse Electric & Mfg. Co., Philadelphia
SOSS, HENRY, Captain Ordnance Dept., U. S. A., Worthington Pump Co., Hazelton

Virginia

KURTZ, WALTER W., Engineer U. S. N. R. F., Supply Dept., Navy Yard, Norfolk

Canada

YARROW, NORMAN A., General Manager, Yarrows, Ltd., Victoria, British Columbia

FOR CONSIDERATION AS JUNIOR

Alabama

SNYDER, CLIFFORD L., 2nd Lieut., U. A. R. C., Nitrate Div., Ord. Dept., U. S. A., U. S. Nitrate Plant No. 1, Sheffield

Connecticut

COOK, FRED L., 2nd Lieut., Ordnance Reserve Corps, Scovill Mfg. Co., Waterbury
FLYNN, JAMES J., Asst., Chief Inspector of Ordnance U. S. Government, Remington Arms Bridgeport Wks., Bridgeport
HEALY, WILLIAM J., Laboratory Asst. in Mechanical Engineering, Sheffield Scientific School, Mason Laboratory of Mechanical Engineering, New Haven

District of Columbia

APPEL, SAUL C., Aeronautical Mechanical Engineer, Dept. of Military Aeronautics Supply Section, Buildings Grounds Branch, Washington
SMITH, BENJAMIN A., Technical Engineer, Bureau of Standards, Aero. Instrument Section, Washington

Georgia

SAUNDERS, WILLIAM H., Student, Georgia School of Technology, Atlanta

Illinois

HOGG, JOHN W., Corn Products Refining Co., Argo
HUTCHISON, FRED P., Efficiency Engineer, Western Electric Co., Inc., Chicago

Indiana

SACKSTEDER, ABNER F., Tool Designer & Checker, Nordyke & Marmon Co., Aviation Division, Indianapolis

Maryland

CRAWFORD, JOHN D., Chief Engineer, Maryland Pressed Steel Co., Hagerstown
MACOMBER, HENRY E., Technical Engineer at Power Plant No. 1, Edgewood Arsenal, Edgewood

Michigan

GUSTAVUS, CHARLES W., Engineer, Murphy Iron Works, Detroit
MERRITT, LEON F., Sr. Inspector of Airplanes & Airplane Engines, Aircraft Production Bureau, Detroit
SWENSON, CLARENCE Q., Asst. Engineer of Test, Ordnance Dept., U. S. A., Reo Motor Car Co., Lansing

New Jersey

MARSH, JOHN W., Designing Engineer, Calco Chemical Co., Bound Brook

New York

CUSTER, GARRY D., Lieut. Junior Grade, United States Navy, U. S. S. Montana, New York
FOSTER, JAMES F., Jr., Testing Materials, Curtiss Aeroplane & Motors Corp., Buffalo
HERRMANN, JOHN F., Mechanical Engineer, Herrmann & Grace Co., Brooklyn
JONES, WALTER H., 2nd Lieut. Ord. R. C., New York Air Brake Co., Watertown
NORMILE, THOMAS H. J., Ship Draftsman, Hull Division, Navy Dept., Brooklyn

Ohio

LINTON, DONALD S., Schedule Clerk, Ordnance Dept., Mosler Safe Co., Hamilton

Pennsylvania

BLACK, WILLIAM E., Shop Draftsman, Dravo Engineering Works, Neville Island

France

KERNS, ROY S., Assembling Locomotives, 19th Engineers (Railway) National U. S. Army, Co. A, American Expeditionary Forces

CHANGE OF GRADING

PROMOTION FROM ASSOCIATE

New York

BLUMGARDT, ISAAC E., Plant Engineer, Bayles Ship Yards, Port Jefferson, L. I.

PROMOTION FROM ASSOCIATE-MEMBER

Georgia

GREGG, ROBERT, Secretary, Atlantic Steel Company, Atlanta

Illinois

SILLCOX, LEWIS K., Mechanical Engineer, Illinois Central Railway, Chicago

New Jersey

BRUNNER, HANS, Production Manager, Essex Production Co., Trenton

Massachusetts

BURGESS, A. BRADLEY, Vice President, Standard Plunger Elevator Co., Worcester

Michigan

HAYNES, EDWARD A., Second Vice-President, Pt. Huron Sul. & Paper Co., Port Huron

Texas

CRAWFORD, CHARLES C., Manager, A. M. Lockett & Co., Ltd., Houston

France

WOODS, SAMUEL H., Captain Q. M. C., U. S. A., Motor Transport Service, American Expeditionary Forces

PROMOTION FROM JUNIOR

California

BEATIE, CECIL E., Engineer, Shell Co. of California, San Francisco

Connecticut

BLACKMER, WALDO H., Works Service Manager, Electric Cable Co., Bridgeport

District of Columbia

SPICE, CHARLES G., Captain, Ord. R. C., Gun Division, Washington

Illinois

ROLLINS, L. E., Mechanical Engineer, Swift & Co., U. S. Yards, Chicago

Massachusetts

SCHWARZ, FRANS H., Master Mechanic and Mechanical Engineer for the Worsted Dept., Pacific Mills, Lawrence

New York

TEHLE, CHARLES J., Chief Draftsman, Marine Dept., Kerr Turbine Co., Wellsville

Ohio

SVENSEN, CARL L., Assistant Professor, Ohio State University, Columbus

Pennsylvania

MACLEAN, ARCHIBALD, JR., Purchasing Dept., Engineer, Westinghouse Elec. & Mfg. Co., Machine Works, E. Pittsburgh
SMITH, HOWARD W., Chief Engineer, Standard Engineering Co., Ellwood City

Texas

PALMER, GUERNSEY A., Manager and Resident Engineer, De La Vergne Engine Co., Houston

SUMMARY

New applications	198
Applications for change of grading:	
Promotion from Associate	1
Promotion from Associate-Member	7
Promotion from Junior	10
Total	216

PERSONALS

In these columns are inserted items concerning members of the Society and their professional activities. Members are always interested in the doings of their fellow-members, and the Society welcomes notes from members and concerning members for insertion in this section. All communications of personal notes should be addressed to the Secretary, and items should be received by September 15 in order to appear in the October issue.

CHANGES OF POSITION

A. F. Van Deinse, formerly connected with the Federal Light and Traction Company, New York, has become associated with the Columbus, Delaware and Marion Electric Company, Marion, Ohio, as general manager.

Edwin H. Seaman, until recently insurance engineer, American Lloyds, New York, has accepted the position of engineer with Johnson and Higgins, New York.

A. H. Chas. Dalley, formerly manager of the Chicago office of the American Engineering Company, of Philadelphia, Pa., has become affiliated with the Locomotive Superheater Company, Chicago, Ill., in the capacity of consulting engineer.

J. O. Persons has accepted the position of general manager of Bayles Shipyard, Port Jefferson, L. I., N. Y. He was until recently associated with the Remington Arms Company, Bridgeport, Conn., in the capacity of works engineer.

J. Carlton Ward, Jr., has become associated with the Pratt and Whitney Company, Hartford, Conn. He was formerly connected with the productive statistics division, Watervliet Arsenal, Watervliet, N. Y.

Robert N. Field has severed his connections with the United States Smelting, Refining and Mining Company, to take a position with the Western Sugar Refinery of San Francisco.

Frederick B. Garrahan, formerly with John Royle and Sons, Paterson, N. J., is now associated with the McGraw-Hill Publishing Company, New York.

James G. Russell, formerly instructor in mechanical engineering, Post Graduate Department, U. S. Naval Academy, Annapolis, Md., has accepted a position with Day and Zimmermann, Inc., Philadelphia, Pa.

James D. Taylor has resigned his position of chief engineer and superintendent of the Twenty-third Street branch of the Y. M. C. A., to assume the duties of chief engineer and assistant superintendent of the Metropolitan Museum of Art, New York.

Frank O. Hoagland, formerly affiliated with the Pratt and Whitney Company, of Hartford, Conn., has become associated with The Bilton Machine Tool Company, Bridgeport, Conn.

W. B. Moses has severed his connection with A. Marx and Son, New Orleans, La., to accept a position with the Engineering Sales Company, Inc., of the same city.

Sverre Petersen, until recently identified with the Lucey Manufacturing Corporation of Tennessee, Chattanooga, Tenn., in the capacity of chief engineer, has accepted the position of engineer with the Roxana Petroleum Company of Oklahoma, Tulsa, Okla.

Ernest B. Talkes has resigned his position as master mechanic of the Federal Furnace Plant, By-Product Coke Corporation, South Chicago, Ill., to accept a similar position with the Inland Steel Company at Indiana Harbor, Ind.

L. W. Helmreich has assumed the position of engineer, electricity, gas, heat and water department of the Public Service Commission of Missouri, Jefferson City, Mo. He was formerly head of the electrical department of the Ranken Mechanical School, St. Louis, Mo.

Alex. B. McKechnie has become affiliated with the G. M. Parks Company, Boston, Mass. He was formerly connected with the Merrill Process Company, of the same city, in the capacity of sales engineer.

Wallace C. Mills, until recently machine designer with Root and Van Dervoort Engineering Company, East Moline, Ill., has assumed similar duties with the Janesville Machine Company, Janesville, Wis.

George A. Hickerson has resigned his position as engineer with McKesson and Robbins, Inc., New York, to accept the position of mechanical appraiser with Ford, Bacon and Davis, New York.

C. J. Beust has entered the mechanical department, U. S. Nitrate Plant, Muscle Shoals, Sheffield, Ala. He was formerly connected with E. I. du Pont and Company, Wilmington, Del., in the capacity of engineering draftsman.

Frederick R. Banks has resigned his position as assistant equipment engineer of the Remington Arms Union Metallic Cartridge Company, Inc., Bridgeport, Conn., to take a position as chief engineer with the McNab and Harlin Manufacturing Company, Paterson, N. J.

Z. E. Sargisson has resigned his position as assistant works engineer for the Pan Motor Company, St. Cloud, Minn., to accept a position as an assistant maintenance engineer with the B. F. Goodrich Company, of Akron, Ohio.

George H. Waters, formerly president of George H. Waters Company, Mariner Harbor, N. Y., has assumed the duties of president of the Raritan Dry Dock Company, Perth Amboy, N. J.

George H. Sharpe has resigned as chief engineer and director of Westcott and Mapes, Inc., New Haven, Conn., to accept the position of deputy administrative engineer for the State of Connecticut, U. S. Fuel Administration, Hartford, Conn.

Robert Mawson, formerly associate editor of the *American Machinist* and recently connected with the firm of Mawson Brothers of Providence, R. I., has accepted the position of publicity manager with the Quigley Furnace Specialties Company, of New York.

James G. Rossman, until recently financial manager for William Hurd Hillyer, New York, is now manager of the banking department of Converse D. Marsh, New York.

ANNOUNCEMENTS

Herbert A. Burns has accepted a position with the New Home Sewing Machine Company, Orange, Mass., in the capacity of manager of the shell plant.

F. Rodney Pleasonton has become connected with the Savage Arms Corporation, as general works manager of its plants at Utica, Sharon and Philadelphia.

Lieut. Col. P. P. Walker, Engrs. U. S. A., is now stationed at Camp Cody and expects to leave shortly for France. Lieutenant Walker is Dean of the School of Engineering, University of Kansas, Prof. Geo. C. Shaad taking his place during his absence.

R. L. Rowley, formerly with the Fire Marshal's Branch of the U. S. Shipping Board, Oakland, Cal., is now engineer for the Pacific division, in charge of fire protection in the shipyards, under the jurisdiction of the Shipping Board.

Henry E. Longwell has assumed the position of chief engineer for the Pierce, Butler and Pierce Manufacturing Corporation, Eastwood, Onondaga Co., N. Y.

S. Carl Shipley, of Minneapolis Minn., has charge of the training of approximately 350 army men who will serve in the capacity of drivers of automobiles and trucks in war service.

John V. Martenis, assistant professor of mechanical engineering at the University of Minnesota, Minneapolis, has undertaken the training of 300 enlisted men in the Navy who are to serve as machinist mates.

Edward E. Gay, Jr., has accepted the position of hull fittings engineer with the American International Shipbuilding Corporation, Hog Island, Pa. Mr. Gay will, however, still maintain his consulting engineering office in Philadelphia, Pa.

Percy Brown has been promoted to the position of general superintendent of the record factories at Bridgeport, Conn., and Toronto, Canada, of the Columbia Graphophone Manufacturing Company.

By order of the County Court, Queens County, dated August 13, 1918, Frederick Stiftermeister's name has been changed to Frederick Alden Spencer.

APPOINTMENTS

Harry K. Fox has been appointed mechanical engineer of the Chicago, Milwaukee and St. Paul Railway Company, Milwaukee, Wis., with headquarters at Chicago, Ill. He was formerly connected with the company in the capacity of engineer of tests.

Everett W. Swartwout, formerly with the New York office of the Nordberg Manufacturing Company, has been appointed manager of the Philadelphia office, with the particular task of serving all the departments of the Emergency Fleet Corporation and various technical departments in Washington, as the company's shops are largely devoted to Government work.

Olin H. Landreth, professor of civil engineering, Union College, Schenectady, N. Y., has been appointed to the Ordnance Department as mechanical engineer in the Production Bureau, and is to be stationed at Washington. To enable him to accept this appointment, the trustees of Union College have extended his leave of absence for another year.

Harry Himmelbau has been appointed assistant to Joseph Harrington, the administrative engineer, U. S. Fuel Administration for Illinois.

Charles C. Trump, secretary and mechanical engineer of the Humphrey Gas Pump Company, Syracuse, N. Y., has accepted an appointment as assistant administrative engineer, under the Federal Fuel Administration for New York State and the Bureau of Conservation of the United States Fuel Administration, devoting his entire time to the work of fuel conservation in the State of New York.

Edward N. Trump is acting as administrative engineer under the Federal Fuel Conservation for New York State, with office in Syracuse, N. Y. Mr. Trump is serving as a volunteer, giving half of his time to this work.

William G. Eager, formerly vice-president of the Valdesta Lighting Company and consulting engineer for the General Utilities and Operating Company of Baltimore, Md., received his commission as lieutenant of the line (senior grade) United States Naval Reserve Force, and has been assigned to Philadelphia field work in that district.

EMPLOYMENT BULLETIN

THE SECRETARY considers it a special obligation and pleasant duty to make the office of the Society the medium for assisting members to secure positions, by putting them in touch with special opportunities for which their training and experience qualify them, and for helping any one desiring engineering services. The Society acts only as a clearing house in these matters.

GOVERNMENT POSITIONS

Stamps should be inclosed for transmittal of applications to advertisers; non-members should accompany applications with a letter of reference or introduction from a member; such reference letter will be filed with the Society records.

CONSTRUCTION MEN on coke-oven plants. Men competent to follow out plans and details of construction and plant layout. Experience in chemical and gas plants serviceable. 0525.

ENGINEERS with experience in machine shops, and men of general engineering experience needed. 0549.

HIGH GRADE TECHNICALLY TRAINED MEN, preferably graduates of a mechanical or electrical engineering course. Those with some practical experience in testing or designing machinery preferred. 0552.

COMBUSTION ENGINEER wanted by the Bureau of Oil Conservation, Oil Division, U. S. Fuel Administration, for each of the following districts, to act as inspector, visiting all plants within his district using fuel oil and natural gas: Boston, Providence, New York City, Philadelphia, Pittsburgh, Buffalo, Detroit, Chicago, Minneapolis, Tulsa, New Orleans, and San Francisco.

It is desirable to have these men act as volunteers where possible, but the Administration is prepared to pay a reasonable compensation for men who cannot afford to give their services to the Government. Only men who have had experience in fuel-oil and natural gas combustion would be of value. 0568.

MECHANICAL, Civil, Electrical and Marine Engineers are required for shipyards, principally on Atlantic Coast. Work to be the designing and construction of hulls and ship equipment. 0597.

YOUNG MEN wanted for the Department of Military Aeronautics. Should have mechanical training, and if possible, be thoroughly grounded in electrical work. May be of draft age and will go as enlisted men, then assigned to Training School for Radio Mechanics and after instruction will be sent overseas. They will be inducted at once. Schools conducted in Pittsburgh and New York City.

CIVILIAN POSITIONS

SUPERINTENDENT for projectile shop. Must be able to handle men intelligently, have had actual experience in the forging and machining of shells, be thoroughly experienced in production work, and possess executive ability. Location Connecticut. 1-0523.

YOUNG SALES ENGINEER for leading firm of power-plant specialty manufacturers. Man with experience in power-plant equipment wanted; technical graduate preferred. Excellent prospects. Location Philadelphia. 1-0524.

ESTIMATOR DRAFTSMAN, who can read blueprints, do the necessary laying out and pick off quantities. Work is all in sheet and plate steel, tanks and boilers, and special apparatus. Location Jersey City. 1-0526.

YOUNG ENGINEER (draft exempt) to assist in supervising operation of private power plants and in engineering new industrial plants. Salary according to results. Location New York. 1-0528.

TWO COLLEGE GRADUATES for drafting room with a few years experience in detailing and drafting in connection with the layout of furnace work, elevator and conveyor machinery, boiler-plant work, etc. Men required to make stress diagrams and estimates of the various structures which they design, and take off quantity estimates. 1-0531.

DRAFTSMAN, experienced and competent man to take care of general layouts such as are made in case a new proposition has to be lined up in the drafting room for estimating purposes or for the purpose of general arrangement and best utilization of available ground area. Man wanted who is well acquainted with the handling of material in large quantities by mechanical appliances and who has preferably had experience in the same line of work at metallurgical plants. 1-0532.

EXPERIENCED CHECKER who can check up all drawings before they leave the drafting room as regards detail dimensions, and also go over the stress diagrams and the general design of buildings and various structures so that the checking will be complete and not have reference only to detail dimensions. 1-0533.

EDITOR with special knowledge in marine engineering and boiler manufacture. Headquarters New York. 1-0534.

ASSISTANT MASTER MECHANIC or MECHANICAL ENGINEER. Mechanical graduate or man with at least three years' college education and some practical experience in machine-shop work or factory maintenance. Work consists principally in the maintenance and operation of hydraulic pumps, presses, and similar lines. To start in office as a clerk and cost accountant at $100 per month. Progress and promotion will depend entirely upon the man himself. Location Canada. 1-0536.

ORGANIZING ENGINEER for large plants operating 30,000 to 40,000 hp. of boilers, large electrical units, also refrigeration machinery, evaporators, stills, gas machinery, and varied mechanical equipment. Young man who has had technical training and experience and is qualified to guide in mechanical development. Location Ohio. Salary depends on man. 1-0542.

DESIGNER for semi-Diesel or hot-bulb heavy-oil engines to be used for marine and land purposes; one who has had experience on this type of machinery. State requirements, salary, etc. Location New York. 1-0543.

MECHANICAL, CIVIL or AERONAUTICAL ENGINEER capable of handling mathematical work connected with the design of aeroplanes. Men with mathematical experience in other lines will be considered. Position is with aircraft factory on Long Island. 1-0556.

ASSISTANT TO DIRECTOR of large university engineering-experiment station, to have some teaching requirements; duties to include all editorial work connected with publication and distribution of bulletins, requiring some practical editorial experience. Initiative and ability to carry out work with minimum supervision on the part of head of the department. Salary will depend largely upon age, experience, and training of man. 1-0558.

YOUNG ENGINEER with some experience in assembling small parts such as time and percussion fuses will be afforded excellent opportunity to show worth as the head of fuse department of a large ammunition company. Salary commensurate with experience and demonstrated ability. Location Connecticut. 1-0562.

SUPERINTENDING MECHANICAL ENGINEER AND FOREMAN for tin-smelting plant. Men familiar with tin-ore products and remanufacturing. Location Brooklyn. 1-0563.

SUPERINTENDENT OF CONSTRUCTION for plant manufacturing conveying machinery. Desire executive type of man both from office and shop standpoint. Salary depends on man. Location New York. 1-0564.

FACTORY SUPERINTENDENT. Manufacturer of steel tanks desires to communicate with technical graduate, married man or one with dependents, who has had shop experience, knows up-to-date production methods, labor problems, and familiar with general cost accounting. In reply state experience and education. Salary to start $3000. Location Massachusetts. 1-0566.

COMBUSTION ENGINEER to do commercial engineering work. Experience with mechanical stokers. Good position for one desiring to prepare for sales work. Location Pittsburgh, Pa. 1-0567.

ENGINEERING SOCIETY requires man of judgment, experience, executive ability and personality, to develop standardization work. Position involves coördinating work of several important committees of manufacturers and users in mechanical engineering lines. State full qualifications and salary. 1-0569.

MECHANICAL ENGINEER along general lines of factory reorganization, together with some mechanical drafting. Salary to start $2500. Location Connecticut. 1-0571.

SALES ENGINEER, between 25 and 32, draft-exempt or in class 4. Must be energetic, have initiative and be a thinker. Man wanted with engineering-college degree and one year's shop experience on machine design, or high-school education and two or three years' work on machine design. Salary $1800, with excellent opportunity for advancement. To travel; New York headquarters. 1-0572.

DRAFTSMAN, preferably one with experience in hydraulic-turbine work. Permanent position and good opportunity for high-grade man only. Give full particulars in first letter. Location Ohio. 1-0573.

HEAD OF SCHOOL FOR BOYS in Detroit. Man experienced in the charge of boys' school covering the grades in the grammar and high-school. Chief requisite, personality. Salary $1500. 1-0574.

DRAFTSMAN on plant layout work of factory buildings. Concern engaged in the manufacture of steel barrels, tanks, oil pumps and portable furnaces for hardening and tempering steel. Location Massachusetts. 1-0575.

SUPERINTENDENT for factory employing about 200 men. Established business. Good opening for right man. Must be thoroughly experienced in general manufacturing, estimating and in the handling of men. Location New Jersey. 1-0576.

YOUNG MAN with some experience in drawing for preparation of wiring diagrams for motor-controller circuits. $15 to $25 per week, according to ability. Employment continuous until drafted into Government service, or, if exempt, can offer permanent position. Location New York. 1-0578.

SUPERINTENDENT for Barrel Manufacturing Division. Must be familiar with making of barrels of light-gage steel; girths are seam welded and heads are lock seamed; experience on oxy-acetylene is also essential.

Splendid opportunity for high-class man. Location Massachusetts. 1-0579.

CHEMISTS OR ENGINEERS wanted by firm engaged in coal-tar distillation and roofing manufacture. Work will be of an experimental nature in connection with new processes of manufacture and new use for products. Location New York. 1-0580.

CHIEF DRAFTSMAN AND GENERAL ASSISTANT to chief engineer. Progressive paper and pulp manufacture. Concern in Canada offers excellent opportunity to capable man preferably with paper-mill experience. 1-0581.

TECHNICAL TRAINED YOUNG MAN with several years practical work wanted for position in publicity department of large manufacturer doing world business. Should be in Class 4 draft. Splendid opportunity for capable man in sales work. Advertising experience not necessary. Location Ohio. 1-0582.

ENGINEERING OR ARCHITECTURAL DRAFTSMAN capable of doing good work, at least high-school education. Work will be largely drafting in office of consulting engineer and includes acting as assistant to engineer on tests in power plants, etc. Some inspection of construction work. Salary $25 per week. Location New York. 1-0583.

ENGINEERS capable of handling responsible position in newly-organized production department of Detroit automobile company, engaged on war orders. Salary $40 to $50 per week. 1-0584.

INSTRUCTOR in mechanical drawing and machine design for day technical school and evening classes. Salary $2000. 1-0585.

TECHNICAL GRADUATE of about 28 years of age, with some experience in installing office and shop systems; physically unfit for military service, or placed in limited service. Man with initiative and ability to get results is preferred, even if no previous experience in the work above named. Location Massachusetts. 1-0586.

TWO MANAGERS manufacturing department and procurement of equipment for expanding cartridge department Illinois. Position of works manager covers manufacturing of cartridges in general way. Can use a factory manager with ability in manufacturing complicated and technical line of goods. 1-0587.

EFFICIENCY ENGINEER. Experienced man with technical training for testing and efficiency work in steam-electric plant near New York. Man with initiative who can recommend and carry out improvements. Tact requisite. State age, education, experience, references and salary expected. 1-0588.

ASSISTANT EFFICIENCY ENGINEER. Young technical man with one or two years' power-plant experience as assistant to efficiency engineer. Opportunity for broad experience and advancement; location near New York. State age, education, experience, references and salary expected. 1-0589.

WORKS MANAGER for plant located in Southern Ohio, manufacturing line of pumps, compressors, heaters, cotton-seed material, machinery and the like. The plant comprises foundry, pattern shop, machine shop, etc. At present is engaged in the assembling of six-ton tractors. Man capable of earning from $6000 to $8000 per year to start. Should be familiar with modern duplicate-parts manufacture, modern shop and foundry administration, cost accounting, stores keeping and kindred allied subjects; capable of developing into general manager. 1-0590.

BUYER of fabricated parts for aviation motors. Work would be under control of outside manufacturing department: qualifications extraordinary, and differ decidedly from those required of the ordinary buyer or purchasing agent. Man with considerable buying experience on fabricated parts, with concern which has been assembling automobiles from purchased parts, or similar buying experience along gas-engine lines. Shop experience and familiarity with machine tools. Proposition concerns one of furnishing tools and materials to the vendor, specifying just how the parts are to be made. American citizen, 35 to 45 years old, capable of earning from $4500 per year up. Position must be filled immediately. Location New York. 1-0591.

PLANNING DEPARTMENT POSITION consists of laying out the work for the different departments and following it all through the different departments to see that it is pushed through the factory in shortest possible time. Working on 92% to 96% Government Work. Location Philadelphia. 1-0592.

MEN WITH TECHNICAL TRAINING IN MECHANICAL ENGINEERING wanted by manufacturer of recording meters and power plant equipment; opening for several men in engineering department. Some power-plant experience. Position offers good inducements, experience and future often leading to permanent positions in efficiency work in large power plants. 1-0593.

SUPERINTENDENT, mechanical installation, familiar with plumbing, heating and lighting, electric line work and house wiring. Salary $3600 to $5000. 1-0599.

YOUNG MEN available for department of mechanical engineering of large Middle West University to replace men called into Government service. 1-600.

MEN AVAILABLE

Only members of the Society are listed in the published notices in this section. Copy for notices should be on hand by the 12th of the month, and the form of notice should be such that the initial words indicate the classification. Notices are not repeated in consecutive issues.

MECHANICAL ENGINEER, age 35, thirteen years' experience, covering design, construction and maintenance of industrial works. Capable of acting as assistant chief engineer, master mechanic or superintendent of steel rolling mill on any maintenance proposition. Thoroughly conversant with technical and practical side of steam, pneumatic and hydraulic work. Also familiar with electrical apparatus. Prefers location near New York, Philadelphia or Baltimore. 1-222.

EXECUTIVE, member, 49, practical workman, technical education, wide experience in manufacturing, covering shop, sales, design, office, finance, management. Large experience in the forging business. 1-223.

GENERAL OR WORKS MANAGER, American, age 47, practical mechanic and designer; executive and sales experience; designed and placed on market well-known line automatic machinery. Successful in handling skilled labor. Working knowledge of general and cost accounting systems, etc. At liberty about September 1st. Position in which an interest in business could be obtained preferred. Salary $5000. 1-224.

MEMBER with broad business and engineering experience here and abroad. American, 45; fully conversant with the principal languages; knowledge of purchasing and selling; tactful in handling of men; at present employed as designer of special plant. Desires change preferably to supervise work, inspect or represent, or act as assistant to executive where responsibility is required. To start, $4000. 1-225.

COMPETENT FOUNDRY MAN capable of handling any foundry proposition, having charge of some of the largest and most up-to-date foundries in the country. 1-226.

MANAGER, EXECUTIVE ORGANIZER. Chemical engineer, technical graduate, not subject to draft. Twenty years' experience conduct of large industries. Fine record in designing and construction. Ample reference. 1-227.

MECHANICAL AND REFRIGERATING ENGINEER, member, thoroughly experienced in refrigerating and general engineering and design of all kinds of machinery power plants, refrigerating and ice-making plants; competent to take charge of office force, supervise erection and handle tactfully executives and men; exemplary habits. 1-228.

MECHANICAL ENGINEER, member, technical graduate, 38; long experience in heavy, light and multiple manufacture, experimental and development work. At present chief draftsman on elevating and conveying machinery. Relations with subordinates and co-workers invariably pleasant and successful. Desires new permanent position in engineering executive line, with increased scope and responsibilities. 1-229.

MECHANICAL ENGINEER, associate member, age 32, married. Now employed as mechanical engineer of plant making large number of interchangeable brass and light gray iron parts. Eleven years tool designing, testing and general engineering and manufacturing. Desires location in Southern New England. 1-230.

CHIEF OPERATING ENGINEER, associate, 40 years of age, with 15 years' experience, desires situation with progressive concern. Nine years' satisfactory service as chief engineer. Experience covers steam, electric and producer gas; Diesel engines and refrigeration. 1-231.

WORKS MANAGER, broad practical experience in design and interchangeable quantity production of small high grade apparatus, such as registers, adding, coin-counting machines and fuses. Can organize new plants intending to engage in above lines. Have been successful in the handling and training of help and securing maximum results from equipment. Fully acquainted with factory systems. Employed at present. Only high-grade connection will be considered. 1-232.

MANAGER now successfully conducting Philadelphia office for large concern manufacturing electrical, mechanical and pneumatic equipment desirous of making change; has acquired unusual business and technical training during 8 years of continuous service with present company. Thoroughly experienced in sales, engineering and construction; handling these departments now in territory comprising five Middle Atlantic States. Young man, married, with excellent references. Salary approximately $4500. 1-233.

PURCHASING EXECUTIVE, also qualified as supervisory-office and plant engineer. Acquainted with largest manufacturers of mechanical and electrical equipment and suppliers of engineering materials. At present engaged along these lines, wishes connection with opportunity for greater activity. 1-234.

SALES ENGINEER, mechanical-electrical, technically trained; American, 35 years of age, married; speaks Spanish and Portuguese, acquainted with machine tools, construction machinery, mechanical-electrical equipment, sugar machinery, 13 years' sales experience; executive ability, desires to connect with manufacturer as sales engineer for South America. 1-235.

SALES ENGINEER with Latin-American experience, speaking Spanish, wishes to make connection for representation in Latin-American countries or Spain. Special qualifications for successful representation in railway supplies, power-plant equipment, etc. Thoroughly versed in foreign trade methods. Mechanical engineer, fourth class in draft. 1-236.

EXECUTIVE, experienced buyer and publicity man; M. E. graduate, located in New York City, will execute commissions for out-of-town concerns, and can devote portion of each day to outside interests. Address care of The Journal. 1-237.

[illegible] Blue print [illegible] de [illegible] No. 3, L. W. F. Tractor Biplane; No. 5, L. V. G. Tractor Biplane; No. 6, Wright Light Scout; No. 7, London and Provincial Tractor; No. 8, Aeromarine Hydroplane; No. 9, Standard Twin Motor Biplane; No. 10, United Eastern Tractor Biplane; No. 11, Lawson Tractor Biplane; No. 12, Friedrichshafen Biplane; No. 23, Curtiss 3-wheel exhibition pusher biplane; No. 30, Nieuport Scout. *New York, 1916-18.* Purchase.

AMERICAN WIRE ROPE. Catalogue and Handbook. *1913.* Gift of American Steel & Wire Company.

AN APPRECIATION OF TWO GREAT WORKERS IN HYDRAULICS. Giovanni Battista Venturi, born 1746; Clemens Herschel, born 1842. By Walter G. Kent. *London, 1912.* Gift of Clemens Herschel.

L'ARMÉE ALLEMANDE A LOUVAIN EN AOUT 1914 ET LE LIVRE BLANC ALLEMAND DU 10 MAI 1915. DEUX MÉMOIRES. *Port Villez, 1917.* Gift of Prof. O. Steels.

THE ATHENAEUM. Subject Index to Periodicals. 1916. Science and Technology, including Hygiene and Sport. *London, 1918.* Purchase.

LA BELGIQUE ET L'ALLEMAGNE. Textes et documents précédés d'un avertissement au lecteur par Henri Davignon. *n. p., 1915.* Gift of Prof. O. Steels.

BIG CREEK INITIAL DEVELOPMENT, PACIFIC LIGHT AND POWER CORPORATION. *1914.*

BOILER FURNACE OPERATION. Science and Common Sense. By Lester Budd. *Philadelphia, n. d.*

CANADA. Munition Resources Commission. Report of the work of the Commission, Nov. 1915-Feb. 1918. First. *Ottawa, 1918.* Gift of Commission.

CLEARING LAND OF ROCKS FOR AGRICULTURAL AND OTHER PURPOSES. By J. R. Mattern. *New York, 1918.* Gift of Institute of Makers of Explosives.

CLEARING LAND OF STUMPS. *New York, 1917.* Gift of Institute of Makers of Explosives.

COLORADO SCIENTIFIC SOCIETY. Year Book. 1882-1916. *Denver, 1916.* Gift of Society.

COMMERCIAL CREDITS THROUGH ACCEPTANCE. Address by Albert Breton. *New York, 1918.* Gift of Guaranty Trust Company.

CONCRETE CONSTRUCTION. June 1918, prepared by Portland Cement Association. Gift of Association.

COURS DE MÉCANIQUE. vols. 1-4. By L. Guillot. *Paris, 1911, 1913, 1918.* Purchase.

DIGEST OF THE FEDERAL RESERVE ACT, including amendments to June 21, 1917. *New York, 1917.* Gift of Guaranty Trust Company.

DISEASE IN MILK. The remedy Pasteurization. The life work of Nathan Straus. Ed. 2. *New York, 1917.* Gift of Mrs. Lina Gutherz Straus.

ELECTRICAL WIRES AND CABLES. Catalogue and Handbook. *1910.* Gift of American Steel & Wire Company.

ELECTRIFICATION OF RAILROADS AS A WAR MEASURE. *East Pittsburgh, 1918.* Gift of Westinghouse Electric & Manufacturing Co.

ESSAYS OF CLEMENS HERSCHEL. Gift of Clemens Herschel.

EXTRACTING NITROGEN FROM THE ATMOSPHERE AT A POWER COST OF OVER 221 TONS PER DAY, FOR A 1000 KILOWATT POWER PLANT (equivalent to over 5,950,000 cu. ft. of Nitrogen gas), or 248 cu. ft. for one kilowat hour. Edition 5. By J. F. Place. *Glenridge, N. J., 1918.* Gift of author.

FEDERAL ESTATE TAX. LAW AND REGULATIONS. Act of Sept. 8, 1916, amended March 3, 1917. *New York, 1917.* Gift of Guaranty Trust Company.

INDUSTRIAL HEATING AS A CENTRAL STATION LOAD. Parts 1-2. *New York, 1917.* Gift of D. D. Miller.

MOODY'S MANUAL OF RAILROADS, 1918—Public Utilities Section. *New York, 1918.* Purchase.

——Complete list of securities maturing July 1, 1918, to June 30, 1920. Vol. VI. *New York, n. d.* Gift of Moody Manual Co.

NEW JERSEY. Department of Conservation and Development. Annual Report, 1917. *Union Hill, N. J., 1918.* Gift of Department.

NEW SOUTH WALES. Water Conservation and Irrigation Commission. Report, 1917. *Sydney, 1918.* Gift of Commission.

NEW YORK CITY. Board of Water Supply. Contract drawings for the construction of portions of the Peekskill division of the Catskill Aqueduct between Hunter's Brook and Foundry Brook Valleys. (Contract No. 2.)

——Contract drawings for the construction of a portion of the Esopus Division of the Catskill Aqueduct in the towns of Olive and Marbletown, Ulster Co., N. Y., 1908. (Contract No. 11.)

——Contract drawings for the construction of Hunter's Brook and Scribner Tunnels and portions of Yorktown cut and cover in the Croton Division of the Catskill Aqueduct in the town of Yorktown, Westchester Co., N. Y., 1908. (Contract No. 23, with specifications.)

THE PROMISE OF OUR VISION. Address by Francis H. Sisson. *New York, 1918.* Gift of Guaranty Trust Company of New York.

PUBLIC UTILITIES REPORTS ANNOTATED. 1918-A. *Rochester, 1918.* Purchase.

——Professional reference list. 1918 issue. *Rochester, 1918.* Purchase.

A RECORD THAT IS A PROMISE. An account of the changes wrought by the war in the financial and industrial structure of Canada. *New York, 1918.* Gift of Guaranty Trust Company of New York.

RED CROSS INSTITUTE FOR CRIPPLES AND DISABLED MEN. Placement Technique in the employment work of the Institute. By Gertrude R. Stein. (Publications, Series 1, no. 9.)

——Relation of the short, intensive industrial survey to the problem of soldier re-education. By G. A. Boate. (Publications, Series 1, no. 10.)

——Training in English Technical Schools for disabled soldiers. By John C. Faries. (Publications, Series 1, no. 8.)

——Vocational School for disabled soldiers at Rouen, France. By J. Breuil. (Publications, Series 1, no. 11.)

SAFE-GUARDING THE HOME AGAINST FIRE. A fire prevention manual for the school children of America. Prepared for the United States Bureau of Education by the National Board of Fire Underwriters.

A SHADE TREE GUIDE. By Alfred Gaskill. *Union Hill, N. J., 1918.* Gift of New Jersey. Department of Conservation and Development.

SPEEDING UP AMMUNITION AND MUNITION PRODUCTION. "Gravity."

STATISTICAL ABSTRACT OF THE UNITED STATES. 1917. *Washington, 1918.* Gift of U. S. Department of Commerce. Bureau of Foreign and Domestic Commerce.

STATISTICS OF EXPRESS COMPANIES. Annual Report. 7th. *Washington, 1918.* Gift of Interstate Commerce Commission.

TEACHING OF SAFETY IN TECHNICAL SCHOOLS AND UNIVERSITIES. A memorandum prepared for the aid of those desiring to undertake such work. National Safety Council, June, 1918. Gift of National Workmen's Compensation Service Bureau.

USE OF EXPLOSIVES IN MAKING DITCHES. *New York, 1917.* Gift of Institute of Makers of Explosives.

USE OF EXPLOSIVES IN THE TILLAGE OF TREES. *New York, 1918.* Gift of Institute of Makers of Explosives.

TRADE CATALOGUES

AERO PULVERIZER COMPANY. New York, N. Y.
Bulletin No. 26. Pulverized fuel combustion.

CENTRAL SCIENTIFIC COMPANY. Chicago, Ill.
Bulletin No. 15. A new analytical balance.
Bulletin No. 17. American made glassware and porcelain for American laboratories. Whatman filter paper. 1917.
—— No. 19. Cenco laboratory rheostats rated for continuous duty. 1918.
—— No. 20. Balances and weights. 1917.
—— No. 36. Matthews gas machine.
—— No. 45. Cenco-Nelson high-vacuum pumps. 1918.
—— No. 50. A new single walled drying oven. 1918.
—— No. 61. A new DeKhotinsky drying oven. 1918.
—— No. 70. Cenco Polar water stills. 1918.

DEVINE, J. P., COMPANY. Buffalo, N. Y.
Bulletin 105A. Devine apparatus for the color, chemical, dyestuff and allied industries.

DE LAVAL STEAM TURBINE COMPANY. Trenton, N. J.
Bulletin N. Centrifugal boiler-feed pumps. 1918.

DELTA STAR ELECTRIC COMPANY. Chicago, Ill.
Bulletin No. 33. High-tension indoor equipment.

ERIE SPECIALTY COMPANY. New York, N. Y.
Erie standard aircraft metal parts. Descriptive booklet.

GENERAL ELECTRIC COMPANY. Schenectady, N. Y.
Bulletin No. 41302A. Polyphase induction motors. 1918.
—— 47070. Direct-current standard-unit panels 90 in. high, 125 and 250 volts 2-wire, and 125/250 volts 3-wire for general power and lighting service.
Class 317 (68202) CR 3100 drum-type controllers for series, etc.

INVINCIBLE VACUUM CLEANER MANUFACTURING COMPANY. Canal Dover, Ohio.
Descriptive booklet of "The Invincible."

IVANHOE-REGENT WORKS OF GENERAL ELECTRIC CO. Cleveland, Ohio.
Catalogue No. 260. Regent bowls and shades with Rozelle color decorations. 1918.
Price list for Catalogue No. 257.

LINK-BELT COMPANY. Philadelphia, Chicago, Indianapolis.
Book No. 312. Link-Belt silent chain the efficient drive for machine tools. 1918.

LUDLUM STEEL COMPANY. Watervliet, N. Y.
Descriptive catalogue of carbon and alloy tool steels, high-speed steel.

PARKS, THE G. M., COMPANY. Fitchburg, Mass.
The Turbo-humidifier, being a simple practical device for producing artificial humidity, using an old principle in a new way. 1918.

SCHRAMM, CHRIS. D., & SON, INC. Philadelphia, Pa. Catalogue No. 18. The Schramm Line.

SHAIN, CHAS. D. Brooklyn, N. Y.
Circular No. 57. Shain copper terminals.

STURTEVANT, B. F., COMPANY. Hyde Park, Mass.
Catalogue No. 150. Fuel economizers and air heaters.
—— No. 234. Steel-plate blowers and exhausters.

L. SONNEBORN SONS, INC.
Lapidolith for all concrete floors. Descriptive booklet.

WHEELER CONDENSER & ENGINEERING CO. Carteret, N. J.
Bulletin No. 109-B. Wheeler-Balcke Cooling towers. 1918.
Bulletin describing The Lillie Evaporator for Waste Waters.

SELECTED TITLES OF ENGINEERING ARTICLES

THE section Selected Titles of Engineering Articles appears in this issue on an enlarged scale.

This development is essentially a war activity. As a result of the war, engineers are constantly confronted with new problems and in consequence of the reconstruction period to follow, this condition will undoubtedly continue to exist for a long time to come.

One of the greatest services which the Society can render at this critical period is to place at the disposal of engineers, as a basis for their work, the means for using the wealth of data and general information published from month to month in the world's technical press. For this to be of any considerable value to the engineer, he must know, first, what information has appeared, and second, where it is to be found. To supply this knowledge in concise and convenient form is the purpose of the Selected Titles as now published.

This work has been made possible by the remarkable collection of current periodicals available in the Library of the United Engineering Society, which is by far the greatest in this country and probably in any country. The Library receives, even now, when some of the foreign periodicals have ceased to come to its shelves, close to a thousand different papers, magazines and transactions of societies in the engineering and scientific fields, in not less than ten languages. The Society's engineering staff examines these publications as they are received and prepares the cards ultimately used for the Selected Titles Section in THE JOURNAL.

In the preparation of the Selected Titles Section chief attention is paid to articles directly concerned with the branches of mechanical engineering. When it is thought they will be of interest or value to mechanical engineers, however, other articles are listed, in the realms of physics and chemistry; civil, mining and electrical engineering, technology, etc.; and in subjects in broadly related fields such as training and education, safety engineering, fire protection, employment of labor, welfare work, housing, cost keeping, patent law, public relations, etc.

The system of classification used is that which it is believed has come to be generally regarded as the best, namely, the simple alphabetical arrangement with the articles under heads and sub-heads which are varied from month to month according to the subject-matter to be indexed. Cross-references have been introduced and it is particularly to be noted that where the titles themselves are not sufficiently descriptive, explanatory sentences have been appended. This feature much more than doubles the labor and expense and, we are assured, correspondingly enhances the value of the index to the reader.

PHOTOSTATIC PRINTS

Photostatic copies may be obtained of any of the articles listed in this section.

Price for each print (up to 11 x 14 in. in size), 25 cents, plus postage. A separate print is required for each page of the larger-size periodicals, but where possible two pages will be photographed together on the same print. Bill will be mailed with the prints.

Orders should be sent to

HARRISON W. CRAVER, *Director,*
Engineering Societies Library,
29 West Thirty-ninth Street,
New York.

AERONAUTICS

Aeroplane Design

Directional Stability of an Airplane. Frederick Bedell. Sibley Jl. of Eng., vol. 32, no. 11, August 1918, pp. 166-167. Exposition of the mechanics of directional stability of an airplane.

Balloons

Military Aerostatics. H. K. Black. Aerial Age, vol. 7, no. 20, July 29, 1918, p. 957. Theory of ballooning. (To be continued.)

Engines

Aluminum Pistons for Aero-Engines. Engineer, vol. 126, no. 3262, July 12, 1918, p. 35, 2 figs. Description of the aluminum pistons found in the Benz engine of a captured German plane.

The Design of Aeroplane Engines. John Wallace. Aeronautics, vol. 15, no. 246, July 3, 1918, pp. 10-11, 2 figs. Details of design employed for the purpose of securing a smooth torque and approximate balance of the moving parts of aircraft engines. (Continuation of serial.)

General Problems

Present-Day Problems in Aeronautics. William B. Stout. Motor Travel, vol. 10, no. 2, July 1918, pp. 20-22. From an address delivered before the Society of Automotive Engineers.

Some Outstanding Problems in Aeronautics. W. F. Durand. Aeronautics, vol. 15, no. 246, July 3, 1918, pp. 19-26. Sixth Wilbur Wright Memorial lecture, read before the Aeronautical Society on June 25, 1918.

Individual Types

The A. E. G. Bombing Biplane. Engineer, vol. 125, no. 3258, June 7, 1918, pp. 484-487, 14 figs. Details of construction and performance of a reconstructed captured German biplane.

The Roland D. II Biplane (Biplan Roland D. II). L'Aérophile, year 26, nos. 9-10, May 15, 1918, pp. 129-132, 8 figs.

Instruments

Perfected Aircraft Compass (Compas Perfectionné de Direction, en Navigation Aérienne). H. Vincent. L'Aérophile, year 26, nos. 9-10, May 15, 1918, pp. 133-136, 6 figs. Describes a *multiplex* compass for use in aerial navigation.

To Ascertain the Speed and Direction of Aeroplanes Over the Water. Aerial Age, vol. 7, no. 19, July 22, 1918, pp. 914-915, 2 figs. Exposition of Admiral Fiske's proposed method.

Materials of Construction

Determination of the Permeability of Balloon Fabrics. Junius D. Edwards. Aviation, vol. 5, no. 1, August 1, 1918, pp. 30-33, 6 figs. (To be concluded.)

How Moisture Affects the Strength of Aircraft Fabrics. G. B. Haven. Automotive Industries, vol. 39, no. 3, July 18, 1918, pp. 100-108, 5 figs. Tests on cotton, linen, balloon fabric, tire fabric and cords.

Steel Tubes, Tube Manipulation and Tubular Structures for Aircraft. W. W. Hackett and A. G. Hackett. Automotive Eng., vol. 3, no. 6, July 1918, pp. 279-260. Review of method of manufacture of tubular work and of some of the forms of manipulation upon steel tubing. From a paper read before the Aeronautical Society, London, May 2. (To be continued.)

The Metallurgist and the Aircraft Program. H. F. Wood. Am. Drop Forger, vol. 4, no. 7, July 1918, pp. 281-282. Description of various parts in Liberty motor, showing how design and choice of material are controlled. (To be continued.)

Model Aeroplanes

Model Aeroplane Building as a Step to Aeronautical Engineering. John [illegible]. M[illegible]Mahon. Aerial Age, vol. 7, no. 20, July 29, 1918, p. 971, 18 figs. Principles of streamline study.

Propellers

A Résumé of Airscrew Theory. M. A. S. Riach. Aeronautics, vol. 15, no. 246, July 3, 1918, pp. 12-15. An attempt to coördinate the aerofoil and momentum theories of screw propulsion.

Conventional Propeller Calculations. F. W. Caldwell. Aviation, vol. 5, no. 1, August 1, 1918, pp. 21-26, 24 figs.

Notes on Airscrew Analysis. M. A. S. Riach. Aeronautics, vol. 15, no. 247, July 10, 1918, pp. 41-42, 4 figs. Proposed modifications in the theory outlined under the title, The Screw Propeller in Air, in Aeronautics of March 21. (Continued from issue of June 12, 1918.)

The Efficiency of an Airscrew. M. A. S. Riach. Aeronautics, vol. 15, no. 247, July 10, 1918, pp. 38-39. Study of the efficiency of an airscrew approached by a consideration of the efficiency of the various elements forming each blade.

Predicting Strength and Efficiency of Airplane Propellers. F. W. Caldwell. Automotive Industries, vol. 39, no. 3, July 18, 1918, 14 figs. Charts and formulæ for calculating horsepower absorbed and torque delivered at given engine and plane speeds.

The Characteristic Coefficients of a Propeller and Some Methods of Plotting Them. E. P. King. Aeronautics, vol. 15, no. 246, July 3, 1918, pp. 4-9, 6 figs. Study of some problems dealing with the variable-pitch propeller. (Continued from issues of Jan. 2, May 1 and June 19, 1918.)

See also Physics (Meteorology).

AIR MACHINERY

Air Compressors

Air Compressor Troubles. R. J. Bailey. Compressed Air Mag., vol. 23, no. 8, August 1918, pp. 8849-8850. Results obtained from a described arrangement.

Lubrication of Air Compressors. W. H. Callan. Coal Age, vol. 14, no. 5, August 1, 1918, pp. 211-213. Suggests that a fairly light oil might be as successful as a heavy oil.

Note.—The abbreviations used in indexing are as follows: And (&); American (Am.); Associated (Assoc.); Association (Assn.); Bulletin (Bul.); Bureau (Bur.); Canadian (Can.); Chemical or Chemistry (Chem.); Electrical or Electric (Elec.); Electrician (Elecn.); Engineer [s] (Engr. [s]); Engineering (Eng.); Gazette (Gaz.); General (Gen.); Heating (Heat.); Industrial (Indus.); Institute (Inst.); Institution (Instn.); International (Int.); Journal (Jl.); London (Lond.); Machinery (Machy.); Machinist (Mach.); Magazine (Mag.); Marine (Mar.); Mining (Min.); Municipal (Mun.); National (Nat.); New England (N. E.); New York (N. Y.); Record (Rec.); Refrigerating or Refrigeration (Refrig.); Review (Rev.); Railway (Ry.); Society (Soc.); United States (U. S.); Ventilating (Vent.); Western (West.); State names (Ill., Minn., etc.); Proceedings (Proc.); Transactions (Trans.); Supplement (Supp.); Mechanical (Mech.); Scientific (Sci.).

Blowing Engines

1500-HP Gas Blowing Engine. Engineer, vol. 126, no. 3262, July 5, 1918, p. 10, 2 figs. Description of large gas blowing engine built for the Partington Steel & Iron Co., Ltd.

Shell Plant

Compressed Air in a Shell Plant. R. E. C. Martin and S. B. King. Mine & Quarry, vol. 10, no. 4, July 1918, pp. 1051-1055. Illustrated article describing installation and operation of compressed air at the plant of Winslow Bros. Co., Chicago, Ill.

BRICK AND CLAY

Burning Clay Wares. Ellis Lovejoy. Clay Worker, vol. 70, no. 1, July 1918, pp. 32-82. Deals with updraft kilns. (Continuation of serial.)

How to Proceed to Cut Burning Costs. J. K. Moore. Brick and Clay Rec., vol. 53, no. 3, July 30, 1918, pp. 207-212, 4 figs. Suggestions to improve the system of burning in an average-size clay plant equipped with round down-draft kilns.

BRIDGES

Arched Steel Cantilevers Used in Park Avenue Viaduct. Harry W. Levy. Eng. News-Rec., vol. 81, no. 2, July 11, 1918, pp. 81-83, 5 figs. Details of viaduct at Grand Central Terminal, New York.

Foundations, Forms and Concrete Distribution Mark Bridge Construction. Edward W. Stearns. Eng. News-Rec., vol. 81, no. 2, July 11, 1918, pp. 68-72, 9 figs. Describes combination unit wood and steel forms and steel arch centers that were used many times.

BUILDING AND CONSTRUCTION

Concrete Houses

Edison House Idea Outdone. Concrete, vol. 13, no. 2, August 1918, pp. 42-46, 15 figs. Layout of 40-house group being built by Ingersoll system, near Elizabeth, N. J.

Interior Construction of the Concrete Industrial House. M. D. Morrill. Contract Rec. & Eng. Rev., vol. 32, no. 30, July 24, 1918, pp. 587-588. Review of the different interior constructions used and suggestions regarding their respective adaptability to various purposes.

Methods of Constructing Concrete Houses. K. H. Talbot. Contract Rec. & Eng. Rev., vol. 32, no. 30, July 24, 1918, pp. 581-584. Résumé of types of forms used in solving the house problem.

Report of American Concrete Institute Committee on Industrial Houses. Eng. & Cement World, vol. 13, no. 2, July 15, 1918, pp. 19-20.

Ten Fireproof Houses of Field and Precast Concrete. Concrete, vol. 13, no. 2, August 1918, pp. 69-71, 12 figs. Description of ten 6-room fireproof dwellings being completed at Ransford, Pa., for the Lehigh Coal & Navigation Co., by the Simpsoncraft system of construction.

Concrete Stairs

Concrete Stairs. A. M. Wolf. Concrete, vol. 13, no. 2, August 1918, pp. 58-60, 8 figs. Designs and design methods.

Earth Pressures

Earth Pressures. Leo Hudson. Can. Engr., vol. 35, no. 3, July 18, 1918, pp. 61-64. Summary of the theories on the subject. Abstract from Trans. Am. Soc. of Municipal Improvements.

Military Buildings

Semi-Military Buildings in the National Army Cantonments. Robert H. Moulton. Architectural Rec., vol. 44, no. 1, July 1918, pp. 21-30. Arrangement and interiors of camp buildings.

Pile Driving

World's Record for Pile Driving. Eng. & Contracting, vol. 50, no. 3, July 17, 1918, p. 58. 220 65-ft. piles put down by 11 men in 9 hr. 5 min.

Sandstone

Sawing and Working Sandstone. Stone, vol. 39, no. 7, July 1918, pp. 324-326. Considerations governing the design and construction of a finishing plant in the vicinity of a quarry.

Shipyards

Hog Island's Ship-Erection Equipment: Four Hundred Tower Derricks for Fifty Ways. Eng. News-Rec., vol. 81, no. 2, July 11, 1918, pp. 77-80, 7 figs. Description of prominent features and details.

How Ship and Housing Work Is Organized and Operated. Eng. News-Rec., vol. 81, no. 3, July 18, 1918, pp. 122-124.

Survey of Sites

Surveying for Housing Projects. Mun. Jl., vol. 45, no. 2, July 13, 1918, pp. 28-29. Instructions by Bureau of Industrial Housing and Transportation for making topographical survey and maps of sites for housing developments.

Wood Mill Buildings

Wood in the Construction of Mill Buildings. W. Kynoch and R. J. Blair. Can. Engr., vol. 35, no. 5, August 1, 1918, pp. 95-96, 2 figs. Corrosive sublimate suggested as preservative where conditions are favorable to growth of fungi.

CEMENT AND CONCRETE

Concrete-Making Plants

Cedar Hollow, Pa., Plant of Charles Warner Co. Concrete (Cement Mill Section), vol. 13, no. 2, August 1918, pp. 13-15, 9 figs. Rotary kiln for lime burning and method of handling the hydrating process.

Gravel Plant of Tarco Construction Co., Cincinnati. Concrete (Cement Mill Section), vol. 13, no. 2, August 1918, pp. 11-12, 2 figs. Arrangement and equipment of the plant.

Concrete Mixes

Effects of Grading of Sand and Consistency of Mix Upon the Strength of Concrete. Llewellyn N. Edwards. Can. Engr., vol. 35, no. 3, July 18, 1918, pp. 49-52, 9 figs. Supplement to the writer's reports of his tests published in the issues of Aug. 16, 23 and 30, and Sept. 6, 1917.

Effect of Time of Mixing on the Strength of Concrete. Duff A. Abrams. Can. Engr., vol. 35, nos. 4 and 5, July 25, 1918, pp. 73-78, 3 figs.; Series of tests on machine-mixed materials; August 1, pp. 103-115, 48 figs.; Tests, diagrams and tables of data obtained from experimental tests. Paper read before Am. Concrete Inst. (To be concluded.)

Method of Proportioning Concrete-Mixtures Based on the Surface-Areas of the Aggregates. L. N. Edwards. Western Eng., vol. 9, no. 8, August 1918, pp. 308-309, 5 figs. Series of experiments and theory advanced by writer that the proportion of cement in a given mortar or concrete mixture should depend upon the surface-area of the aggregates.

Slag as an Aggregate for Concrete Ships. Curtis C. Meyers. Iron Age, vol. 102, no. 3, July 18, 1918, pp. 152-154, 4 figs. Slag concrete claimed to be superior to crushed stone or pebble concretes.

The Basic Principle of Concrete Mixes and the Truly Fundamental Role Played by Water. Duff A. Abrams. Eng. & Contracting, vol. 50, no. 4, July 24, 1918, pp. 77-78. Experimental research concerning the effect of water on the strength and other properties of concrete.

The Basic Principle of Concrete Mixes. Duff A. Abrams. Min. & Sci. Press, vol. 117, no. 1, July 6, 1918, pp. 23-24, 1 fig. The effect of water in concrete.

Water and Its Influence on Concrete Mixing. Building News, vol. 115, no. 3314, July 10, 1918, p. 30, 1 fig. Series of tests carried out in the Structural Materials Research Laboratory of the Lewis Institute, Chicago.

Finishes

Problems in Devising a New Finish for Concrete. J. J. Earley. Eng. & Cement World, vol. 13, no. 3, August 1, 1918, pp. 30-32. Abstract of a paper before the Am. Concrete Inst.

Form Work

Efficiency Methods in Form Work. A. B. McDaniel. Concrete, vol. 13, no. 2, August 1918, pp. 61-64, 4 figs. Make-up of forms; erection of forms; wrecking; cost of work.

See also Coal Industry (Mine Concreting); Roads and Pavements (Concrete Pavements).

CHEMICAL TECHNOLOGY

Ammonium Sulphate from Gas Works

Alkali Works Chief Inspector's Report. Gas Jl., vol. 143, no. 2878, July 9, 1918, pp. 62-63. Consideration of the direct process of sulphate of ammonia manufacture in gas works.

Estimation of Polysulphide. W. S. Curphey. Gas Jl., vol. 143, no. 2878, July 9, 1918, p. 69. From author's 1917 annual report as chief alkali inspector.

The Direct Process of Sulphate Making in Gas Works. W. S. Curphey. Gas Jl., vol. 143, no. 2878, July 9, 1918, pp. 68-69. From author's 1915 and 1916 annual reports as chief alkali inspector. (To be continued.)

Analysis

A Standard Apparatus for the Determination of Sulfur in Iron and Steel by the Evolution Method. H. B. Pulsifer. Jl. Indus. & Eng. Chem., vol. 10, no. 7, July 1, 1918, pp. 545-550, 3 figs. Description of the apparatus for determinations by the evolution method using concentrated HCl.

Iodide Copper Method with Sodium Fluoride. A. L. Reese. Eng. & Min. Jl., vol. 105, no. 26, June 29, 1918, p. 1170. Details of a process of determining copper by the iodide process in which the interference of ferric salts is prevented by the addition of sodium fluoride.

Rapid Determination of Carbon in Steel by the Barium Carbonate Titration Method. J. R. Cain and L. C. Maxwell. Jl. Indus. & Eng. Chem., vol. 10, no. 7, July 1, 1918, pp. 520-522. Method developed by Bureau of Standards for use where speed is important.

The Perchlorate Method for the Determination of the Alkali Metals. F. A. Gooch and G. R. Blake. Chem. News, vol. 117, no. 3048, May 24, 1918, pp. 196-198. Desirability of including potassium within the scope of the investigation of the perchlorate precipitation of rubidium and caesium.

Nitrogen Compounds

Nitrogen and Its Compounds. Horace Freeman. Chem. News, vol. 117, nos. 3049 and 3051, June 7, 1918, pp. 205-207. Early attempts to utilize atmospheric nitrogen; discovery of cyanamide; development of the arc process; the Haber process; establishment of the cyanide process in America; July 5, 1918, pp. 231-233. Manufacture of cyanamide and uses of its derivatives. Address before Board of Trade of Niagara Falls, Ont. From the Can. Chem. Jl.

The Formation of Nitrites from Nitrates in Aqueous Solution by the Action of Sunlight, and the Assimilation of the Nitrites by Green Leaves in Sunlight. Benjamin Moore. Proc. Royal Soc., vol. 90, no. B627, June 1, 1918, pp. 158-167. Report of experimental work and compilation of thermochemical determinations.

Potash Recovery

Recovery of Potash. Eng. & Cement World, vol. 13, no. 2, July 15, 1918, p. 68. Chemical and commercial methods for recovering potash from silicates.

Tanning

The Chrome-Tanning Industry. Chem. News, vol. 117, no. 3051, July 5, 1918, pp. 233-235. Processes and reputed advantages.

CLAY

(See Brick and Clay)

COAL INDUSTRY

Coke and By-Products

Coke-Oven By-products in 1917. Colliery Guardian, vol. 116, no. 3002, July 12, 1918, pp. 69-70. Report made under the Alkali Works Act.

Development of the Coke Industry in Colorado, Utah and New Mexico. F. C. Miller. Trans. Am. Inst. Min. Engrs., no. 140, August 1918, pp. 1307-1310.

Recovery of By-products in Coke Manufacture. M. Meredith. Coal Age, vol. 14, no. 2, July 13, 1918, pp. 60-62. Increased use of by-product ovens in Britain; the by-products recovered.

Loading and Handling

An Unloading Tower and Reloading Plant. J. O. Durkee. Coal Industry, vol. 2, no. 8, August 1918, pp. 299-302, 4 figs. Unloading, screening, storing and loading coal at the Island Creek Coal Co.'s plant on the Ohio river at Sekitan.

Marcus Screens at Plants of Carnegie Coal Co., Pennsylvania. Richard G. Miller. Coal Age, vol. 14, no. 4, July 25, 1918, pp. 171-174, 7 figs. Description of coal-cleaning plants.

Mine Concreting

Concrete Foundations, Drift Linings and Reservoirs. J. F. Springer. Coal Age, vol. 14, no. 5, August 1, 1918, pp. 204-210, 8 figs. Suggestions for the use of concrete in and around mines.

Mine Conveying

A Suggestion for Increasing Coal Production. H. D. Levin. Coal Age, vol. 14, no. 3, July 20, 1918, pp. 104-105, 3 figs. Use of light, easily portable loading conveyors suggested.

Mining

A Successful Labor-Saving Machine. N. L. Harmon. Coal Industry, vol. 2, no. 8, August 1918, pp. 290-292, 2 figs. Automatic safety mine-car cages and feeder built by an Ohio concern.

Coal Mining in British Columbia. R. Dunn. Coal Age, vol. 14, no. 2, July 13, 1918, pp. 55-57. New development hampered by cost of material and lack of men. Sales statistics for 1916 and 1917.

Electric Labor-Saving Devices in Coal Mining. Graham Bright. Coal Age, vol. 14, no. 3, July 20, 1918, pp. 116-120, 13 figs.

How Electrical Methods are Speeding Up Coal Mining Operations. Elec. Rec., vol. 24, no. 2, August 1918, pp. 21-23. Details of electrical haulage methods and equipment now used in different mines in Western Pennsylvania and Ohio.

Improvements in Coal Mining Methods. H. H. Stoek. Coal Industry, vol. 2, no. 8, August 1918, pp. 286-289, 5 figs. Suggestions regarding the method of underground mining considering the roof, floor and inclination of seam.

Increased Coal Output by Stripping. A. C. Vicary. Coal Age, vol. 14, no. 3, July 20, 1918, pp. 94-96, 4 figs. Advocates use of this method wherever possible.

Model Safety-First Coal Mine in Central Illinois. Coal Age, vol. 14, no. 1, July 6, 1918, pp. 4-10, 10 figs. Features of the Madison Coal Corporation's mine.

Some of the Coal Producer's Problems. D. H. McDougall. Can. Min. Jl., vol. 39, no. 11, June 1, 1918, pp. 183-184. Presidential address before the Mining Society of Nova Scotia.

The Eastern Middle-Anthracite Field. E. B. Wilson. Coal Industry, vol. 2, no. 8, August 1918, pp. 292-294, 4 figs. Third of a series on practical geology, describing and giving thickness, area and level of the measures of the eastern middle Pennsylvania anthracite coal field.

Working a Thin Seam by Coal Cutters and Face Conveyors. S. T. Boam. Iron & Coal Trades Rev., vol. 97, no. 2627, July 5, 1918, pp. 12-13, 2 figs. From a paper before the South Midland Branch of the Nat. Assn. of Colliery Managers.

Trip Feeders

Trip Feeders. C. L. Miller. Coal Industry, vol. 2, no. 8, August 1918, pp. 307-308, 3 figs. Formulae, curves, data and drawings for trip-feeder design.

Washing

The Emergency and Clean Coal. G. H. Elmore. Coal Age, vol. 14, no. 3, July 20, 1918, pp. 122-126, 8 figs. Suggests more modern coal washeries.

See also Fuels and Firing (Coke).

CONVEYING

(See Hoisting and Conveying)

COOLING

Cooling of Condenser Water by Towers and Spraying. E. W. Marriott. Indus. Australian & Min. Standard, vol. 59, no. 1544, June 13, 1918, pp. 621-622, 6 figs.

DRYDOCKS

Construction of Pearl Harbor Drydock Completed. Eng. News-Rec., vol. 81, no. 4, July 25, 1918, pp. 173-177, 7 figs. Novel method of placing unit sections of concrete base and walls from floating drydock and building upper works in movable cofferdams.

EARTHWORK

Excavations

Blasting Methods at Ajo. S. U. Champe. Min. & Sci. Press, vol. 117, no. 2, July 13, 1918, pp. 46-48, 6 figs. Description of ore excavation methods.

Blasting Methods at Ajo. S. U. Champe. Western Eng., vol. 9, no. 8, August 1918, pp. 326-328, 6 figs. Methods of preparing the ground to receive the charges for blasting employed in the copper mountain deposit at Ajo, Ariz., belonging to the New Cornelia Copper Co.

The Tailing Excavator at the Plant of the New Cornelia Copper Co., Ajo., Ariz. F. Moeller. Tran. Am. Inst. Min. Engrs., no. 140, August 1918, pp. 1229-1234, 6 figs. Extension of the use for which the mechanical unloader was first designed.

Levee Construction

Levee Construction in North Texas with Draglines. O. W. Finley. Eng. & Contracting, vol. 50, no. 3, July 17, 1918, pp. 65-66. A description of reclamation work with cost figures and present values.

ELECTRICAL ENGINEERING

Alternating-Current Engineering

Characteristic Curves and Conditions of Stability of an Operating System. (Sur les courbes caractéristiques et les conditions de stabilité des régimes). J. Bethenod. Revue Générale de l'Electricité, vol. 4, no. 2, July 13, 1918, pp. 35-36, 1 fig. Study of a particular case of spontaneous inception of oscillatory phenomena.

Batteries

Dry Cells and Wet Batteries. William J. Herdman. Electricity, vol. 32, no. 1443, July 5, 1918, p. 355. Care of Lalande Cells. (Continued.)

Eddy Currents

On Copper and Iron Losses in Alternating Current Machine with Deep Slots (in Japanese). T. Isshiki. Denki Gakkwai Zasshi, no. 358, May 31, 1918.

Hysteresis Losses in Iron (Remarque sur les pertes dans le fer par hystérésis). M. Latour. Revue Générale de l'Electricité, vol. 4, no. 2, July 13, 1918, pp. 36-37. Determination of the relation between the hysteresis angle τ and the Steinmetz coefficient η. Remarks on a similar study by the same writer published in the issue of April 13, 1918.

Electric Furnace

The Manufacture of Ferro-Alloys in the Electric Furnace. R. M. Keeney. Tran. Am. Inst. Min. Engrs., no. 140, August 1918, pp. 1321-1373. Processes followed in the manufacture of ferrochrome, ferromanganese, ferromolybdenum, ferrotungsten, ferrovanadium and ferrouranium.

Electrodeposition of Metals

The Deposition of Nickel Upon Cast Iron from a Hot Electrolyte. Royal F. Clark. Metal Industry, vol. 16, no. 7, July 1918, p. 309. From a paper before the Electro-Platers Society, July 1918.

The Maintenance of High Ampere Efficiency in Electrolytic Copper Refining. M. H. Merriss and M. A. Mosher. Eng. & Min. Jl., vol. 106, no. 3, July 29, 1918, pp. 95-99, 8 figs. Practical notes on methods to secure high ampere efficiency, details as to correct method of hanging and controlling sheets; use of volt-meter to detect short-circuits and bad contacts.

Electrolysis

Electrolysis Mitigation. Scientific Am. Supp., vol. 86, nos. 2220 and 2221, July 20, 1918, pp. 46-47; Discussion of causes and methods of regulating electrolytic conditions of underground structures; July 27, p. 58; Essentials in electrolysis regulations.

Generators

Rewinding and Reconnecting Direct Current Armature Windings for a Change in Voltage. T. Schutter. Elec. Eng., vol. 52, no. 1, July 1918, pp. 45-48, 5 figs. Describes practical methods.

Heating

Electrically Heated Devices. Elec. Rec., vol. 24, no. 2, August 1918, pp. 82k-82r. Tables giving trade name, size or capacity, wattage, number of heat-units, cost to operate, voltage and retail price of electrically heated devices.

High-Frequency Currents

On the Discharge Between Metallic Electrodes and Continuous Electric Oscillations. H. Yagi. Jl. of the College of Engineering, Tokyo Imp. Univ., vol. 9, no. 4, February 28, 1918, pp. 115-152, 27 figs. Experiments on discharges in air and in coal gas; oscillations; Wien's quenched spark gaps; secondary oscillation; fluctuation of the secondary current.

Radiotelegraphy. G. E. Mitchell. Scientific Am. Supp., vol. 86, no. 2223, August 10, 1918, pp. 88-90. Uses and possibilities of radiotelegraphy in the war.

Wave Velocity and Capacity of Horizontal Helices in Wireless Telegraphy and Transmission Line Protective Apparatus. A. Press. Elecn., vol. 81, no. 6, June 7, 1918, pp. 106-107. A mathematical treatment.

High-Tension D. C. Current

Very High Tension Direct Current for Laboratory Use (La production du courant continu à très haute tension pour laboratoire d'essai). Jean Saroléa. Revue Générale de l'Electricité, vol. 4, no. 1, July 6, 1918, pp. 4-8, 3 figs. Description of apparatus to obtain very high-tension continuous currents in a laboratory by means of Fleming valves.

Insulators

Extra-High-Tension Insulators (in Japanese). H. Tachikawa. Denki Gakkwai Zasshi, no. 359, June 30, 1918. Paper read before the meeting of Tokyo Local Section. (Continued.)

Lamps

Management of Lamp Works. T. Nakagawn (in Japanese). Denki Gakkwai Zasshi, no. 354, January 1918, pp. 97-105.

Proposed Standardization of the Thread of Edison Base Lamps (Projet d'unification des filetages des culots de lampes à vis Edison). Ch. Zetter. Revue Générale de l'Electricité, vol. 4, nos. 1-4, July 6-27, 1918, pp. 9-21, 39-49, 73-84, 105-112, 10 figs. Comparative notes on work done by the Commission of the Union of Syndicates of Electricity with reference to the standardization of small electrical appliances.

Lightning Arrester

New Type of Lightning Arrester Makes Its Appearance. Elec. Ry. Jl., vol. 52, no. 3, July 20, 1918, pp. 101-102, 4 figs. The "oxide film" arrester has general properties of the aluminum cell arrester with additional features.

Magnetism

Hypothetical Theory on Magnetization of Magnetic Substances (in Japanese). T. Takeuchi. Denki Gakkwai Zasshi, no. 358, May 31, 1918.

Magnetic Susceptibility and Electric Resistivity. F. H. Loring. Chem. News, vol. 117, no. 3051, July 5, 1918, pp. 229-231, 4 figs. Additional notes to a previous general paper on magnetic susceptibility.

Motors

Indirect Construction of the Precise Diagram for Rotating Field Motors. (Construction indirecte du diagramme rigoureux des moteurs à champ tournant). V. Genkin. Revue Générale de l'Electricité, vol. 3, no. 26, June 29, 1918, pp. 931-933, 4 figs. Graphical construction of the cyclic diagram of a rotating field motor, taking into consideration the resistance of the stator.

On the Sub-Synchronous Speed of Squirrel-Cage Induction Motors (in Japanese). L. Takeshi. Denki Gakkwai Zasshi, no. 356, March 31, 1918.

Precipitators

Electrical Precipitation from Flue Gas. Iron Age, vol. 102, no. 5, August 1, 1918, p. 273, 3 figs. High-voltage direct current passed through chains hanging in flue from a copper refinery electrifies metallic particles, projecting them against grounded wall where they drop into hoppers.

New Electrical Precipitation Treater (in Japanese). M. Shibusawa. Denki Gakkwai Zasshi, no. 354, January 1918, pp. 61-87.

Resistance and Light

Substances of Variable Resistance Under the Action of Light (Corps à résistivité variable sous l'action de la lumière). M. Case. Revue Générale de l'Electricité, vol. 3, no. 25, June 22, 1918, p. 889. Process employed to find other substances than selenium of variable resistance under the action of light; results obtained.

Roentgen Rays

Discussion on Recent Development of Roentgen Radiation (in Japanese). Denki Gakkwai Zasshi, no. 355, February 1918, pp. 167-171.

Rotary Converters

Starting Rotary Converter. F. D. Newbury and M. W. Smith. Power Plant Eng., vol. 22, no. 12, June 15, 1918, pp. 499-500, 2 figs. Comparison of results with transformer secondaries connected to collector rings and when alternating-current circuit is open.

Starting Rotary Converters. W. R. Bowker. Elec. Eng., vol. 52, no. 1, July 1918, pp. 40-42, 10 figs. Analysis of the problem and exposition of present methods used to solve it.

Storage Battery

Developments in the Use of Storage Batteries. G. F. Wakeman. Jl. of Elec., vol. 41, no. 3, August 1, 1918, pp. 120-121. Some of the present applications and future possibilities.

Switchgear

Automatic Control of Electric Heaters, Valves and Similar Apparatus. G. E. Palmer. Electricity, vol. 32, no. 1442, June 28, 1918, pp. 341-342, 2 figs. Diagrams of switch connections for automatic control of electric heaters, valves, etc.

Some Considerations Relating to Large Power Station Switchgear. H. W. Clothier. Elecn., vol. 81, no. 9, June 28, 1918, pp. 175-179, 11 figs. Deals particularly with oil switches for large outputs. Controlling factors in design. Drawings of a form of switchgear in successful operation and suitable for use in a station of 60,000 kw.

Three- and Four-Way Switch Circuits. Terrell Croft. Elec. Eng., vol. 52, no. 1, July 1918, pp. 19-21. Diagrams and explanations of the wiring connections for several three- and four-way circuits. (To be continued.)

Telephones

Leeds Automatic Exchange. J. Hedley. Elecn., vol. 81, no. 5, May 31, 1918, pp. 84-87, 6 figs. Description of a new telephone exchange of the full automatic Strowger type, five-figure system.

New Private Branch Exchange Switchboard of Bell System (in Japanese). S. Osada. Denki Gakkwai Zasshi, no. 357, April 30, 1918.

Transformers

Discussion on Resonance Phenomena in High Voltage Transformers (in Japanese). H. Yagi. Denki Gakkwai Zasshi, no. 354, January 1918, pp. 131-135.

Higher Harmonics in the Magnetizing Current of a Single Phase Transformer (in Japanese). K. Takamoto. Denki Gakkwai Zasshi, no. 355, February 1918, pp. 171-191.

Outdoor Water-Cooled Transformers. R. von Fabrice. Power, vol. 48, no. 6, August 6, 1918, pp. 198-199, 1 fig. Necessary equipment to handle oil and to furnish a suitable cooling-water supply for outdoor water-cooled oil-insulated transformers.

Resonance Phenomena in High Voltage Transformers (in Japanese). K. Nishi. Denki Gakkwai Zasshi, no. 358, May 31, 1918. (Continued.)

Transmission Lines

Air Break Switches and Auxiliary Equipment for Outdoor Substations. Elec. Rec., vol. 24, no. 2, August 1918, pp. 42-51. Diagrams and illustrations of present types.

Characteristics of Iron and Steel Conductors. Charles E. Oakes and P. A. B. Sahm. Elec. World, vol. 72, no. 4, July 27, 1918, pp. 150-151. Complete test data for calculation of electrical characteristics of iron and steel conductors.

Charging Currents and Earthing Devices in Transmission Lines. H. Behrend. Elecn., vol. 81, no. 11, July 12, 1918, pp. 222-223, 3 figs. Abstract of an article in the Elektrotechnische Zeitschrift, no. 25, 1917.

Computation of Inductive Circuits in Parallel (Calcul des circuit inductifs en dérivation). H. Pécheux. Revue Générale de l'Electricité, vol. 3, no. 25, June 22, 1918, pp. 891-894, 5 figs. Attempt to show that it is possible to solve problems of technical electricity by means of vectors and projections without using imaginary quantities.

Connections of Subterranean High-Tension Cables (Juntas de los cables subterráneos a alta tensión). H. Aldum. Boletin de la Asociacion Argentina de Electro-Técnicos, vol. 4, no. 2, February 1918, pp. 639-645. Résumé of a conference before the Physics Institute of La Plata. (To be continued.)

Heating of Underground Cables (in Japanese). T. Yoneda. Denki Gakkwai Zasshi, no. 357, April 30, 1918.

On the Abacus for Calculating the Resistance of Parallel Conductors (Sur les abaques relatifs au calcul de la resistance des conducteurs associés en parallele). L. Zoretti and J. Bethenod. Revue Générale de l'Electricité, vol. 3, no. 26, June 29, 1918, pp. 933-934. Remarks on M. Custex's article on the resistance of parallel conductors published in issue of March 23.

On the Distribution of Potential Along the String of the Suspension Insulator (in Japanese). H. Sagusa. Denki Gakkwai Zasshi, no. 357, April 30, 1918.

Practical Study of Transmission Lines by Means of Hyperbolic Functions with Imaginary Variables (Calcul pratique des lignes de transmission électriques par les fonctions hyperboliques des variables imaginaires). G. Viard and M. Latour. Revue Générale de l'Electricité, vol. 4, no. 3, July 20, 1918, pp. 67-71, 3 figs. Review of the computations for transmission lines by means of hyperbolic functions with imaginary variable quantities; description of a graph which permits the determination of the tension and the current at any point in a transmission line, taking into consideration the resistance, inductance, capacity and losses of the line.

Providing Strength and Attractiveness in Special Overhead Supports. Charles R. Harte. Elec. Ry. Jl., vol. 52, no. 3, July 20, 1918, pp. 92-95, 12 figs. Discussion of various types of overhead bridges and other special structures.

Public Safety and High and Low Tension Overhead Transmission Systems (La seguridad pública y las lineas aéreas de alta y baja tension). F. Linderman. Boletin de la Asociacion Argentina de Electro-Técnicos vol. 4, no. 1, January 1918, pp. 617-621. Recommendations of several practices in the arrangement of transmission systems.

Sag Calculation for Iron Wire Lines. M. D. Leslie. Elec. World, vol. 72, no. 5, August 3, 1918, pp. 196-197, 1 fig. Stringing iron wire with less sag suggested as a practicable war-time economy where the usual safety factor is not essential and weather conditions are not severe. A formula to apply is given.

The Test Sheath Cable and Its Potentialities. C. J. Beaver. Elecn., vol. 81, no. 10, July 5, 1918, pp. 204-205, 3 figs. Description of a construction such that injurious effects from outside and leakage from inside the cable are bound to be interrupted by the test sheath conductor.

See also Foundry (Electric Furnace); Hydraulics (Hydroelectric Plants); Marine Engineering (Electric Propulsion); Metallurgy (Copper Refining); Motor-Car Engineering (Electric Vehicles); Physics (Electricity); Power Generation (Electric Power Applications).

ENGINEERING MATERIALS

Boiler Plates

A Cause of Failure in Boiler Plates. Walter Rosenhain and D. Hanson. Engineering, vol. 105, no. 2738, June 21, 1918, pp. 692-694, 8 figs. The failure of a boiler plate in the last stages of manufacture accounted for by the phenomena of grain growth in the steel. From a paper read before the Iron & Steel Inst.

Brass

Brass Weakness. James Scott. Metal Industry, vol. 16, no. 7, July 1918, pp. 319-320, 3 figs. A microscopical explanation.

Bronze

Manganese in Aluminum Bronze. Charles Vickers. Brass World, vol. 14, no. 7, July 1918, pp. 202-203, 2 figs. Effect of manganese in aluminum bronze; results of tests.

Cast Iron

Cast Iron at High Temperatures. Power, vol. 48, no. 4, July 23, 1918, pp. 120-121, 3 figs. Data from several sources, with curves.

Malleable Cast Iron. E. Turner. Page's Eng. Weekly, vol. 32, no. 720, June 28, 1918, pp. 304-306. Methods of producing malleable cast iron and theory of the malleableizing process. (To be continued.) Paper presented at a meeting of the West of Scotland Iron and Steel Institute.

Glass

Strength of Circular Flat Plate of Glass. W. Richards. Mechanical World, vol. 63, no. 1637, May 17, 1918, p. 235, 1 fig. Account of the testing of a piece of ordinary plate glass.

Non-Ferrous Alloys

The Hardness of Alloys of Non-Ferrous Metals. P. Ludwik. Brass World, vol. 14, no. 7, July 1918, p. 207. Compilation of experimental results.

Road Materials

Apparent Specific Gravity of Fine Non-Bituminous Highway Material. Good Roads, vol. 16, no. 6, pp. 48-52, 2 figs. Tentative tests proposed by Committee D-4 of the Am. Soc. of Testing Materials for sand, stone and slag screenings and similar materials.

Rubber

Vulcanization of Rubber by Selenium. Charles R. Boggs. Chem. News, vol. 117, no. 3048, May 24, 1918, pp. 199-200.

Tungsten

Raw Materials Necessary in the Electrical Industry: Tungsten (De quelques matières premières nécessaires à l'industrie électrique: le tungstène). D. Pector. Revue Générale de l'Electricité, vol. 4, no. 3, July 20, 1918, pp. 87-94. History and metallurgy of tungsten; principal deposits of its ore. (To be continued.)

Wire Rope

Splicing Wire Rope. Western Eng., vol. 9, no. 8, August 1918, pp. 313-314. Sketches explaining splicing in its different stages. Abstract from Leschen's "Hercules," March 1918.

The Factor of Safety of Wire Ropes. S. A. Mining Jl. & Eng. Rec., vol. 27, no. 1393, June 8, 1918, pp. 146-147. Discussion of a previous paper giving empirical values for the factor of safety of wire ropes used for winding in mine shafts. (To be continued.)

Wood

Relative Resistance of Various Hardwoods to Injection with Creosote. Ry. Rev., vol. 63, no. 3, July 20, 1918, pp. 79-86, 12 figs. From Bul. 606, U. S. Dept. of Agriculture by Clyde H. Teesdale and J. D. McLean.

See also Aeronautics (Materials of Construction); Building and Construction (Sandstone; Cement and Concrete; Fuels and Firing (Soot Cleaners); Refractories; Roads and Pavements (Road Materials); Steel and Iron (Vina Steel).

FACTORY MANAGEMENT

Non-Repetitive Work

Managing Non-Repetitive Work. Norman Howard. Indus. Man., vol. 56, no. 1, July 1918, pp. 55-58. How conditions and operations can be standardized for tool-making and machine-shop repairs.

Shifts

Changing Power Plant Shifts. J. C. Hawkins. Power, vol. 48, no. 6, August 6, 1918, pp. 202-203, 1 fig. How a schedule of change of watches was arranged in a plant employing three shifts, each working 8 hr. each.

Shop Management

Working Out a Theory in Shop Management. Am. Mach., vol. 49, no. 4, July 25, 1918, pp. 145-147. The method of the White Motor Co. in running the shop on commission and giving the men a direct voice in the management.

Workmanship as an Efficiency Aim. C. W. Starker. Indus. Man., vol. 56, no. 1, July 1918, pp. 25-26. Points out the danger of sacrificing workmanship for money-making instinct and quantity output in the wrong application of efficiency schemes.

Special Work

Money-Saving Factors in the Maintenance of Special Work. R. C. Cram. Elec. Ry. Jl., vol. 52, no. 3, July 20, 1918, pp. 103-108, 11 figs. Necessity of intelligent selection of special work, careful workmanship in installation and accurate records of performance and prompt attention to repairs.

FOUNDRY

Brass Furnace

The Care of the Brass Furnace. J. A. Fletcher, Jr. Metal Industry, vol. 16, no. 7, July 1918, p. 310, 1 fig. The experience of a large foundry with high-melting-point metals.

Castings

Electric v. Converter Castings. C. R. Messenger. Page's Eng. Weekly, vol. 33, no. 722, July 12, 1918, p. 17. Figures and facts based on 2029 tests with an electric, and 2436 with a converter, furnace. From a paper read before the Am. Foundry Men's Assn.

Manufacturing Heavy Malleable Iron Castings. A. Walter Lorenz. Foundry, vol. 46, no. 312, August 1918, pp. 350-351, 2 micrographs.

Cupola

Advantages Offered by the Oil-Fired Cupola. W. S. Dickson. Foundry, vol. 46, no. 312, August 1918, pp. 381-382, 2 figs. In the process described, crude oil is sprayed directly onto the coke bed to increase the heat and reduce the amount of coke used.

Electric Furnace

The Webb Electric Steel Furnace. Iron Age, vol. 102, no. 5, August 1, 1918, pp. 257-260, 4 figs. A high-voltage unit developed and operated by the Old Dominion Iron & Steel Corporation; low-carbon steel for engine bolts.

Grinding

The Economical Foundry Use of Grinding Wheels. W. T. Montague. Foundry, vol. 46, no. 312, August 1918, pp. 362-367, 8 figs. What wheels to use and how they should be operated to obtain the best results in casting work; safety factors. Paper read at the Metals division of the Am. Inst. of Min. Engrs.

Molding

Why the Inclined Mold is a Fallacy. R. R. Clarke. Foundry, vol. 46, no. 312, August 1918, pp. 351-352.

Patternmaking

Emergency Patterns for a Seven-Foot Gear. J. L. Gard. Foundry, vol. 46, no. 312, August 1918, p. 361, 2 figs.

Making a Pattern for a Gas Engine Cylinder. Frank B. Raebig. Foundry, vol. 46, no. 312, August 1918, pp. 383-385, 14 figs. Construction of core boxes also described, as well as two methods of molding (with necessary pattern changes).

Patternmaking and Molding Cast Tooth Gears. Jabez Nall. Foundry, vol. 46, no. 312, August 1918, pp. 377-380, 9 figs. Practice of a generation ago contrasted with that of today and a gear-molding machine discussed.

Sand Blast

The Sand Blast in the Foundry. H. L. Wadsworth. Brass World, vol. 14, no. 6,

June 1918, pp. 174-175. Two classes of sand blasting; rotary table machines; kinds of abrasives; suggestions as to compressors. From a paper read before the Am. Foundrymen's Assn.

Welding

Welding Propellers in Panama Canal Foundry. John H. Moffett. Foundry, vol. 46, no. 312, August 1918, pp. 356-358, 6 figs. How blades are repaired by burning-on, with a comparison of costs with autogenous processes; making the molds and pouring the metal.

FORGING

Electric Power

The Electrical System of the Forge Shop. Edward McLlvried. Am. Drop Forger, vol. 4, no. 7, July 1918, pp. 271-272, 1 fig. Applications of electric power and discussion of two methods of driving machinery.

Electric Steel

Electric Steel for the Forging Industry. Arthur V. Farr. Am. Drop Forger, vol. 4, no. 7, July 1918, pp. 264-267, 6 figs. Two methods of manufacturing electric steel.

Forge-Shop Design

The Problem of Forge Shop Design. J. T. N. Hoyt. Am. Drop Forger, vol. 4, no. 7, July 1918, pp. 262-263, 3 figs. Typical examples of forge-shop designs and detailed descriptions of construction.

Hollow Forgings

Development of Flaws in Hollow Forgings. A. S. Hesse. Am. Mach., vol. 49, no. 4, July 25, 1918, pp. 153-154, 3 figs. Improper methods of forging which develop flaws in hollow forgings such as gun tubes. Proper remedies suggested.

Quenching Oils

Question of Quenching Oils for Forgings. George W. Pressell. Am. Drop Forger, vol. 4, no. 7, July 1918, pp. 273-277, 6 figs. Report of experiments showing values of different substances in quenching steel.

FUELS AND FIRING

Chimneys

Tall Chimneys in Metallurgical Plants. Eng. & Min. Jl., vol. 106, no. 4, July 27, 1918, pp. 168-171, 13 figs. List of world's tallest chimneys in metallurgical plants.

Coal

Coal—Its Origin and Composition. H. B. Miller. Queensland Government Min. Jl., vol. 19, no. 217, June 15, 1918, pp. 263-265. Length of time to form 1 ft. of peat, interval between coal beds, data on sulphur in coal and calorific value of coal.

Coal Analysis

Analysis of Canadian Fuels. (In five parts.) Bulletins 22-26, Canada Department of Mines, Mines Branch. Tables giving the composition, condition and value of samples from each one of the areas in the coal districts of Canada.

Determination of Volatile Matter and Ash in Coal. Norton H. Humphrys. Gas World, vol. 68, no 1771, June 29, 1918, pp. 436-437. Proposed device and procedure.

Coal Evaluation

An Alinement Chart for the Evaluation of Coal. A. F. Blake. Jl. Indus. & Eng. Chem., vol. 10, no. 8, August 1, 1918, pp. 627-629, 1 fig. Chart for determining the relative values of different coals, given the price per ton and the chemical analysis.

Coal Selection

Coal and Its Selection—A Factor in Power Plant Management. R. June. Concrete (Cement Mill Section), vol. 13, no. 2, August 1918, pp. 16-19, 4 figs. Classification of coals; question of size; influence of moisture; ash problem; heating value; purchase of coal under specifications.

Coal Storage

Detailed Facts About Storing Soft Coal. H. H. Stoek. The Black Diamond, vol. 61, no. 3, July 20, 1918, pp. 48-49, 4 figs. Suggestions for obviating the difficulties and dangers in storing soft coal. (Concluded.)

Storing Coal at Mooseheart, Illinois. Power, vol. 48, no. 3, July 16, 1918, pp. 76-78, 2 figs. A flexible system of portable conveyors. Circular systems of piling. Estimated cost of storing and reclaiming 20 cents per ton.

Coke

Mechanical Condition of Blast Furnace Coke. G. D. Cochrane. Iron Age, vol. 102, no. 4, July 25, 1918, pp. 202-203, 1 fig. Machine for testing hardness; effect on coke consumption in blast furnaces; action of gases on hard and soft coke. From a paper read before the Iron & Steel Inst., London, May 1918.

Fuel Saving

Concrete Examples of Coal Conservation. H. E. Dart. The Locomotive, vol. 32, no. 2, April 1918, pp. 34-43, 2 figs. How the Hartford Steam Boiler Inspection and Insurance Co. has reduced the average coal consumption in its office building by about 25 per cent. (From the Hartford Courant.)

Fuel Saving in Power Plants. Railroad Herald, vol. 22, no. 8, July 1918, pp. 164-165. Fundamentals of the approved national plan of organization in connection with conservation of fuel in power plants throughout the United States.

Fuels. E. R. Knowles. Steam, vol. 22, no. 2, August 1918, pp. 35-41, 4 figs. Classification of fuels and study of their respective features.

Furnaces

Adapting Furnaces to Available Fuel. Osborn Monnett. Power Plant Eng., vol. 22, no. 13, July 1, 1918, pp. 524-526, 7 figs. Proportions and arrangements of baffles in hand-fired furnaces.

Natural Gas

Gasoline from Natural Gas by Compression. W. P. Dykema. Compressed Air Mag., vol. 23, no. 8, August 1918, pp. 8852-8854. Theory of precipitation; condensation by cooling; condensation by compression; absorption theory; use of combination compression and refrigeration process. (From Bureau of Mines Bul.)

The Compression Process for Extracting Natural Gas from Gasoline. W. P. Dykema. Western Eng., vol. 9, no. 8, August 1918, p. 310. Data compiled from Bul. No. 151, issued by the U. S. Bureau of Mines on the Recovery of Gasoline from Natural Gas by Compression and Refrigeration.

Oil Fuel

Supply of Oil Available from Shales. G. Egloff and J. C. Morrell. Oil and Gas Jl., vol. 17, no. 10, August 9, 1918, pp. 46-48. Chemical constitution of clays, shales and slates.

What Substitution of Oil for Coal Can do. Steam, vol. 22, no. 2, August 1918, pp. 47-49. Results obtained at different plants in New England with fuel oil, which is being supplied them on account of the scarcity of coal.

Peat

Distillation of Peat. R. Hauser. Colliery Guardian, vol. 116, no. 3002, July 12, 1918, p. 72. Results of experiments on peat.

Powdered Coal

Coal Conservation in Fact. C. R. Knowles. Elec. Rev., vol. 72, no. 26, June 29, 1918, pp. 1078-1079. Writer believes coal in gaseous and pulverized form must eventually replace lump for true conservation.

Control of Combustible and Air in Burning Powdered Coal. W. G. Wilcox. Compressed Air Mag., vol. 23, no. 8, August 1918, pp. 8839-8841. Effect of grinding coal on its fuel efficiency and study of the methods for mixing air and powdered coal. From a paper read before the Western New York section of the Am. Chem. Soc.

Mixer and Feeder for Powdered Coal. Compressed Air Mag., vol. 23, no. 8, August 1918, p. 8842. "Lopulco" powdered fuel mixing and feeding apparatus of the Locomotive Pulverized Fuel Co., New York.

The Possibilities of Powdered Coal. W. G. Wilcox. Scientific Am. Supp., vol. 86, no. 2221, July 27, 1918, pp. 62-64. Report of experiments. Paper delivered before the Western New York Section of the Am. Chem. Soc.

Use of Pulverized Coal at the Bunker Hill and Sullivan Smelting and Refining Plant. C. T. Rice. Eng. & Min. Jl., vol. 106, no. 3, July 20, 1918, pp. 91-94, 6 figs. Holbeck return system for the use of pulverized coal, with application to boilers, furnaces and kettles.

Smokeless Combustion

Combustion and Smokeless Furnaces. J. W. Hays. Steam, vol. 22, no. 2, August 1918, pp. 44-46. Laws governing combustion; exposition of the different heat theories; mechanical equivalent of heat. (To be continued.)

The Carbonization of Bituminous Coal. C. T. Malcolmson. Coal Industry, vol. 2, no. 8, August 1918, pp. 295-297. Account of process for the manufacture of smokeless fuel followed during the last three years at Irvington, N. J., in a series of experiments conducted for Blair & Co. of New York. Paper to be presented before the Am. Inst. Min. Engrs.

Soot Cleaners

Why Cast Iron Protects Soot Cleaner Elements against High Temperature. Popular Engr., vol. 10, no. 1, July 1918, pp. 23-26, 6 figs. Study and conclusions of the Vulcan Soot Cleaner Co. of Du Bois, Pa.

See also Brick and Clay; Railroad Engineering, Steam (Locomotive Fuel).

GAS POWER

See Internal-Combustion Engineering; Fuels and Firing (Natural Gas); Producer Gas.

GAS PRODUCERS

(See Producer Gas)

HEATING

Boilers

Some Failures of Cast-Iron Heating Boilers. E. Mason Parry. The Locomotive, vol. 32, no. 2, April 1918, pp. 43-49, 5 figs. Example demonstrating the author's claim that the failure of cast-iron sections of a cast-iron boiler is due in practically every case to the overheating of surfaces exposed directly to the products of combustion, through allowing the water level in the boiler to recede below that which has been predetermined by the designer.

Electric

Electric Heating in Manufacturing. Thomas Robson Hay. Indus. Management, vol. 56, no. 1, July 1918, pp. 53-55. Advantages of electric heating and practical points in installing and operating electric heating equipment.

Heating Systems

Fuel Saving Heating Systems. Alfred G. King. Domestic Eng., vol. 84, no. 4, July 27, 1918, pp. 146-150, 3 figs. Details of construction of an accelerated hot water heating system.

Reasons for Failures of Heating Systems. J. D. Hoffman. Heat. & Vent. Mag., vol. 15, no. 7, July 1918, pp. 13-18. Effect of poor building construction; space restrictions in warm-air furnace heating. From a paper before the Am. Soc. of Heat & Vent. Engrs., Buffalo, June 1918.

Returning Condensation in High and Low Pressure Heating Systems. C. L. Hubbard. Domestic Eng., vol. 84, no. 6, August 10, 1918, pp. 197-198, 4 figs. Notes on various methods of saving condensation in both high and low-pressure heating systems. (To be continued.)

Hot-Water Service

Hot Water Service. M. W. Ehrlich. Power Plant Eng., vol. 22, no. 12, June 15, 1918, pp. 489-491, 3 figs. Outlines methods for calculating heating surface required.

Steam

Dripping One-Pipe Steam Heating Systems. Albert L. Baum. Power, vol. 48, no. 6, August 6, 1918, pp. 194-195, 6 figs. Ways of obviating noises and rendering quick heating an easy matter.

Substations

The Heating of Substations. R. von Fabrice. Power, vol. 48, no. 4, July 23, 1918, pp. 129-130. Considers the heat losses from the electrical equipment and gives a practical illustration.

Temperature Control

Temperature Control in Modern Heating Systems. Charles L. Hubbard. Domestic Eng., vol. 84, no. 3, July 20, 1918, pp. 78-81, 22 figs. Notes on the installation and operation of temperature regulating devices and their value in connection with fuel conservation. (Continued.)

Workshops

Factory Heating. C. L. Hubbard. Steam, vol. 22, no. 2, August 1918, pp. 33-35. Computations for heat loss and steam requirements. (To be continued.)

Steam-Heating of Workshops. Mechanical World, vol. 63, no. 1637, May 17, 1918, pp. 236-237. Factors involved in the calculation of the size of heating apparatus necessary for a given building.

The Heating and Ventilation of Workshops. Engineer, vol. 126, no. 3262, July 5, 1918, pp. 4-5, 1 fig. Heating arrangements of a 927-ft. building.

See also Electrical Engineering (Heating).

HOISTING AND CONVEYING

Conveying Machinery

How to Move Materials by Machinery. Henry J. Edsall. Indus. Management, vol. 56, no. 1, July 1918, pp. 42-49, 22 figs. Application of various types of elevating and conveying machinery to the handling of coal, crushed stone, cement in bags, and packages and vegetables in a canning establishment, with a per hour capacity in each case.

Hoisting by Stages

Hoisting by Stages from Deep Mines. B. A. Balzari. Min. & Sci. Press, vol. 117, no. 2, July 13, 1918, pp. 57-58, 2 figs. Description of hoist at Argonaut mine, California.

Hoists

Practical Hints in Bucket-Elevator Operation. A. M. Nicholas. Queensland Government Mining Jl., vol. 19, no. 217, June 15, 1918, pp. 267-268. From a paper read before the Am. Inst. Min. Engrs.

The New Portland Municipal Elevator. Henry Blood. Eng. & Cement World, vol. 13, no. 3, August 1, 1918, pp. 19-22, 4 figs. Details of construction.

Loco Tractor

A New System of Transport. Engineer, vol. 125, no. 3261, June 28, 1918, pp. 550-552, 5 figs. Describes the Loco-Tractor, a special form of machine to replace the locomotive on pioneer light railways; guide trucks on rails with driving wheels rubber-tired run on prepared strips of road metal on each side of the track.

Steel Cables (Hoisting Ropes)

Hoisting with Steel Cables. E. Levy. Western Eng., vol. 9, no. 8, August 1918, p. 315. Causes of breakage of ropes and suggested directions to the master mechanic.

Hoisting with Steel Cables. Ernest Levy. Min. & Sci. Press, vol. 117, no. 1, July 6, 1918, p. 21. Reasons for breaking; directions to master mechanics for care of ropes; warnings to hoistmen.

Life and Care of Hoisting Ropes. Coal Age, vol. 14, no. 1, July 6, 1918, pp. 11-13. Suggestions as to the best rope; when to renew ropes; recutting and re-coning ropes to change point of recurring stress.

Winding Drums

The Strength of Winding Drums. John S. Watts. Power, vol. 48, no. 4, July 23, 1918, pp. 127-128, 1 fig. Mathematical calculations of the safe strength of a shell of a drum to carry more than one coil of rope, such as the drum of a hoisting or winding engine.

Winding Engines (Electric)

Electric Deliveries for the "Black Diamond." A. Jackson Marshall. Elec. Rev., vol. 73, no. 2, July 13, 1918, pp. 70-71, 2 figs. Data on comparative cost of electric, gasoline and horse delivery of coal.

Electric Winding Engines and Mine Hoists. H. H. Broughton. Elecn., vol. 81, no. 10, July 5, 1918, pp. 206-209, 2 figs. First of a series. Describes scope of work and gives notes of general interest on the question of power supply.

Motor-Driven Shaft-Hoist Installation. Coal Age, vol. 14, no. 2, July 13, 1918, pp. 50-54, 7 figs.

35-Ton Wagon Hoist at Acklam Works. Iron & Coal Trades Rev., vol. 97, no. 2629, July 19, 1918, p. 67, 3 figs. Description of an electrically driven hoist.

Wire Ropes

The Factor of Safety of Wire Ropes Used for Winding in Mine Shafts. J. A. Vaughn. Jl. of the South African Inst. of Engrs., vol. 16, no. 11, June 1918, pp. 196-200, 1 fig. Author's reply to discussion of his original article published in issue of November 1917.

See also Coal Industry (Mine Conveying); Engineering Materials (Wire Rope); Power Plants (Ash Conveyors).

HYDRAULICS

Lindsay Strathmore Irrigation Project. S. E. Kieffer. Eng & Cement World, vol. 13, no. 3, August 1, 1918, pp. 13-17. Special features in connection with lining of flume and canal with the cement gun on a large irrigation project.

Dams

Design of a Tilting Dam. V. B. Siems. Can. Engr., vol. 35, no. 4, July 25, 1918, pp. 79-81. Details of construction of the Loch Raven Tilting Dam built on the Gunpowder River, to increase the water supply of Baltimore, Md. From paper read before the Am. Water Works Assn.

Repair Washout Under Dam by Sheet Pile Cutoff Embedded in Concrete. Eng. News-Rec., vol. 81, no. 4, July 25, 1918, pp. 186-189, 2 figs.

Reservoir Dams. Engineering, vol. 105, no. 2738, June 21, 1918, pp. 687-689, 18 figs. A description of the geologic and engineering features of the Howden and Derwent dams of the Derwent Valley Waterworks.

Hydroelectric Plants

Automatic Hydro-Electric Generating Station. L. B. Bennett. Page's Eng. Weekly, vol. 33, no. 722, July 12, 1918, p. 18. Description of the automatic generating station recently put into operation by the Iowa Ry. & Light Co.

Construction Problems at Copco Plant. Elec. World, vol. 72, no. 5, August 3, 1918, pp. 201-202, 3 figs. Account of construction of an hydroelectric installation on the Klamath River, Oregon.

Electric Power for Mining in Yavapai County, Arizona. Eng. & Min. Jl., vol. 105, no. 25, June 22, 1918, pp. 1113-1116, 2 figs. Description of the Irving and Childs hydroelectric plants of the Arizona Power Co., having a fall of 1600 ft. and operating 250 miles of lines.

Hydroelectric Development in Iron Mountain Region. Elec. Rev., vol. 72, no. 25, June 22, 1918, pp. 1027-1028, 5 figs. Brief description of some developments in Michigan.

Modern Development of Large Hydro-Electric Power Schemes. C. Fred. Holmboe. Elecn., vol. 81, no. 8, June 21, 1918, pp. 142-147, 11 figs. The initial investigation of conditions; three cheap waterpower developments in detail.

Kutter's Formula

Algae Growths Increase Value of n in Kutter's Formula. Paul Taylor. Eng. News-Rec., vol. 81, no. 4, July 25, 1918, pp. 179-181, 6 figs. Studies made in 1912-16 in Tieton irrigation canal lined with reinforced-concrete lock indicate that growths raise n from 0.012 to 0.014.

Siphons

Mine Siphon Practice. Compressed Air Mag., vol. 23, no. 8, August 1918, pp. 8848-8849. Conditions to be observed in the installation and operation of mine siphons. (From Coal Age.)

Waterwheel Repairs

Utilize Dry Season to Overhaul Waterwheels. C. A. Graves. Elec. World, vol. 72, no. 5, August 3, 1918, p. 203, 3 figs.

See also Power Plants (Steam Hydro-electric Plant).

INTERNAL-COMBUSTION ENGINEERING

Cylinder Walls

Thickness of Cylinder Walls of Light Internal Combustion Engines. Akimasa Ono. Jl. of the Soc. M. E., Tokyo, vol. 21, no. 52, June 1918, pp. 21-34, 2 figs. Application of the general approximate theory of a thin cylindrical wall deformed symmetrically about the axis to the case of a cylinder wall partially subjected to internal pressure.

Diesel Engines

Tar Oil Fuel for Diesel Engines. Petroleum World, vol. 15, no. 213, June 1918, pp. 234-235. Report of The Heavy-Oil Engine Fuel Committee of the Diesel Engine Users' Assn., based on experimental comparisons of fuels. (Continued.)

The American Motorship "Oregon." Automotive Eng., vol. 3, no. 6, July 1918, pp. 266-270, 4 figs. Details of the construction of an American-built wooden ship equipped with two 650-hp. Diesel-type engines for main and auxiliary drives.

Werkspoor Marine Diesel Engines. Engineering, vol. 105, no. 2736, June 7, 1918, pp. 634-635, 7 figs. An illustrated description.

Heavy-Oil Engines

Rational Design for an Oil Engine. John F. Wentworth. Marine Rev., vol. 48, no. 8, August 1918, pp. 334-344, 8 figs. Study of the principles governing the selection of the different features in designing a marine oil engine and presentation of a design made according to the conclusions reached in the discussion.

The Heavy Oil Engine. Charles E. Lucke. Scientific Am. Supp., vol. 86, no. 2221, July 27, 1918, pp. 50-51. A review of the present construction and future development. Presented before the Engineers' Club of Philadelphia. (To be continued.)

The Heavy-Oil Engine from a Scientific Standpoint. Charles E. Lucke. Motorship, vol. 3, no. 8, August 1918, p. 24. (Concluded.)

Hvid Engine

Possibilities of the Hvid Engine. E. B. Blakely. Motorship, vol. 3, no. 8, August 1918, pp. 30-31. Requirements of the kerosene motor.

Ignition

Mechanical Construction of Ignition Magnetos. H. R. Van Deventer. Gas Eng., vol. 20, no. 8, August 1918, pp. 377-394, 26 figs. Paper read before a joint meeting of the National Gas Engine Assn. and the Soc. of Automotive Engineers, June 1918.

Low-Compression Engines

Some Features of Low-Compression Oil Engines. L. H. Morrison. Power, vol. 48, no. 4, July 23, 1918, pp. 123-127, 9 figs. Brief review of the principles of the two-stroke cycle type, various cylinder head designs, with their advantages and disadvantages, necessity for water injection, causes leading to scored cylinders.

Lubrication

Internal-Combustion Engine Lubrication and Lubricants. P. H. Conradson. Power, vol. 48, no. 3, July 16, 1918, p. 107. Abstract of paper read before the Am. Soc. for Testing Materials.

Lubrication and Fuel Economy. S. F. Lentz. Power Wagon, vol. 21, no. 165, August 1918, pp. 31-33. Conservation of motor fuel by the selection of a suitable lubricating oil. Paper read before the Nat. Gas. Eng. Assn.

Lubrication of Marine Heavy-Oil Engines. Motorship, vol. 3, no. 8, August 1918, pp. 9-15. Details of the leading types of lubricators.

Operating Costs

Operating Costs of Oil Engines. John Pierce. Power Plant Eng., vol. 22, no. 12, June 15, 1918, p. 504. Cost of fuel in cents per kw-hr. in one plant of about 2200 kw. capacity.

Sizes to Manufacture

The Number of Sizes of Engines to Manufacture. Theo. C. Menges. Nat. Gas Engine Assn. Bul., vol. 3, no. 12, July 1918, pp. 11-17. Curves showing the proportion of cubic feet of piston displacement, weight, cost and selling price, to the nominal horsepower of an engine. Paper read at the 11th annual meeting of the N. G. E. A. (To be continued.)

See also Aeronautics (Engines); Hoisting and Conveying (Loco Tractor).

IRON

(See Steel and Iron)

LABOR

British

British Railway Labor, Wages and Living Under Government Control. Ry. Rev., vol. 62, no. 24, June 15, 1918, pp. 863-867. Summary from report of railroad wage commission of phases of British railway experience.

Crippled Soldiers

The Return of the Crippled Soldier to Industrial Work. Am. Mach., vol. 49, no. 3, July 18, 1918, pp. 99-100. A discussion of the problem.

Housing Methods

Home Attractions Keep Track Laborers Satisfied. Clifford A. Elliott. Elec. Ry. Jl., vol. 52, no. 4, July 27, 1918, pp. 150-152, 4 figs. Solving the labor problem by providing free section houses with all conveniences, land for gardens and chicken raising, as well as free transportation to amusement places for employees and their families.

Man-Power Conservation

Conservation of Miners by Employment of Mechanical Equipment. R. L. Herrick. Coal Age, vol. 14, no. 4, July 25, 1918, pp. 162-167, 14 figs. Suggests many ways in which man power may be conserved by modern equipment.

Mutuality Plan

Oliver Iron Mining Co. Adopts Labor Cooperation Policy. Eng. & Min. Jl., vol. 105, no. 26, June 29, 1918, pp. 1166-1167. An account of the "mutuality" plan of the Oliver Iron Mining Co., establishing a medium whereby employees may make known their grievances and a mutual interchange of ideas may be brought about.

Physical Training

How Physical Training Helps Factory Executives. D. C. Stanbrough. Indus. Management, vol. 56, no. 1, July 1918, pp. 20-21, 2 figs.

Reading Rooms

Development of Santa Fe Reading Room System. Charles E. Parks. Ry. Age, vol. 65, no. 4, July 26, 1918, pp. 179-182, 10 figs. Reasons for its establishment; its activities and the good results that have been secured from it.

Schools

Coal-Mining Instruction in the Evening Schools of Derbyshire and Leicestershire. George Forster. Iron & Coal Trades Rev., vol. 97, no. 2628, July 12, 1918, pp. 34-35. Paper read before the South Midland Branch of the Nat. Assn. of Colliery Managers.

Training Men for the Shipyards. F. Forrest Pease. Am. Mach., vol. 49, no. 3, July 18, 1918, pp. 109-110. The experiences of the Shipping Board and suggestions as to how other industries may profit from them.

Training Men Instead of Stealing Them. Fred H. Colvin. Am. Mach., vol. 48, no. 25, June 20, 1918, pp. 1035-1039, 12 figs. Account of the training shop for developing skilled mechanics established by the Norton Grinding Co., Worcester, Mass.

Vestibule Schools for the Unskilled. H. E. Miles. Indus. Management, vol. 56, no. 1, July 1918, pp. 10-12. Shows how such schools are organized and gives results from those already in operation.

Turnover

Minimum Turnover in Machine-Shop Labor. Stanley H. Bullard. Iron Age, vol. 102, no. 4, July 25, 1918, pp. 204-206. Labor policy and wage classification plan of the Bullard Machine Tool Co. Results in output and *esprit*.

LIGHTING (ILLUMINATION)

Elements of Illuminating Engineering. Ward Harrison. Elec. Eng., vol. 52, no. 1, July 1918, pp. 37-39. Principles involved in the science of lighting buildings and public highways. (Continuation of serial.)

Artificial Daylight

A Precision Method for Producing Artificial Daylight. I. G. Priest. Physical Rev., vol. 11, no. 6, June 1918, pp. 502-504, 1 fig. Diagrams showing relative energy plotted against wave length of sunlight at the earth's surface and of light from a gas-filled tungsten lamp passed through a quartz plate 0.5 mm. thick between crossed nicol prisms, the path of the light being parallel to the optic axis of the quartz. Abstract of a paper presented before the Am. Phys. Soc.

Factories

How to Plan a Lighting Installation for a Factory. Elec. Rev., vol. 73, no. 2, July 13, 1918, pp. 49-52. Simple rules for contractor or lighting salesman for laying out the lighting system under average conditions, using standard reflectors and Mazda lamps.

Industrial Lighting for Shops. O. L. Johnson. Ry. Rev., vol. 62, no. 25, June 22, 1918, pp. 916-918, 2 figs. Some suggestions and "don'ts" for shop lighting.

Farm Buildings

Wiring of Farm Buildings for Lighting. Elec. Rev., vol. 73, no. 2, July 13, 1918, pp. 67-68, 1 fig. Chart for finding proper wire size for low-voltage lighting plants.

Meat-Packing Plants

Improved Lighting of Meat-Packing Plants. F. H. Bernhard. Elec. Rev., vol. 73, no. 3, July 20, 1918, pp. 87-92, 12 figs.

Textile Mills

Better Lighting of Textile Mills. F. H. Bernhard. Elec. Rev., vol. 72, no. 26, June 29, 1918, pp. 1070-1077, 10 figs. Better lighting to improve quality of product; lighting requirements of textile mills.

See also Electrical Engineering (Lamps).

LUBRICATION

See Air Machinery (Air Compressors); Internal-Combustion Engineering (Lubrication); Machine Tools (Lubrication); Motor-Car Engineering (Lubrication); Railroad Engineering, Steam (Lubrication); Testing and Measurements (Viscosity Measurement).

MACHINE PARTS

Bearings

Notes on Babbitt and Babbitted Bearings. J. L. Jones. Tran. Am. Inst. Min. Engrs., no. 140, August 1918, pp. 1395-1401, 5 figs. Results of tests performed at progressively increasing temperatures on bearing bronze and description of a process and a tool claimed to give smoother and more accurate surfaces to bearings than heretofore possible.

Crankshafts

Broken Crankshafts. Maurice M. Clement. Power Plant Eng., vol. 22, no. 14, July 15, 1918, pp. 564-565. Some causes and their prevention.

Gears

On Matsumura's Interchangeable Wheel Teeth (in Japanese). Tsuruzo Matsumura. Jl. of the Soc. M. E., Tokyo, vol. 21, no. 52, June 1918.

Reliable Gears. C. J. Brown. Coal Age, vol. 14, no. 3, July 20, 1918, pp. 99-100. Hardness and toughness for reliability accomplished by heat treatment of steel.

See also Mechanics (Helical Springs); Motor-Car Engineering (Springs).

MACHINE SHOP

Boring-Mill Operation

Time Studies for Rate Setting on Gisholt Boring Mills-I. Dwight V. Merrick. Indus. Management, vol. 56, no. 1, July 1918, pp. 34-41, 11 figs. The preparation of a boring mill for the work to be done. Seventeen tables give the necessary data, each table being devoted to a single operation.

Bulldozer Operation

Essentials of Bulldozer Operations—The V-Blocks. J. V. Hunter. Am. Mach., vol. 49, no. 5, August 1, 1918, pp. 195-199, 18 figs. Examples of operations on this machine.

Coloring, Lacquering and Finishing

Approved Practice in Coloring and Lacquering. James Steelman. Brass World, vol. 14, no. 6, June 1918, pp. 163-167, 9 figs. Oxidizing effects on silver; electric ovens.

Black and Steel Gray Finishes on Brass and Iron. Fred J. Liscomb. Brass World, vol. 14, no. 6, June 1918, pp. 159-161. Some objection to the "Rock Island" formulae; a consideration of the arsenic solution for steel-gray finish; lacquering.

Crankshaft Making

A California Jobbing Shop. Frank A. Stanley. Am. Mach., vol. 49, no. 3, July 18, 1918, pp. 121-123. Laying out, roughing down and finishing crankshafts for gasoline motors.

Die Casting

Die-Casting of Aluminum Bronze. H. Rix and H. Whitaker. Page's Eng. Weekly, vol. 32, no. 708, April 5, 1918, pp. 160-162. Process of die casting and factors affecting the future development of the industry.

Grinding

Cylindrical Grinding. W. D. Adamson. Machy. Market, no. 925, July 26, 1918, p. 21. Classification and description of internal-grinding machines. (Continued.)

Heat-Treating

The Electric Furnace for Heat-Treating. T. F. Baily. Am. Drop Forger, vol. 4, no. 7, July 1918, pp. 257-260, 3 figs. From a paper presented at the convention of the Am. Drop Forge Association.

Indian Shop

New Smith, Forge, Spring Die Sinkers and Drop Forging Shops at Khargpur Works, Bengal-Nagpur Ry. Ry. Gaz., vol. 29, no. 1, July 5, 1918, pp. 18-22. Layout of buildings and equipment.

Pipe (Smokers') Making

The Making of a Smoker's Pipe. J. V. Hunter. Am. Mach., vol. 49, no. 3, July 18, 1918, pp. 93-98, 17 figs. Description of the manufacture of brier pipes.

Square (Gage Makers') Making

Making Accurate Squares for Gagemakers. John Teckeer. Am. Mach., vol. 48, no. 25, June 20, 1918, pp. 1041-1043, 10 figs. Describes methods by which a gage maker can produce his own squares.

See also Foundry (Welding; Sandblast); Marine Engineering (Welding); Steel and Iron (Heat Treatment).

MACHINE TOOLS

Boxing Machinery

Boxing Machinery to Prevent Damage. Luther D. Burlingame. Indus. Management, vol. 56, no. 1, July 1918, pp. 27-33, 18 figs. Practice of Brown & Sharpe Manufacturing Co. in packing machinery and tools for shipment.

Cost

The Rising Cost of Machine Building. Ludwig W. Schmidt. Am. Mach., vol. 49, no. 5, August 5, 1918, pp. 209-211.

Drills

Cable or Well Drills as Adapted to Blast Hole and Quarry. Eng. & Cement World, vol. 13, no. 2, July 15, 1918, pp. 60-66.

Choosing the Right Rock Drill. John F. Berteling. Mine & Quarry, vol. 10, no. 4, July 1918, pp. 1069-1073. A few instances of actual experience in fitting different types of drilling machines to various kinds of work.

Drill Bits and Drill Steel—Selecting, Forging and Tempering. George H. Gilman. Mine & Quarry, vol. 10, no. 4, July 1918, pp. 1075-1082, 18 figs. Present practice, specifications for straight-carbon hollow drill steel, details of the sharpening shop, and duties of the inspector regarding the tempering of drills.

Properties of Twist-Drills. B. W. Benedict and W. P. Lukens. Western Eng., vol. 9, no. 8, August 1918, p. 319. Conclusions drawn from an investigation of twist drills at the Engineers Experiment Station of the Univ. of Illinois. Abstract from Bul. No. 103 of the Eng. Experiment Station of the Univ. of Illinois.

Foreign Tariffs

Effect of Changes in Foreign Tariffs on the American Machine-Tool Industry. L. W. Schmidt. Am. Mach., vol. 48, no. 25, June 20, 1918, pp. 1047-1049.

Jigs and Fixtures

Templets, Jigs and Fixtures. Joseph Horner. Engineering, vol. 105, no. 2736, June 7, 1918, pp. 628-632, 50 figs. Fourth of a series, the present describing fixtures and jigs used in the manufacture of a radial drilling machine.

Lubrication

The Lubricating Problem. Raymond Francis Yates. Am. Mach., vol. 48, no. 25, June 20, 1918, pp. 1039-1040, 3 figs. Points out importance of lubricating machine tools.

Remanufacturing

Remanufacturing Machine Tools. Sibley Jl. of Eng., vol. 32, no. 11, August 1918, pp. 171-173, 4 figs. Offers solution to the problem of redistributing tools and of restoring them to their original condition of operation.

Toolroom

Toolroom Methods in a Pacific Coast Factory. Frank A. Stanley. Am. Mach., vol. 48, no. 25, June 20, 1918, pp. 1051-1055, 13 figs. Making of a varied line of punches, dies, jigs and fixtures; interesting presswork and tools.

MARINE ENGINEERING

Boilers

Corrosion of Marine Boilers. D. E. Rees. Am. Marine Engr., vol. 13, no. 7, July 1918, pp. 16-17. Suggestions in the care of marine boilers. From a paper read before the Inst. of Marine Engrs.

Cargo Ships

Standard Cargo Ships. Sir George Carter. Int. Mar. Eng., vol. 23, no. 7, July 1918, pp. 407-413, 6 figs. British practice in the design and construction of standard cargo ships. Paper read before the Inst. of Naval Architects, London, March 1918.

Cargo-Vessel Design

Longitudinal Framing and Diagonal Planking. J. R. Oldham. Nautical Gaz., vol. 93, no. 6, August 10, 1918, p. 65, 4 figs. A proposed bulk-cargo-vessel design.

Modern Shipbuilding and Economy in Material. Shipbuilding and Shipping Rec., vol. 11, no. 19, May 9, 1918, pp. 515-516, 3 figs. A series of comparisons between the transverse and longitudinal systems of framing wooden and steel ships. From a paper by J. W. Isherwood before the Soc. of Engrs.

The Relation of Speed to Dimensions in Merchant Ships. Shipbuilding & Shipping Rec., vol. 12, no. 3, July 18, 1918, p. 65. Experimental facts regarding the effects that details of construction of a ship have on speed.

Concrete Ships

Concrete Ship for the U. S. Shipping Board. Nauticus, vol. 1, no. 7, July 13, 1918, pp. 204-208. Specifications and com-

parative weight for a standard concrete ship given by the Emergency Fleet Corporation to the Committee of Commerce, U. S. Senate.

Construction of Concrete Ships for Emergency Fleet Corporation. R. J. Wig. Western Eng., vol. 9, no. 8, August 1918, pp. 306-307. Abstract of special report to Edward N. Hurley, chairman, U. S. Shipping Board, dated April 5, 1918.

Government Attitude on the Concrete Ship. Waldon Fawcett. Int. Mar. Eng., vol. 23, no. 7, July 1918, pp. 381-382.

The Big Concrete Ship Not Unreasonable. J. F. Springer. Int. Mar. Eng., vol. 23, no. 7, July 1918, pp. 383-386. A reply to Professor Everett's article on The Fallacy of Concrete Ship Construction.

Deep-Sea Diving

The Possibilities of Deep-Sea Diving. Robert G. Skerrett. The Rudder, vol. 34, no. 8, August 1918, pp. 370-374. Discusses pressures the human body is capable of withstanding.

Electric Power

Electricity's Part in Building and Navigating of Ships. H. A. Hornor. Elec. Eng., vol. 52, no. 1, July 1918, pp. 15-18. Electrical apparatus used in ships. (Continuation of serial.)

Electric Propulsion

Electrical Ship Propulsion. Am. Marine Engr., vol. 13, no. 7, July 1918, pp. 13-14. Study of the convenience in using an electric plant as a flexible gearing between the power generator and the propeller. From Engineering (London).

Fumigating Apparatus

Fumigating Apparatus for Shipyards and Emigrant Ships. Shipbuilding and Shipping Rec., vol. 12, no. 1, July 4, 1918, pp. 15-16, 1 fig. Apparatus constructed on the principle of the destruction of infection and of vermin by high-pressure dry-saturated steam which insures a temperature of 250 deg. fahr., thus destroying all germs without damaging or even wetting the goods.

Hog Island

Shipbuilding in the United States. Engineer, vol. 125, no. 3261, June 28, 1918, pp. 554-555, 18 figs. A description of the shipbuilding plant at Hog Island.

Propellers

Screw Propellers. D. W. Taylor. Shipbuilding and Shipping Rec., vol. 12, no. 1, July 4, 1918, pp. 35-39, 30 figs. Formulae and set of curves for the determination of the dimensions of screw propellers. (End of serial; previous articles appeared in vol. 10 (July-December 1917), pp. 55, 81, 223, 274, 464 and vol. 11, p. 469.)

Salvage

Deep Water Salvage. The Nautical Gaz., vol. 93, no. 3, July 20, 1918, p. 28, 2 figs. Proposed device for raising vessels from great depths.

Salvage of Merchant Ships. Engineer, vol. 125, no. 3260, June 21, 1918, pp. 532-534, 9 figs. Description of the work of the Salvage Department of the Admiralty.

The Salvage of Deeply Sunken Ships. R. G. Skerrett. Scientific Am., vol. 119, no. 3, July 20, 1918, pp. 43-58. Engineering difficulties in salving a ship and account of some of the reports of the Salvage Department of the British Admiralty.

Seattle

Seattle Shipbuilders Overcome Pioneer Difficulties and Set New Speed Records. Claude A. Osier. Eng. News-Rec., vol. 81, no. 4, July 25, 1918, pp. 160-164, 8 figs. High-speed work in inadequate plant; persistent expediting of material; labor problems; two new machines used.

Ships' Hulls

Oil- and Water-tight Joints in Ships' Hulls. Evers Burtner. Int. Mar. Eng., vol. 23, no. 7, July 1918, pp. 404-406, 24 figs. Effective methods of securing water- and oil-tight joints in ships' structure under different conditions.

Statistics

American Merchant Marine Will Total 5,000,000 Tons in 1920. Edward N. Hurley. Int. Mar. Eng., vol. 23, no. 7, July 1918, pp. 379-381. Address by Chairman of U. S. Shipping Board at Univ. of Notre Dame, June 10, 1918.

Tonnage Measurement

Explanation of the Several Methods of Expressing the Tonnage of Vessels. Sibley Jl. of Eng., vol. 32, no. 11, August 1918, pp. 170-171. Compiled from material supplied by the Chief of the Hull Drafting Department at the Harlan plant of the Bethlehem Shipbuilding Corp.

Power, Speed and Dead Weight Carrying Capacity of Screw Steamers. H. P. Frear. Sibley Jl. of Eng., vol. 32, no. 11, August 1918, pp. 168-170. Treatise of the elementary facts and principles connected with the subject.

Tonnage and Displacement Explained. The Rudder, vol. 34, no. 8, August 1918, pp. 388-391. (Continued from preceding issues.)

Welding, Electric

Electric Welding in Ship Work—A Rivetless Vessel. Times Eng. Supp., no. 525, July 1918, p. 149. Possibilities of extending the electric-welding system used in the building of a rivetless ship recently launched on the south coast of England and built in a shipyard operated by the Inland Waterworks and Docks Section of the Royal Engineers.

Wooden Ships

Revival of Wooden Ships. Nautical Gazette, vol. 93, no. 5, August 3, 1918, p. 52. Comparison between wooden and steel ships.

See also Internal-Combustion Engineering (Diesel Engines; Heavy Oil Engines); Power Generation (Electric Power Applications); Research (Marine Engineering).

MATHEMATICS

Differential Equations

Brief Synopsis of Differential Equations. N. W. Akimoff. Automotive Eng., vol. 3, no. 6, July 1918, pp. 247-250. Preliminary review of differential equations in their application to the study of oscillations.

Contribution to the Study of Oscillation Properties of the Solutions of Linear Differential Equations of the Second Order. R. G. D. Richardson. Am. Jl. of Mathematics, vol. 40, no. 3, July 1918, pp. 283-316.

Interpolation Properties of Orthogonal Sets of Solutions of Differential Equations. O. D. Kellogg. Am. Jl. of Mathematics, vol. 40, no. 3, July 1918, pp. 225-234. Types of boundary conditions and establishment of the property (D). Continued from No. 2. Presented to the Am. Mathematical Soc.

Determinants

P-Way Determinants, with an Application to Transvectants. Lepine Hall Rice. Am. Jl. of Mathematics, vol. 40, no. 3, July 1918, pp. 242-262. Definition of a determinant, formulated to remove the restriction in Cayley's law of multiplication and to set up a new case in Scott's law of multiplication; generalization to P dimensions of Metzler's theorem in two dimensions concerning a determinant, each of whose elements is the product of k factors.

Integration

Directed Integration. H. B. Phillips. Am. Jl. of Mathematics, vol. 40, no. 3, July 1918, pp. 235-241. Manner of directly attaching the algebraic sign to the element of integration, multiple integrals being treated like curvilinear.

On the Numerical Solution of Integral Equations. E. T. Whittaker. Proc. of the Royal Soc., vol. 94, no. A662, June 1, 1918, pp. 367-383. Theoretical solutions of integral equations of the Abel and Poisson types.

Theory of Functions

A Theorem on the Variation of a Function. Paul R. Rider. Bul. of the Am. Mathematical Soc., vol. 24, no. 9, June 1918, pp. 430-431.

On a Certain Functional Equation. Tsuruichi Hayashi. Science Reports of the Tôhoku Imperial University, vol. 7, no. 1, July 1918, pp. 1-32. Study of convex closed curves inscribable and revolvable in a polygon.

On a Certain General Class of Functional Equations. W. Harold Wilson. Am. Jl. of Mathematics, vol. 40, no. 3, July 1918, pp. 263-282. Contribution to systematize a general theory. Read before the Am. Math. Soc.

Theory of Functions (Théorie des fonctions). M. C. de la Vallée Poussin. Académie des Sciences, vol. 166, no. 21, May 27, 1918, pp. 843-846. Analytical investigation of the properties of the derivatives of some forms of trigonometric expressions.

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Volume Generated by the Rotation of a Spherical Contour (Sur les volumes engendrés par la rotation d'un contour sphérique). M. A. Buhl. Académie des Sciences, vol. 166, no. 22, June 3, 1918, pp. 896-897. Derivation of the general formula by the method of integral calculus.

MECHANICS

Columns, Critical Loading

Critical Loading of Struts and Structures. W. L. Cowley and H. Levy. Proc. of the Royal Soc., vol. 94, no. A662, June 1, 1918, pp. 405-422, 6 figs. Discussion of the stability of a prismatic homogeneous strut on simple supports, generalization of the equation of three moments, and study of the external loading due to wires in tension attached to a beam in the region of the supports.

Elastic-Strain Analogies

Transmission of Activation in Passive Metals as a Model of the Protoplasmic or Nervous Type of Transmission. Ralph S. Lillie. Science, vol. 48, no. 1229, July 19, 1918, pp. 51-60. Close analogies between the physico-chemical nature of nerve conduction and the electric current and inadequate comparison of nerve action to the transmission of mechanical influences such as elastic strain or vibration and to the propagation of explosive waves.

Helical Springs

Strength of Helical Springs. W. A. Atkinson. Mechanical World, vol. 63, no. 1637, May 17, 1918, pp. 234-235, 3 figs. Explanation of an accompanying table of maximum loads in pounds, and corresponding deflection per coil in inches of helical round steel wire springs.

Pipes, Curved

Stresses in Curved Pipes. J. S. Henzell. Mechanical World, vol. 64, no. 1644, July 5, 1918, p. 4, 2 figs. Analytical study of the effect of internal fluid pressure on curved pies. (To be continued.)

Shafts, Horizontal, Critical Speed

The Lower Critical Speed of Horizontal Shafts (in Japanese). Iwao Oki. Jl. of the Soc. M. E., Tokyo, vol. 21, no. 52, June 1918.

Sphere, Light, Movement in Air

On the Movement of a Light Spherical Ball in Air (Sur le mouvement d'une balle sphérique légère dans l'air). Paul Appell. Journal de Physique, vol. 7, March-April 1917, pp. 49-52. Remarks on Lord Rayleigh's article on the irregular flight of a tennis ball, published in the Messenger of Mathematics, no. 73, 1877.

Steel Columns

Recommended Unit-Stresses in Steel Columns and Struts. Western Eng., vol. 9, no. 8, August 1918, p. 312. Diagram showing stresses recommended for different values of l/r both by the Am. Ry. Eng. Assn. formula and by the formula recommended by a special committee of the Am. Soc. C. E.

See also Engineering Materials (Glass); Power Plants (Piping).

METAL ORES

Crushing Resistance

Crushing Resistance of Various Ores. L. W. Lennox. Trans. Am. Inst. Min. Engrs., no. 140, August 1918, pp. 1255-1264, 10 figs. Account of tests and summary of results.

Lead

Mineralogy of Ores. H. L. Payne. Min. and Oil Bul., vol. 4, no. 8, July 1918, p. 339. Information concerning the ores of lead: galenite, cerussite, anglesite, crocoite. (Continuation of a serial.)

Mercury

Note on Extraction of Mercury from its Ores by Sodium Sulphide. C. H. Holland. New Zealand Jl. of Science & Technology, vol. 1, no. 3, May 1918, pp. 153-154. Report of experiments and description of method.

Molybdenum

Molybdenite Operations at Climax, Colorado. D. F. Haley. Trans. Am. Inst. Min. Engrs., no. 140, August 1918, pp. 1183-1188. Geology, mining system and marketing of the deposit.

Pyrites

Pyrite Deposits of Leadville, Colo. H. S. Lee. Trans. Am. Inst. Min. Engrs., no. 140, August 1918, pp. 1223-1229. Geology, occurrence of the ore, method of mining it and its value in the manufacture of sulphuric acid.

Radium

Radium. Richard B. Moore. Trans. Am. Inst. Min. Engrs., no. 140, August 1918, pp. 1165-1182. History, disintegration series, ore deposits, metallurgical treatment, methods of ore concentration, supply of ore, substitute for and uses of radium.

Spelter

Spelter Statistics for 1917. W. R. Ingalls. Eng. & Min. Jl., vol. 106, no. 4, July 27, 1918, pp. 176-181.

Sulphur

Recently Recognized Alunite Deposits at Sulphur, Humboldt County, Nevada. I. C. Clark. Eng. & Min. Jl., vol 106, no. 4, July 27, 1918, pp. 159-163, 5 figs.

Tungsten

Molybdenum, Tungsten and Bismuth. Indus. Australian & Min. Standard, vol. 59, nos. 1544 and 1546, June 13 and 27, 1918, pp. 623-624, 688-689; vol. 60, no. 1547, July 4, 1918, pp. 29-30, 1 fig. Treatise on these minerals dealing with the general character, associated metallic minerals and geological features of their ores. (To be continued.)

Tungsten Ore Deposits Near Falcon Lake, Manitoba. Justin S. DeLury. Can. Min. Jl., vol. 39, no. 11, June 1, 1918, pp. 186-188, 6 figs. Map of area and brief description of its geology.

Tungsten Ores in Southern Rhodesia. H. B. Maufe. South African Min. Jl. & Eng. Rec., vol. 27, part 2, no. 1390, p. 61. Abstract from Report No. 4 of the Southern Rhodesia Geological Survey.

Vein Formation

The Mechanics of Vein Formation. S. Taber. Trans. Am. Inst. Min. Engrs., no. 140, August 1918, pp. 1189-1222, 5 figs. Methods of vein formation.

See also Engineering Materials (Tungsten).

METALLURGY

Baghouses

Baghouses for Zinc Oxide. John F. Cregan, Eng. & Min. Jl., vol. 106, no. 3, July 20, 1918, pp. 126-132, 7 figs. Further improvement and standardization in design essential.

Blast Furnaces

Copper Tuyeres for Blast Furnaces. A. K. Reese. Blast Furnace & Steel Plant, vol. 6, no. 8, August 1918, pp. 329-330, 2 figs. Results obtained with copper tuyeres and considerations on their adoption. Paper read before the British Iron & Steel Inst.

Principal Changes in Blast Furnace Lines. J. G. West. Blast Furnace & Steel Plant, vol. 6, no. 8, August 1918, pp. 323-329, 56 figs. Discussion of theoretical lines and account of the development of the hearths. (Continued.)

Copper Refining, Electrolytic

New Cornelia Copper Company's Plant a Success. R. B. Leach. Min. and Oil Bul., vol. 4, no. 8, July 1918, pp. 315-328, 4 figs. Layout of buildings and description of processes followed by a plant said to produce 80 lb. of pure electrolytic copper per min.

Cyanide Process

Charcoal Precipitation of Gold in Cyanide Solutions. Chem. Eng. & Min. Rev., vol. 10, no. 118, July 1918, pp. 309-310. Comments on a paper describing the Moore-Edmands process, as installed at the Yuannii mine, W. A., published in the issue of November 1917.

Effect of Oxygen Upon the Precipitation of Metals from Cyanide Solutions. T. B. Crowe. Trans. Am. Inst. Min. Engrs., no. 140, August 1918, pp. 1279-1282. Effect of vacuum precipitation on consumption of cyanide and opposing action of oxygen and hydrogen.

Fine-Grinding Cyanide Plant of Barnes-King Development Co. J. H. McCormick. Trans. Am. Inst. Min. Engrs., no. 140, August 1918, pp. 1283-1291, 4 figs. Description of the operations in the mine.

Roasting for Amalgamating and Cyaniding Cripple Creek Sulphotelluride Gold Ores. A. L. Bomfield and M. J. Trott. Trans. Am. Inst. Min. Engrs., no. 140, August 1918, pp. 1265-1278, 2 figs. Classification of ores, chemical reactions in roasting and rapid methods of analysis for sulphur in ores.

Recent Progress

Notes on Recent Metallurgical Progress. E. P. Mathewson. Eng. & Min. Jl., vol. 106, no. 3, July 20, 1918, pp. 138-145, 3 figs. Impressions received during a journey of observation among the great smelteries of the United States, with practical comments on design and operation.

Rolling Alloy Strips

New Installation for Rolling Alloy Strips. Blast Furnace & Steel Plant, vol. 6, no. 8, August 1918, pp. 819-821. Process of the Nat. Pressed Steel Co., Massillon, Ohio.

Silver-Lead Smeltery

Ideal Layout for Silver-Lead Smeltery. Guy C. Riddell. Eng. & Min. Jl., vol. 106, no. 3, July 20, 1918, pp. 115-122, 3 figs. Details of a plant for a 100- to 3000-ton daily charge.

Slag, Open-Hearth, Basic

Utilization of Basic Open Hearth Slag. Blast Furnace & Steel Plant, vol. 6, no. 8, August 1918, p. 322. Account of the progress of this industry in England. From Jl. Soc. Chem. Industry.

See also Aeronautics (Materials of Construction).

MILITARY ENGINEERING

Ballistics

Internal Ballistics. Engineer, vol. 125, no. 3258, June 7, 1918, p. 490. Abstract of a lecture by Lieut.-Col. A. G. Hadcock delivered at the Royal Inst.

Planetary Ballistics

Planetary Ballistics (De balistica planetaria). Madrid Cientifico, year 25, no. 956, June 5, 1918, pp. 281-283. Mathematical investigation of the range of a projectile in terms of its initial velocity and the angle of projection.

Gun Erosion

Gun Erosion. Engineering, vol. 105, no. 2736, June 7, 1918, p. 640. Discusses H. M. Howe's views on the hardening of the gun bore, reasons for cracking, and suggests a remedy for erosion troubles. Abstract of a paper read by H. C. H. Carpenter before the Inst. of Naval Engrs.

Military Training

Army Engineer School in France Standardizes Work in the Field. Robert K. Tomlin, Jr. Eng. News-Rec., vol. 81, no. 3, July 18, 1918, pp. 112-117, 13 figs. Course of training for men recommended for commissions; classes trained in mining, pioneering, bridging, topography, camouflage, sound ranging and interpretation of aerial photographs.

Training Mechanics for Service in Army Field Units. J. V. Hunter. Am. Mach., vol. 49, no. 4, July 25, 1918, pp. 163-167, 13 figs. Methods employed in training drafted men for the needs of the Army.

Torpedoes

Moving Targets and Torpedo Attack. Engineer, vol. 125, no. 3261, June 28, 1918, pp. 561-563, 14 figs. A mathematical consideration.

See also Munitions.

MINES AND MINING

Cementation and Concreting

Cementation in the Illinois Oil Field. M. L. Nebel. Eng. & Min. Jl., vol. 105, no. 24, June 15, 1918, pp. 1080-1082, 1 fig. Use of cement, excluding water, to increase immediate production and probably total extraction, also lower operating costs.

Notes on Shaft Relining With Concrete. G. G. Stonemark. Eng. & Min. Jl., vol. 106, no. 1, July 6, 1918, pp. 8-10. Methods used in two Minnesota shafts.

Cementing

Stripping and Relining a Shaft at Cowdenbeath, Fife. Henry Rowan. Queensland Government Min. Jl., vol. 19, no. 217, June 15, 1918, pp. 266-267. From a paper read before the Min. Inst. of Scotland.

Electrical Operation

Earthing Electrical Services in Mines. Colliery Guardian, vol. 116, no. 3002, July 12, 1918, pp. 70-71. Necessity of a good earth contact; the ideal earth.

The Safe Operation of Power Plant Switchboards. L. Fokes. Colliery Guardian, vol. 116, no. 3001, July 5, 1918, pp. 17 18, 8 figs. Safe methods of handling electricity in mines.

Mine Surveying

The Future Aspect of Mine Surveying. John Proctor. Colliery Guardian, vol. 116, no. 3003, July 19, 1918, pp. 121 122. Influence of magnetic declination, extraneous objects and electricity on surveys; description of methods adopted; necessity for accuracy.

Oil

Methods of Increasing the Recovery from Oil Lands. J. O. Lewis. Automotive Eng., vol. 3, no. 6, July 1918, pp. 274-277. Suggested ways in which it is claimed more crude oil can be obtained from any given oil field. (Concluded.)

Sand Filling

Notes on Sand Filling in Mines. C. H. Greathead. Colliery Guardian, vol. 116, no. 3003, July 19, 1918, p. 125.

Ventilation

Canvas Tubing for Mine Ventilation. Lester D. Frank. Queensland Government Min. Jl., vol. 19, no. 217, June 15, 1918, pp. 249-251, 4 figs. Manner in which canvas tubing is being used in the North Butte Company's mines at Butte, Mont. Abstract from Bul. A. I. M. E., February 1918.

MOTOR-CAR ENGINEERING

British Motors

The Industrial Motor. Motor Traction, vol. 27, no. 696, July 3, 1918, pp. 1-2. The products of the British motor industry reviewed and classified according to their respective uses. (Continuation of serial.)

Electric Vehicles

The Electric Vehicle Committee. Motor Traction, vol. 27, no. 696, July 3, 1918, pp. 14-15. Annual report for the year ended March 31, 1918.

War Time Uses of Industrial Electric Trucks. Elec. Rec., vol. 24, no. 2, August 1918, pp. 57-67. Uses of electric trucks and specifications of the different types.

Electrical Equipment

Ignition, Starting, Generating and Lighting System on Automotive Vehicles. C. L. White. Auto and Tractor Shop, vol. 17, no. 10, July 1918, pp. 240-241, 4 figs. Elementary facts and principles of ignition; connection of batteries; make-and-break ignition systems.

Lighting Generators and Starting Motors for the Automobile. Elec. Rec., vol. 24, no. 2, August 1918, pp. 68-73. Features of modern designs of lighting generators and starting motors and outline of their necessary auxiliary devices.

The Care and Repair of Automobile Starting and Lighting Batteries. Auto and Tractor Shop, vol 17, no. 10, July 1918, pp. 244-246, 3 figs. Remarks and suggestions. (To be continued.)

The Testing of British-Made Magnetos. H. M. Buist. Autocar, vol. 41, no. 1186, July 13, 1918, p. 44. Suggestions resulting from a visit of the author to a number of British magneto factories.

Lubrication

A New Chassis Lubrication System. Automotive Industries, vol. 39, no. 3, July 18, 1918, pp. 95-96, 4 figs. Scheme by which oil is fed to bearings by wicks and quantity fed is regulated by localized compression of the wicks.

Motor Buses

The Industrial Motor. Motor Traction, vol. 27, no. 696, July 3, 1918, pp. 1-2. Capabilities and costs of public-service vehicles. (To be continued.)

Speedometers

Speedometers and How to Care for Them. L. W. Burchinal. Auto and Tractor Shop, vol. 17, no. 10, July 1918, pp. 249-250, 5 figs. Principle of operation of each one of the four different types of speedometers; forms of speedometer cables; method of attaching speedometer sprockets and swivel joint to the front wheel of an automobile.

Springs

The Springs of the Car. F. M Faual. Auto and Tractor Shop, vol. 17, no. 10, July 1918, pp 255-256, 9 figs. History of the introduction of springs in the manufacture of vehicles and review of the principles involved in their use

Tires

A New South African Tire. The Autocar, vol. 40, no. 1184, June 29, 1918, p 651, 1 fig Features of a new casing claimed to be of advantage on deeply rutted roads.

Tractors

Economical Sizes of Tractors. Ernest Goldberger. Power Wagon, vol. 21, no. 165, August 1918, pp 53-54, 2 figs. Record of the performances of tractors in different kinds of work

Soil Resistance and the Tractor. Fred. M. Loomis. Motor Age, vol. 34, no. 3, July 18, 1918, pp. 20-23. Rules to figure drawbar pull and to determine the size of machine needed.

The Oil-Burning Tractor Engine. H. T. Sward. Automotive Eng., vol. 3, no. 6, July 1918, pp. 265-266. Development and special requirements of the oil-burning tractor. Paper read before the joint meeting of the Chicago Section of the Soc. of Automotive Engrs. and the Nat. Gas. Eng. Assn. in Chicago, Ill.

Trucks

Applying Engineering Principles in the Design of Trucks. Norman Litchfield. Elec. Ry. Jl., vol. 52, no. 3, July 20, 1918, pp. 109-111, 2 figs. Eight points to consider; the calculation of the stresses.

Chassis Design of Class B Trucks. Cornelius T. Myers. Power Wagon, vol. 21, no. 165, August 1918, pp. 41-44, 2 figs. Account of the specifications and details of design adopted at the Quartermaster General's Office.

Measuring Motor Truck Ability. Francis W. Davis. Power Wagon, vol. 21, no. 165, August 1918, pp. 26-28. Suggested technical method for determining the hill-climbing ability of a motor truck.

Motor Trucks Build Roads. Good Roads, vol. 16, no. 5, August 3, 1918, pp. 44-45. Machines utilized to haul graders in various localities.

See also Internal-Combustion Engineering (Cylinder Walls).

MUNITIONS

Anti-Aircraft Guns

The Three-Inch Anti-Aircraft Gun, Model 1918. Am. Mach., vol. 49, no. 5, August 1, 1918, pp. 185-190, 5 figs.

Canadian Shell Plant

Canadian National Steel Plant. W. F. Sutherland. Can. Machy., vol. 20, no. 4, July 25, 1918, pp. 75-81. Illustrated article describing the steel plant operated by the Imperial Munitions Board for the British Government.

Chemistry and Metallurgy

The Chemist and Metallurgist in the Munitions Industry. F. E. Gardiner. Can. Machy., vol. 20, no. 4, July 25, 1918, pp. 98-103. Work of the chemist and of the metallurgist in munition factories.

French Field Gun

The Development of the French 75-mm. Field Gun. J. A. Lucas. Am. Mach., vol. 49, no. 4, July 25, 1918, pp. 149-152, 11 figs. The invention, construction and operation during the years of its use.

Hand Grenades

Some Types of Modern Hand Grenades. Rudolph C Lang. Am. Mach., vol. 49, no. 4, July 25, 1918, pp. 139-143, 11 figs. A history of the hand grenade and a description of various types now in use.

Rapid-Fire Guns

The Madsen Gun. Engineer, vol. 125, no. 3258, June 7, 1918, pp. 495-498, 6 figs. Details of the new automatic small-arm which depends for its action on the recoil of the barrel.

Shell Production

Efficient Appliances for Economic Shell Production. J. H. Rodgers. Can. Machy., vol. 20, no. 4, July 25, 1918 pp. 104-108, 8 figs. Illustrations indicating a number of accessories that have been instrumental in the manufacture of the various shells.

Great New Jersey Shell-Loading Plant. Committee on Public Information. Am. Mach., vol 49, no 3, July 18, 1918, pp. 125-130, 8 figs Description of a plant turning out 52,000 loaded shells per day.

How Dummy Iron Shells Are Molded and Cast. H. Cole Estep. Foundry, vol. 46, no. 312, August 1918, pp. 347-350, 6 figs. Two-part flask employed with most of mold in cope; special gating arrangements necessary.

Specifications for Semisteel Projectiles. Foundry, vol 46, no. 312, August 1918, pp. 345-346. Refers to cast semi-steel projectiles, experiments upon which have proven satisfactory enough to warrant ordering 500,000.

See also Air Machinery (Shell Plant).

PHYSICS

Acoustics

The Influence of Amplitude and of Electromagnetic Driving on the Frequency of Tuning Forks. D. C. Miller. Physical Rev., vol. 11, no. 6, June 1918, pp. 497-498, 2 figs. Results of an investigation of the frequency of tuning forks conducted with the Koenig Clock-Fork Abstract of paper presented before the Am. Phys. Soc.

Electricity

On the Formation of Negatively Electrified Rain Drops. F. Sanford. Physical Rev., vol. 11, no. 6, June 1918, pp. 445-448, 1 fig. Negatively electrified drops may be blown from positively electrified drops by a wind which regularly gives off positive charges to water.

The Air-Damped Vibrating System: Theoretical Calibration of the Condenser Transmitter I. B. Crandall. Physical Rev., vol. 11, no. 6, June 1918, pp. 449-460, 8 figs. Mechanical theory of the Wente's condenser transmitter; mechanism of air-dampening and formulae for practical calculations. Paper read before Am. Phys. Soc.

The New Thermo-Electric Effect (Le nouvel effet thermo-électrique). M. Carl Benedicks. Revue de Métallurgie, year 15, no. 3, May-June 1918, pp. 329-332, 3 figs. Outline of experiments demonstrating that differences in temperature establish an electric current in a homogeneous metallic circuit.

Expansion of Metals

Expansion of Metals by Heat. John Roger. Western Eng., vol. 9, no. 8, August 1918, p. 316. Table of coefficients of expansion of metals by equal units of temperature and by equal units of energy, and of other physical properties of these substances.

Ions

On the Possibility of Tone Production by Rotary and Stationary Spark Gaps (in Japanese). H. Yagi. Denki Gakkwai Zasshi, no. 353, January 19218, pp. 105-131.

Liquids

Why Water Overfills a Tumbler. Will H. Coghill and Carl O. Anderson. Scientific Am. Supp., vol. 86, no. 2221, July 27, 1918, pp. 52-53, 3 figs. Study of flotation in its connection with the metal-mining industry.

Luminescence

The Photo-Luminescence and Katho-Luminescence of Calcite. E. L. Nichols, H. L. Howes and D. T. Wilber. Physical Rev., vol. 11, no. 6, June 1918, pp. 485-486. Experiments showing that calcites of the Franklin Furnace variety when subjected to kathode bombardment exhibit phosphorescence of the type hitherto supposed to be peculiar to the uranyl salts. Abstract of a paper presented before Am. Phys. Soc.

Meteorology

Cooling of the Lower Regions of the Atmosphere During the Night. (Sur le refroidissement nocturne des couches, basses de l'atmosphère). Henri Perrotin. L'Aérophile, year 26, no. 9210, May 15, 1918, p. 136. Calculation of the radiation coefficients of the atmosphere at different levels from measured temperature values.

On the Times of Sudden Commencement of Magnetic Storms. S. Chapman. Phys. Soc. of Lond., vol. 30, part 4, June 15, 1918, pp. 205-214 Discussion of the question as to how far magnetic storms commence simultaneously at different parts of the earth, based on the data collected by Bauer for 15 magnetic storms.

Optics

A Theory of Color Vision and the Selective Action of the Eye. R. A. Houston. Scientific Am. Supp., vol. 86, no. 2223, August 10, 1918, pp. 92-93, 10 figs. A non-mathematical account of a theory described in the Proc. Royal Soc., A92, p. 424, 1916. From Science Progress.

Absorbing Power of the Earth's Atmosphere (Contribution a l'étude du pouvoir absorvant de l'atmosphère terrestre). M. A. Boutaric. Annales de Physique, vol. 9, March-April 1918, pp. 113-203, 28 figs. Beginning of an extensive report of observations on the light-absorbing power of the atmosphere and a study of its bearing on the proportion of polarized light diffused by the sky.

Discussion on Visible and Invisible Rays (in Japanese). Denki Gakkwai Zasshi, no. 359, June 30, 1918. Paper read before the meeting of Kwansai Local Section.

Limit of Sensibility of the Eye and Minimum Value of Radiant Energy Which Can Be Perceived Visually (La limite de sensibilité de l'oeil et le minimum de puissance perceptible visuellement). H. Buisson. Journal de Physique, vol. 7, March-April 1917, pp. 68-74. Account of the methods followed by Langley, Drude, Russell and Reeves for evaluating the least mechanical power which can be perceived visually.

On Tracing Rays Through an Optical System. T. Smith. Phys. Soc. of Lond., vol. 30, part 4. June 15, 1918, pp. 221-233, 1 fig. Modification of the formulae for rays in an axial plane published by the author in Proc. Phys. Soc., vol. 27, p. 502, and outline of method followed in calculations relating to the transverse focal lines.

Photograph of an Aurora Model. C. C. Trowbridge. Physical Rev., vol. 11, no. 6, June 1918, pp. 482-483. Description of photographs of a large model of the aurora constructed to study the optical effects of perspective. Abstract of a paper presented before the Am. Phys. Soc.

The Law of Symmetry of the Visibility Function. I. G. Priest. Physical Rev., vol. 11, no. 6, June 1918, pp. 498-502, 1 fig. Deductions from an attached diagram showing the relative visibility of radiant power plotted against wave-length as abscissae. Abstract of a paper presented before the Am. Phys. Soc.

Transparency of Certain Carbon Compounds to Waves of Great Length. H. P. Hollnagel. Physical Rev., vol. 11, no. 6, June 1918, p. 505. Transparency of quartz, benzene, carbon bisulphide and other substances to residual rays of rock salt ($h = 52\ \mu$). Abstract of Am. Phys. Soc. paper.

Visible and Invisible Rays (in Japanese). M. Kimura. Denki Gakkwai Zasshi, no. 254, January 1918, pp. 87-97.

Oscillatory Phenomena

An Harmonic Synthesizer Having Components of Incommensurable Period and Any Desired Decrement. W. J. Raymond. Physical Rev., vol. 11, no. 6, June 1918, pp. 479-481. Apparatus constructed by the mechanician of the Department of Physics of the Univ. of California which serves to draw continuous curves showing graphically the characteristics of complex harmonic motions. Abstract from paper presented before the Am. Phys. Soc.

Variation of Velocity of Waves Due to Motion of the Source. D. Alter. Physical Rev., vol. 11, no. 6, June 1918, pp. 481-482. Generalization of the mathematical theory which asserts that the velocity of sound depends upon the velocity of the source as well as upon the kind of medium of propagation of waves. Abstract of paper presented before the Am. Phys. Soc.

Precipitation

Electrostatic Precipitation. O. H. Eschholz. Tran. Am. Inst. Min. Engrs., no. 140, August 1918, pp. 1293-1306, 11 figs. Present extension of the electrostatic process of fume precipitation; essential features of this system.

Recent Progress

Notes on Recent Progress in Physics (Quelques récents progrès de la Physique). Leon Bloch. Revue Générale des Sciences, year 20, no. 7, April 15, 1918, pp. 198-208. Résumé of recent researches in advanced laboratory work.

Solutions

A Method for the Quantitative Study of Gases in Metals. H. M. Ryder. Physical Rev., vol. 11, no. 6, June 1918, p. 486. Abstract of paper presented before the Am. Phys. Soc.

Solutions of Gases in Liquids (Les solutions des gaz dans les liquids). M. Felix Michaud. Annales de Physique, vol. 9, March-April 1918, pp. 203-232. Beginning of a proposed thorough revision of the theory of gas solutions.

Spectrum

Methyl-Violet as a Red-Sensitiser of the Photographic Plate. Usuburo Yoshida.

Memoirs of the College of Science, Kyoto Imp. Univ., vol. 3, no. 3, April 1918, pp. 69-71, 4 figs. Account of experiments.

The Effect of an Electric Field on the Spectrum Lines of Helium. T. Takamine and N. Kokubu. Memoirs of the College of Science, Kyoto Imp. Univ., vol. 3, no. 3, April 1918, pp. 81-92, 10 figs. Results obtained from investigations relating mainly to the more refrangible lines of helium. (Continued.)

The Reversal of Spectrum Lines Produced by a Spark Under Water. Toshikazu Mashimo. Memoirs of the College of Science, Kyoto Imp. Univ., vol. 3, no. 3, April 1918, pp. 73-79, 1 fig. Result of experiments performed with the view of following the investigations of Konen, Lockyer, Hale and Finger regarding the reversal of lines in the different regions of the spectrum.

Wave-Lengths of the Tungsten X-Ray Spectrum. Elmer Dershem. Physical Rev., vol. 11, no. 6, June 1918, pp. 461-476, 6 figs. Resolving power of a crystal used as a diffraction grating for X-rays; methods of applying the theories concerning resolving power, description of apparatus used in securing the X-ray spectrum; tabulation of experimental results; theoretical considerations.

Structure of Matter

Atomic and Molecular Numbers. Herbert Stanley Allen. Jl. of the Chem. Soc., vols. 113 and 114, no. 667, May 1918, pp. 389-396. Present value of the atomic weight in face of the recent investigations in connection with radioactive elements.

Note on the Weiss Molecular Field in Ferromagnetic Substances. Kôtarô Honda. Science Reports of the Tôhoku Imperial Univ., vol. 7, no. 1, July 1918, pp. 53-58. Comments on Weiss' assumption that if a ferromagnetic substance undergoes the action of an external field, each molecule is in addition subjected to the action of a large field in the direction of the external field.

On the Relation Between the K X-Ray Series and the Atomic Numbers of the Chemical Elements. W. Duane and Kang-Fuh Hu. Physical Rev., vol. 11, no. 6, June 1918, pp. 488-489. Result of measurements of critical absorption frequencies from manganese ($N = 25$) to cerium ($N = 38$), all measured with the same apparatus. Abstract of a paper presented before the Am. Phys. Soc.

Radiation and the Electron. R. A. Millikan. Scientific Am. Supp., vol. 86, no. 2221, July 27, 1918, pp. 60-61, 2 figs. Suggestions for solving the problem of the transmission of light through interstellar space. Article presented at the meeting of the Section of Physics and Chemistry of the Franklin Institute. (To be continued.)

The Electromagnetic Inertia of the Lorentz Electron. G. A. Schott. Proc. of the Roy. Soc., vol. 94, no. A662, June 1, 1918, pp. 422-436. Remarks on G. W. Waker's paper on The Effective Inertia of Electrified Systems Moving with High Speed, in Proc. Roy Soc., A, vol. 93, p. 448, 1917.

The Entropy of a Metal. H. S. Allen. Phys. Soc. of Lond., vol. 30, part 4, June 15, 1918, pp. 215-220, 1 fig. Discussion of the hypotheses assumed in the theory of Ratnowsky and examination of the latter's expression for the entropy of one gram-atom of a substance in the solid state in view of the values obtained by Lewis and Gibson.

The Resonance and Ionization Potentials for Electrons in Thallium Vapor. P. D. Foote and F. L. Mohler. Physical Rev., vol. 11, no. 6, June 1918, pp. 486-487. Account of experiments and interpretation of results obtained. Abstract of paper presented before the Am. Phys. Soc.

POWER GENERATION AND SELECTION

Canada

Availability of Energy for Power and Heat. J. Blizard. Jl. Eng. Inst. of Can., vol. 1, no. 3, July 1918, pp. 112-115. Outline of the sources of energy supply in Canada and of the requirements they meet.

Electric-Power Applications

Application of Electricity in the Modern Navy in the World (in Japanese). T. Minohara. Denki Gakkwai Zasshi, no. 356, March 31, 1918.

Electric Plant at a Canadian Smelting Works. Engineer, vol. 126, no. 3263, July 12, 1918, pp. 24-26, 2 figs. Description of an hydraulic and a steam plant.

Electric Power Supply in the Future. Engineer, vol. 125, no. 3258, June 7, 1918, pp. 498-499. Report of the Committee appointed by the Board of Trade to consider steps to be taken to insure an adequate supply of electric power for all classes of consumers.

Electrically Operated Quarry and Rock Crushing Plant in Chicago. Elec. Rev., vol. 72, no. 26, June 29, 1918, pp. 1067-1069, 7 figs. Electric power applied to drills, haulage, crushers and screens.

Electricity in Agriculture. Elec. Times, vol. 54, no. 1394, July 4, 1918, pp. 19-20, 3 figs. Some notes on electric plowing in France.

Electricity in Coal-Mining Operations. Frank Huskinson. Elec. Rev., vol. 73, no. 1, July 6, 1918, pp. 1-4, 9 figs. Factors governing selection of electrical equipment; comparisons of alternating and direct current; advantages of central-station service.

Motor Drive in Newburgh Shipyard. W. H. Easton. Elec. World, vol. 72, no. 4, July 27, 1918, pp. 160-161, 6 figs. Standard types chosen to insure prompt delivery; individual motor drive selected for speeding output; foolproof equipment permits use of unskilled labor.

Motor Drive in Paper and Pulp Mills. C. E. Clewell. Elec. World, vol. 72, no. 4, July 27, 1918, pp. 152-154, 5 figs. Important applications, particularly beaters and grinders; variations on power requirements; examples of group and individual drive. First of a series.

Opportunities for Central-Station Power in the Oil Fields. L. E. Mohrhardt. Elec. Rev., vol. 73, no. 1, July 6, 1918, pp. 7-11, 7 figs. Application of electric power to the various operations involved and data on horsepower requirements.

See also Forging (Electric Power); Hydraulics (Hydroelectric Plants); Marine Engineering (Electric Power).

POWER PLANTS

Ash Conveyors

Economic Handling of Ashes. Reginald Trautschold. Indus. Management, vol. 56, no. 1, July 1918, pp. 17-20, 4 figs. Suction and steam jet conveyors, bucket carriers, and ash cars. Description of latest developments in ash-handling apparatus and approximate handling cost per ton.

Suction Conveyors for Ashes. R. Trautschold. Compressed Air Mag., vol. 23, no. 8, August 1918, pp. 8843-8845. Mechanical method of accomplishing the ash-handling task. From Indus. Management.

Automatic Stokers

Modern Plant of Paris Medicine Co. Power Plant Eng., vol. 22, no. 13, July 1, 1918, pp. 519-523, 7 figs. Illustrated description of a 100-kw. plant having automatic stokers.

Boiler House

Boiler Settings—Multiple Retort Underfeed Stokers. Charles H. Bromley. Power, vol. 48, no. 4, July 23, 1918, pp. 112-117, 9 figs. The latest and best practice in boiler settings for the multiple retort underfeed stoker. The problem of burning high-volatile and high-ash coals.

Improving Boiler-room Operation. J. L. Kentish-Rankin. Elec. Rev., vol. 72, no. 24, June 15, 1918, pp. 986-989. Bettering performance by standard improved methods and indicating instruments.

The Maintenance of Economy in the Boiler House. D. Wilson. Elecn., vol. 81, no. 9, June 28, 1918, pp. 169-171. The importance of regular and detailed records. The transmission of heat. The sampling and testing of coal with a view to accuracy. Routine desirable in regard to the control of flue gases and combustible in ashes.

Chimneys

Calculations of Sheets for Tapered Stack. John A. Cole. The Boiler Maker, vol. 17, no. 7, July 1918, pp. 187-189, 2 figs. Arrangement of forms for recording calculations to order and lay out cone sheets for tapered portion of stack.

Classification

Power Plant Classification. A. P. Connor. Power Plant Eng., vol. 22, no. 14, July 15, 1918, pp. 566-568. Questionnaire of the Fuel Administration on power-plant equipment and operation. How to fill it out. The Administration's requirements.

Coal Handling

Problems in Coal Handling. W. B. Woodhouse. Elecn., vol. 81, no. 9, June 28, 1918, pp. 162-165, 4 figs. Variations in supply and demand; data regarding quantities for a 100,000-kw. plant; ground necessary for sidings; methods of handling coal and ashes.

Isolated Plants

Isolated Service for Economy. Power Plant Eng., vol. 22, no. 14, July 15, 1918, pp. 559-564, 8 figs. Description of the new condensing turbine plant of the Burroughs Adding Machine Co. at Detroit.

Piping

Determining the Heat Given Off by Engine and Power Piping. E. V. Hill and W. J. Mauer. Heat. & Vent. Mag., vol. 15, no. 7, July 1918, pp. 18-24, 9 figs. Data and results of tests made by the Ventilation Division of the Health Department of the City of Chicago.

Steam Pipe Explosions. Edward Ingham. Colliery Guardian, vol. 115, no. 3000, June 28, 1918, p. 1297, 4 figs. A theoretical investigation of the means for reducing steam-pipe explosions.

Underground Pipe Mains—Material, Depreciation, Sizes for Steam and Water. Charles L. Hubbard. Power, vol. 48, no. 3, July 16, 1918, pp. 80-83. Formulæ and tables for calculating pipe sizes, etc.

Steam Hydroelectric Plant

Galt Waterworks. W. F. Sutherland. Power House, vol. 11, no. 7, July 1918, pp. 195-197. Combined steam and hydroelectric pumping station on the Grand River south of the city of Galt.

See also Electrical Engineering (Electrolysis); Steam Engineering (Steam Traps).

PRODUCER GAS AND GAS PRODUCERS

"Gasteam" Plant at Ford City, Ontario. Power, vol. 48, no. 6, August 6, 1918, pp. 187-193, 13 figs. A combination alternating- and direct-current plant employing "Gasteam" engines; boiler feedwater to recover waste heat from gas-engine cylinder jackets; gas producer plant and its operating methods.

Generation of Suction Gas for Gas Engines. Chem. Eng. and Min. Rev., vol. 10, no. 118, July 1918, pp. 305-306. Results of an investigation made into the working conditions of two suction-gas units at a Bendigo mine, the engines of which developed the required horsepower when connected with charcoal generators, but were found to be deficient in power on being supplied from wood generators.

Practical Operation of a Producer-Gas Power Plant. Francisco R. Ycasimo and Felix V. Valencia. Philippine Jl. of Science, May 1918, vol. 13, no. 3, pp. 99-131, 9 figs. Discussion of tests on Philippine fuels and description of the suction producer gas plant in the power house of the Bureau of Science, Manila.

PUMPS

Air Lift

Irrigating Florida Fruit by the Air Lift System. John Oliphant. Mine & Quarry, vol. 10, no. 47, July 1918, pp. 1064-1065.

Centrifugal Pumps

Modifying Centrifugal Pumps for Direct Motor Connection. B. B. Jackson. Eng. & Cement World, vol. 13, no. 2, July 15, 1918, pp. 70-73, 1 fig. Article explaining a given diagram of the characteristics of a 7-in. medium-head centrifugal pump when operated at five different speeds.

Piston and Plunger Pumps

Lift and Force Pumps. J. H. Perry. Domestic Eng., vol. 84, no. 6, August 10, 1918, pp. 144-196, 5 figs. Design, construction and operation of pumps of the piston and plunger types.

Rotary Feed Pumps

The Weir Turbine-Driven Rotary Feed Pump. Shipbuilding and Shipping Rec., vol. 11, no. 25, June 20, 1918, pp. 683-684, 2 figs.

RAILROAD ENGINEERING, ELECTRIC

Armatures

Some Notes on Maintenance of Armatures. R. H. Parsons. Elec. Traction, vol. 14, no. 8, June 1918, pp. 330-333, 11 figs. Practical suggestions on the care of armatures on electric railways.

Braking, Regenerative

Regenerative Electric Braking on Locomotives of the C., M. & St. P. Ry. W. F. Coors. Ry. Rev., vol. 62, no. 24, June 15, 1918, pp. 867-869, 1 fig. Simplified wiring diagram of the direct-current regenerative braking scheme.

Circuit Breaker

High Speed Circuit Breaker Prevents Flash-over on Milwaukee Electrification. Elec. Ry. Jl., vol. 52, no. 4, July 27, 1918, pp. 154-156, 6 figs. Description of function and operation of a circuit breaker used by the Chicago, Milwaukee & St. Paul Ry., and said to avoid the energy waste resulting from the use of a permanent resistance.

Electrification

Electrification of the Philadelphia Chestnut Hill Section, Pa. R. R. Ry. Gaz., vol. 28, no. 26, June 28, 1918, pp. 756-759. Particulars relating to the electrification of a suburban line.

The Electrification of the Railroads of America (Un mot sur l'électrification des grands chemins de fer aux Etats-Unis d'Amerique). J. Cartier. Revue Générale de l'Electricité, vol. 3, no. 26, June 29, 1918, pp. 913-918. Account of the system of operation in use by the electrified roads of America and study of the reasons which decided in favor of their electrification.

Freight Handling

Freight Handling on the South Shore Lines. Elec. Traction, vol. 14, no. 8, June 1918, pp. 317-321, 4 figs. Features of single-phase electric railway service between Chicago and South Bend, covering the Calumet industrial district.

Italian State Railways

Italian State Railways. Elec. Ry. & Tramway Jl., vol. 38, no. 924, June 14, 1918, pp. 219-220, 2 figs. Polyphase high-speed locomotives 2-C-2, group E 332, recently put into use by the Ateliers de Construction di Oerlikon.

Overhead and Track Work

A Graphical Method of Solving D. C. Track-Circuit Problems. H. M. Proud. Ry. Engr., vol. 39, no. 462, July 1918, pp. 141-145, 5 figs. Attempt to shorten calculations involved in the use of elaborate mathematical formulæ by using graphs in the solution of track problems. Paper presented before the Inst. of Ry. Signal Engrs. (To be continued.)

Electric Railway Construction on the Detroit Superior Bridge. Elec. Ry. Jl., vol. 52, no. 4, July 27, 1918, pp. 145-146, 10 figs. Description of the overhead and track work.

The Maximum Regulating Resistance and Maximum Shunt Resistance of Track Circuits. W. J. Thorrowgood. Ry. Engr., vol. 39, no. 462, July 1918, pp. 140-141. Discussion of an original article published in the issues of May and June, 1918. Paper read before the Inst. of Ry. Signal Engrs.

Passenger Handling

Electric Railway Construction on the Detroit-Superior Bridge. Elec. Ry. Jl., vol. 52, no. 4, July 27, 1918, pp. 145-146, 3 figs. Track, power-supply system and provision for handling passengers on the concrete and steel bridge across the Cuyahoga River at Cleveland, Ohio.

Rail Joints

When Is a Rail Joint Well Bonded? G. H. McKelway. Elec. Ry. Jl., vol. 52, no. 3, July 20, 1918, pp. 111-112, 2 figs. The difference in the conductance of a bonded joint and that of the bond.

RAILROAD ENGINEERING, STEAM

Air Brakes

A 100-Car Test of the Automatic Straight Air Brake. Ry. Age, vol. 65, no. 4, July 26, 1918, pp. 173-176, 4 figs. Runs on Virginian Railway with 100 A. S. A. and combinations of 50 A. S. A. and 50 Westinghouse brakes.

Maintenance of Freight Brakes. T. H. Goodnow. Railroad Herald, vol. 22, no. 8, July 1918, pp. 170-171. Remarks made at a meeting of the Car Foreman's Assn. of Chicago.

Car Axles

Mine Car Axles. B. P. Lieberman. Coal Age, vol. 14, no. 5, August 1, 1918, pp. 219-222, 5 figs. The suitability of iron and steel car axles; improvement of a steel axle of proper analysis by mechanical and heat treatment.

Cross Ties

Standard Specifications for Cross Ties. Ry. Maintenance Engr., vol. 14, no. 8, August 1918, pp. 273-274. Specifications adopted by the Central Advisory Purchasing Committee of the Railroad Administration.

Feedwater Heaters

Feedwater Heaters. J. Snowden Bell. Ry. Rev., vol. 63, no. 1, July 6, 1918, pp. 14-16, 3 figs. Basic principles of construction of feedwater heaters for locomotives. Read before the Am. Master Mechanics' Assn.

Government Control

Railways, Waterways and Highways. Edward A. Bradford. Ry. Rev., vol. 62, no. 26, June 29, 1918, pp. 935-938, 4 figs. Discussion of the present conditions of Government control in the coöperation of waterways, railways and highways.

Locomotive Design

First of the U. S. Standard Locomotives Completed. Ry. Age, vol. 65, no. 3, July 19, 1918, pp. 131-133, 5 figs. Details and description of light Mikado type built by Baldwin Locomotive Works.

Methods of Valve Setting for Walschaert Gear as Used by Am. Loco. Co. J. J. Jones. Loco., vol. 9, no. 2, August 1918, pp. 385-388, 4 figs. Regulations of the Am. Loco. Co.

Mikado Type of Locomotive for United States Government. Ry. Rev., vol. 63, no. 3, July 20, 1918, pp. 87-88, 1 fig. Description of design said to fairly represent the best of conservative thought in American locomotive design.

Modern Locomotive Engine Design and Construction. M. I. and J. T. H. Ry. Engr., vol. 39, no. 462, July 1918, pp. 131-135, 3 figs. Feedwater supply; locomotive feedwater heating systems. (Continuation of a serial.)

New Consolidation Locomotives and Excursion Cars on the Victorian Railways. Engineer, vol. 126, no. 3262, July 5, 1918, pp. 15-16, 5 figs.

Pacific and Mikado Type Locomotives. C., B. & Q. R. R. Ry. Rev., vol. 63, no. 1, July 6, 1918, pp. 1-5, 8 figs. Description of four types.

Recent Advances in Locomotive Efficiency. Paris, Lyons & Mediterranean Ry. Charles R. King. Ry. Rev., vol. 62, no. 24, June 15, 1918, pp. 851-855, 7 figs. The return to the use of compound locomotives with superheated steam after discovery that with improvements in design the superheater compounds are 35 per cent more efficient than the simples.

Locomotive Fuel

Anthracite Silt as a Locomotive Fuel. Ry. Rev., vol. 62, no. 24, June 15, 1918, pp. 857-860, 4 figs. Experiments made to adapt the silt mixture to locomotive use and the methods of preparation.

Lubrication

Coal Production and Lubrication. Reginald Trautschold. Coal Age, vol. 14, no. 4, July 25, 1918, pp. 175-176. Importance of lubrication of mine cars.

Railroad Operation

The Bearing of Malaria on Railroad Operation. H. W. Van Hovenberg. Ry. Age, vol. 65, no. 1, July 5, 1918, 2 figs. Descriptions of benefits to a road from a campaign to eliminate this sickness.

Roadbeds

Concrete Roadbed on Northern Pacific Ry. Eng. & Contracting, vol. 50, no. 3, July 17, 1918, pp. 55-56, 1 fig. Description of an experimental concrete roadbed with detail of construction.

Oil and Concrete-Reinforced Concrete in Railway Work. Ry. Age., vol. 39, no. 462, July 1918, pp. 135-137. Conditions under which oil may affect concrete. (Continuation of serial.)

Shocks in Trains

Shocks in Long Passenger Trains. R. Burges. Railroad Herald, vol. 22, no. 8, July 1918, pp. 172-175. Study of the factors that result in shocks. Review of a paper presented before the Southern and Southwestern Ry. Club.

Shops and Terminals

Buffalo Division Engine Terminals, Lehigh Valley R. R. Ry. Rev., vol. 62, no. 25, June 22, 1918, pp. 895-903, 25 figs. Modernizing the entire Buffalo division. An illustrated description of the important features.

Chilean Railroad Shops of American Design. Walter W. Nowak. Iron Age, vol. 102, no. 3, July 18, 1918, pp. 131-135, 3 figs. Plans won the $20,000 first prize from European engineers. A description of the shops.

New Shops and Engine Terminals, Buffalo, Rochester & Pittsburgh Ry. Ry. Rev., vol. 62, no. 25, June 22, 1918, pp. 907-911, 12 figs. Description of improved engine terminals and shop facilities, features of which are laid out for the requirements of Mallet compounds.

New York Central Opens Cleveland Freight Terminal. Ry. Age, vol. 65, no. 3, July 19, 1918, pp. 117-133, 11 figs. Description of the four-million dollar project.

Signal System

Position-Light Signals on Pennsylvania Railroad. Ry. Age, vol. 65, no. 4, July 26, 1918, pp. 177-178, 1 fig. The extension of the use of this type, its simplified aspects and reduction in costs of maintenance.

Train Operation by Signal Indication. Henry M. Sperry. Ry. Rev., vol. 63, no. 1, July 6, 1918, pp. 9-14, 6 figs. Features of the automatic block signal installation on the Erie from New York to Chicago of interest from a train-operation standpoint.

Train Operation by Signal Indication on the Erie. Henry M. Sperry. Ry. Age, vol. 65, no. 1, July 5, 1918, pp. 5-10, 6 figs. Some forms of train orders eliminated by use of power-operated train-order signals.

Stores

Railway Stores Methods and Problems. W. H. Jarvis. Ry. Gaz., vol. 28, no. 26, June 28, 1918, pp. 753-754; vol. 29, no. 1, July 5, 1918, pp. 9-12. Waste paper; tenders for scrap material; inspection of materials; standard patterns; standardization of materials. (Continuation of serial.)

Superheating

Installation and Maintenance of Superheater Dampers. Ry. Rev., vol. 62, no. 24, June 15, 1918, pp. 886-889, 6 figs. Adapted from Bul. No. 3 by the Locomotive Superheater Co.

Superheaters on Small Locomotives. Railroad Herald, vol. 22, no. 8, July 1918, p. 171. Dimensions of small locomotives built with superheaters by the Vulcan Iron Works, Wilkes-Barre, Pa.

Water Tanks

Creosoted Water Tanks. C. R. Knowles. Ry. Maintenance Engr., vol. 14, no. 8, August 1918, pp. 272-273.

See also Hoisting and Conveying (Loco Tractor).

REFRACTORIES

Silica Brick in Open-Hearth Furnace Roofs. Iron Age, vol. 102, no. 5, August 1, 1918, pp. 270-272. Deterioration as observed by French authorities; role of iron oxide and lime in their manufacture; composition after use in roofs. Translation abstracts made by E. C. Buck.

REFRIGERATION

Ammonia Solubility

The Solubility of Ammonia. M. J. Eichhorn. Ice & Refrigeration, vol. 55, no. 2, August 1, 1918, pp. 41-47, 6 figs. Formulae, tables, existing scientific data and review of researches concerning ammonia solutions in water.

Refrigeration, Electrical

The Opportunity of Electrical Refrigeration. H. N. Sessions. Jl. of Elec., vol. 41, no. 3, August 1, 1918, pp. 104-107. Possibilities of extension of electrical refrigeration.

RESEARCH

Industrial

Coöperation in Industrial Research. Iron Age, vol. 102, no. 3, July 18, 1918, pp. 140-144. A report of the topical discussion at the meeting of the Am. Soc. for Testing Materials, Atlantic City.

Organization of Industrial Research. Arthur D. Little. Eng. & Contracting, vol. 50, no. 4, July 24, 1918, pp. 90-91. New aspect of research; aims of research organization; research and technical schools; principles of general application in industrial-research laboratories.

Marine Engineering

Research in Marine Engineering. A. E. Seaton. Int. Mar. Eng., vol. 23, no. 7, July 1918, pp. 420-423. How lack of research has retarded progress in marine engineering; what it can accomplish. Paper read before the Inst. of Naval Architects, London, March 1918.

ROADS AND PAVEMENTS

Brick Pavements

The Bound Bases for Brick Pavements. John S. Crandell. Am. City, vol. 19, no. 2, August 1918, pp. 102-103. Suggested specifications for a tar-bound base for brick pavements. From an address before the Nat. Paving Brick Manufacturing Assn.

Concrete Pavements

Concrete Pavements. Murray A. Stewart. Can. Engr., vol. 35, no. 3, July 18, 1918, pp. 57-59. Recital of experimental work undertaken to ascertain the respective merits of different classes of concrete. Paper contributed to the 1917-1918 Trans. Am. Soc. of Mun. Improvements.

Construction of Concrete Pavements. J. L. Harrison. Eng. & Cement World, vol. 13, no. 13, August 1, 1918, pp. 27-29. Account of the behavior of a concrete road and general remarks regarding requirements of concrete for road use.

Costs

Ultimate Costs of Bituminous and Water-bound Macadams Nearly Equal in New York. Dudley P. Babcock. Eng. News-Rec., vol. 81, no. 2, July 11, 1918, pp. 87-90. Highway department investigation indicates that total tonnage affects cost but slightly; equation derived for the relation of ultimate cost to traffic tonnage.

Granite Paving Blocks

Granite Paving Block Industry. Stone, vol. 39, no. 7, July 1918, pp. 317-318. An account of the state of the industry throughout the country based on reports compiled under the direction of the U. S. Geological Survey.

Highways

Effect of Heavily Loaded Motor Trucks on Surfaced Highways. Western Eng., vol. 9, no. 8, August 1918, pp. 311-312. Discussion by several Eastern highway officials on the effect of motor-truck traffic on improved highways and of measures to be taken to protect such highways from deterioration. From the official magazine of the U. S. Office of Public Roads.

Problem of Highway Transportation. F. A. Seibarling. Eng. & Cement World, vol. 13, no. 2, July 15, 1918, pp. 23-26. Suggestions to adopt permanent construction on rural roads as a solution to the transportation problem.

Resurfacing

Who Pays for Resurfacing Pavements? Can. Engr., vol. 35, no. 4, July 25, 1918, pp. 83-86. Results of an investigation carried out by the Am. Soc. of Municipal Improvements regarding methods of securing and financing resurfacing of worn pavements followed by the principal cities of the United States and Canada.

Road Materials

Typical Specifications for Bituminous Road Materials. Bulletin No. 691 (60 pages), U. S. Department of Agriculture, July 10, 1918. Specifications offered by the Office of Public Roads and Rural Engineering and prepared partly from the results of its own experimental work.

Shrinkage of Road Materials

Determination of the Shrinkage of Gravel and Sand-Clay Mixtures Packed by Traffic. Roy M. Green. Good Roads, vol. 16, no. 5, August 3, 1918, pp. 39-40, 1 fig. Account of tests made and curve showing results obtained.

See also Engineering Materials (Road Materials).

SAFETY ENGINEERING

Electrical Accidents

Safeguarding the Home and Person from Electrical Accidents. Elec. Eng., vol. 52, no. 1, July 1918, pp. 25-36. Abstract from circular No. 75 of the U. S. Bureau of Standards setting forth the causes of electrical accidents.

Industrial-Plant Accidents

Reduction of Accident Hazard. R. L. Gould. Am. Mach., vol. 48, no. 25, June 20, 1918, pp. 1057-1060, 1 fig. A discussion of the questions confronting the safety engineer in his endeavor to minimize the risk of accident in our industrial plants and suggestions for promoting the work.

Mine Accidents

Protective Devices of Electrical Equipments in Mine Against Gases and Moisture (in Japanese). M. Furuta. Denki Gakkwai Zasshi, no. 355, February 1918, pp. 191-215.

Quarry-Operation Accidents

Accident Prevention in Quarry Operation. William H. Baker. Eng. & Contracting, vol. 50, no. 3, July 17, 1918, pp. 59-61. Abstract from an address delivered before the Nat. Safety Council.

Smelteries and Refineries

Safety Appliances in Smelteries and Refineries. George M. Douglass. Eng. & Min. Jl., vol. 106, no. 3, July 20, 1918, pp. 105-108, 8 figs. Devices used in a modern plant. Causes of common accidents and their prevention.

See also Electrical Engineering (Lightning Arrester; Transmission Lines).

SANITARY ENGINEERING

Carbon Dioxide in Air

The Safe Limit of Carbon Dioxide in the Working Atmosphere. G. O. Higley. Am. Jl. of Public Health, vol. 8, no. 7, July 1918, pp. 477-481.

Disinfectants

Report of the Committee on Standard Methods of Examining Disinfectants. Am. Jl. of Public Health, vol. 8, no. 7, July 1918, pp. 506-521.

Sewerage

An Inventory and Prospectus for a Comprehensive Sewerage System. H. W. Taylor. Am. City, vol. 19, no. 2, August 1918, pp. 139-143. A recent development in the city of Glens Falls, N. Y.

Sewage Treatment in Sedalia. Mun. Jl., vol. 45, no. 2, July 13, 1918, pp. 23-25, 3 figs. Missouri city employing grit chamber, Imhoff tanks, sludge beds, dosing tank and sprinkling filters to avoid polluting a small stream.

Uses and Accomplishments of Chlorine Compounds in Sanitary Science. Charles H. Jennings. Fire and Water Eng., vol. 64, no. 3, July 17, 1918, p. 44. Extract from a paper read by Mr. Jennings before the Southwestern Water Works Assn. at its convention in Tulsa, Okla.

Soap Solutions

On the Bactericidal Efficiency of Soap Solutions in Power Laundry. H. G. Elledge and W. E. McBride. Am. Jl. of Public Health, vol. 8, no. 7, July 1918, pp. 494-498.

Water

Analysis and Quality of Water. Mun. Jl., vol. 45, no. 4, July 27, 1918, p. 71. Table showing the results of the analyses of water made by several hundred municipal plants. (Concluded.)

Chemical and Bacteriological Examination of the London Waters. A. C. Houston. Can. Engr., vol. 35, no. 5, August 1, 1918, pp. 98-100. Report of the Metropolitan Water Board of London.

Water Purification. R. A. Collect. Indian Industries & Power, vol. 15, no. 9, May 1918, pp. 389-393, 2 figs. Extensive description of a Paterson filter plant, with an explanation of purifying process. (Concluded.)

See also Marine Engineering (Fumigating Apparatus).

STEAM ENGINEERING

Boiler Construction

Engineering Specialties for Boiler Making. The Boiler Maker, vol. 18, no. 7, July 1918, pp. 202-204, 6 figs. Description of new tools, machinery, appliances and supplies for the boiler shop and of improved fittings for boilers.

Method of Determining Row of Least Efficiency in Boiler Seams. D. Shirrell. Loco., vol. 9, no. 2, August 1918, pp. 366-368, 1 fig. Offered proof that the least efficiency—i.e., whether this least efficiency is in the outer row of rivets through the single welt or in the outer row of the double welt, depends upon the ratio between the thickness of the boiler shell plate and the diameter of the rivet.

Condensers

Getting a High Vacuum at the Turbine Exhaust. Hartley LeH. Smith. Elec. Ry. Jl., vol. 52, no. 3, July 20, 1918, pp. 99-101. Shows how faults in condenser design are being overcome and emphasizes some fundamental considerations.

Recent Developments in Condensers. D. W. R. Morgan. Elec. World, vol. 72, no. 5, August 3, 1918, pp. 204-206, 4 figs. Necessity of efficient air removal in surface condensers; relative advantages of steam air ejectors and hydraulic and reciprocating air pumps; increasing use of jet condensers for large units.

Steam Condensers. J. H. Coates. Nat. Eng., vol. 22, no. 8, August 1918, pp. 358-361, 1 fig. Reasons for selecting one of the two general types of condensers for a given service. Abstract of a paper read before the Iowa State Convention, N. A. S. E.

The Problem of Condensing in Large Power Stations. J. H. Rider. Elecn., vol. 81, no. 9, June 28, 1918, pp. 172-174. Emphasis laid on large quantities of water necessary in a plant of 200,000 kw. Methods which may be used when the flow of water on a river site is insufficient, with figures showing reduction in vacuum which results. The limitations of cooling towers for large power stations.

High-Pressure Steam

Possible Economies by the Use of High-Pressure Steam. Frederick Samuelson. Elecn., vol. 81, no. 9, June 28, 1918, pp. 166-168, 4 figs. Considers improved efficiency obtainable by increasing both the temperature and pressure of the steam. Emphasizes economy obtainable by using steam from turbines for heating feedwater. Particulars of high-pressure steam plant at the Rugby works of the British Thomson-Houston Co., Ltd.

Steam Plant Design—Care for High Pressures and Temperatures. Times Eng. Supp., no. 525, July 1918, p. 147. Possibility of obtaining higher overall efficiencies in large power stations by the use of steam at higher pressures and temperatures than have hitherto been usual. Paper read by Mr. J. H. Shaw before the Inst. of Elec. Engrs.

Reciprocating Engines

A Uniflow Engine Installation. Iron & Coal Trades Rev., vol. 97, no. 2629, July 19, 1918, p. 53, 2 figs. Description of two 500 hp. Robey uniflow steam engines.

Steam Engine Economy. D. Arnot. Practical Engr., vol. 57, no. 1635, June 27, 1918, pp. 304-305, 3 figs. Exposition of methods used and summary of results obtained in tests on several types of engines. (Concluded.)

Steam Traps

Some Notes on Steam Traps. Machy. Market, no. 925, July 26, 1918, pp. 19-20, 4 figs. Expansive traps so constructed that the amount of expansion is magnified in such a way that the trap itself can be made considerably smaller. (Continuation of a serial.)

Turbines

Discussion on the Stal-Turbine (in Japanese). Denki Gakkwai Zasshi, no. 355, February 1918, pp. 161-167.

Small Steam Turbines. J. Humphrey. Iron & Coal Trades Rev., vol. 97, no. 2629, July 19, 1918, p. 53, 2 figs. Comments on their use in mines.

Turbines Furnish Additional Power. Coal Industry, vol. 2, no. 8, August 1918, pp. 304-306, 1 fig. How the exhaust steam from a reciprocating engine may be utilized to furnish additional power through a turbine-generator unit.

Value of Stal-Turbine as Land Electric Generator (in Japanese). K. Koyama. Denki Gakkwai Zasshi, no. 355, February 1918, pp. 215-231.

2500 Hp. Rateau Marine Geared Turbines. Engineer, vol. 126, no. 3263, July 12, 1918, pp. 36-38, 8 figs. Illustrated description of turbines and gears.

See also Cooling; Engineering Materials (Boiler Plates); Marine Engineering (Boilers); Power Plants (Steam Hydroelectric Plant); Railroad Engineering, Steam (Superheating); Thermodynamics (Latent Heat of Steam).

STEEL AND IRON

Briquetting Ores

Present Knowledge and Practice in Briquetting Iron Ores. Guy Barrett and T. B. Rogerson. Automotive Eng., vol. 3, no. 6, July 1918, pp. 261-263. Methods followed and machines used in briquetting iron ores and diagrammatic sketches of several presses. (To be continued.)

Electrical Resistance in Steel

On the Thermal and Electric Conductivities of Nickel Steels. Kôtarô Honda. Science Reports of the Tôhoku Imperial Univ., vol. 7, no. 1, July 1918, pp. 59-66, 2 figs. Investigation of Wiedmann-Franz' law establishing that the ratio of the conductivities

of two substances is independent of their nature.

The Effect of Annealing on the Electrical Resistance of Hardened Carbon Steels. I. P. Parkhurst. Jl. Indus. & Eng. Chem., vol. 10, no. 7, July 1918, pp. 515-518, 3 figs. Investigations showing that the total change in resistance increases with the carbon content and that the change is very rapid at the beginning of annealing but becomes slower as the resistance decreases.

Ferromanganese

Liquid Ferromanganese in Steel Making. Iron Age, vol. 102, no. 4, July 25, 1918, pp. 208-209. Advantages over using the solid alloy; type of melting furnace; cost and savings by one American steel maker.

Heat Treatment

Effect of Mass on Heat Treatment. E. F. Law. Mechanical World, vol. 63, no. 1637, May 17, 1918, p. 238. Abstract of a paper read before the Iron & Steel Inst.

Heat Treatment and the Hardening and Tempering of Steel. C. A. Edwards. Can. Machy., vol. 20, no. 4, July 25, 1918, pp. 82-86, 17 figs. Facts relative to heat treating in general of both carbon and alloy steels. From a paper read before the Manchester Assn. of Engrs.

Ingots

On the Distribution of Temperature in Steel Ingot During Cooling. Sêzô Saitô. Jl. of the Soc. M. E., Tokyo, vol. 21, no. 51, May 1918, pp. 15-30, 18 figs. Calculation of the distribution of temperature in cylindrical and rectangular ingots.

Macrostructure of Steel

Macrostructure of Steel (La macrostructure de l'acier). A. Portevin and V. Bernard. Revue de Métallurgie, year 15, no. 3, May-June 1918, pp. 273-280, 44 figs. Experimental determination of the structure of steel by means of the Stead-Le Chatelier reagent.

Nicu Steel

Nickel Copper—*Nicu* Steel. R. W. Leonard. Page's Eng. Weekly, vol. 33, no. 722, July 12, 1918, p. 19. Manufacture of nickel-copper steel. From a paper presented to the Can. Soc. of C. E.

Steel Ingots

Causes of Defects in Steel Ingots. J. N. Kilby. Iron Age, vol. 102, no. 5, August 1, 1918, pp. 266-269, 4 figs. Benefit of lime in acid open-hearth slags and the saving of manganese; temperature and speed of pouring. From a paper before the Iron & Steel Inst., London, May 1918.

Volume Changes of Steel

Expansion Changes in Nickel-Steels (Changements que provoquent dans la dilatabilité des aciers au nickel les actions thermiques ou mécaniques). Ch-Ed. Guillaume. Archives des Sciences Physiques et Naturelles, vol. 45, June 1918, pp. 407-417, 2 figs. Interpretation of experiments performed on different specimens of nickel-steel and determination of the change produced in the coefficient of expansion of these alloys by thermal or mechanical agents.

On the Slow Contraction of Hardened Carbon Steels. Tokujiro Matsushita. Science Reports of the Tôhoku Imperial Univ., vol. 7, no. 1, July 1918, pp. 43-52, 4 figs. Investigation of the gradual evolution of heat accompanying the contraction of hard carbon steel.

See also Electrical Engineering (Electric Furnace); Forging (Electric Steel); Machine Shop (Heat Treating); Military Engineering (Gun Erosion).

TESTING AND MEASUREMENTS

Electrical Measuring Apparatus

The Temperature Coefficient in Electrical Measuring Apparatus (El coeficiente de temperatura en los medidores eléctricos). Boletin de la Asociacion Argentina de Electro-Técnicos, vol. 4, no. 1, January 1918, pp. 615-617. Beginning of an article proposing the adoption of several tests to be performed on electrical measuring apparatus in order to rate their accuracy.

Hardness

Notes on Testing Hardness of Metals. J. W. Craggs. Scientific Am. Supp., vol. 86, no. 2223, August 10, 1918, pp. 94-95. Discussion of the use and application of the methods for testing hardness.

Resistance of Materials (Résistance des Matériaux). H. Le Chatelier and A. Bogitch. Académie de Sciences, vol. 166, no. 21, May 27, 1918, pp. 840-843. Comparison of the results on the hardness of materials of construction obtained by the use of Brinell's ball with the data derived by other methods.

Heat-Measuring Instruments

Requirements in Treating Materials. J. F. Beall. Am. Drop Forger, vol. 4, no. 7, July 1918, p. 283. Development of heat-measuring instruments.

Impact Tests of Steel

The Tension, Impact and Repeated Impact Tests of Mild and Hard Steels. Tsuruzo Matsumura. Jl. of the Soc. M. E., Tokyo, vol. 21, no. 52, June 1918, pp. 1-11, 16 figs. Result of comparative tests on steel bars of various grades of hardness.

Refractometer

A Differential Refractometer. G. A. Shook. Louisiana Planter & Sugar Manufacturer, vol. 61, no. 4, July 27, 1918, p. 58, 2 figs. Attempt to develop an instrument for measuring the difference in refractive index between two liquids.

Sand

Testing Sand for Concrete. Eng. & Cement World, vol. 13, no. 2, July 15, 1918, p. 70. Color test for detecting the presence in sand of organic impurities of a humus nature which would render concrete unfit for use in high-grade work such as is required in roads, pavements or in building construction.

Viscosity Measurement

Measurement of the Viscosity of a Fluid with a Galvanometer (Application du galvanomètre à cadre mobile à la mesure de la viscosité des fluides). Revue Générale de l'Electricité, vol. 3, no. 26, June 29, 1918, p. 938. Additional notes on the method of measuring the viscosity of a liquid by comparison to the viscosity manifested in induction phenomena submitted to the French Soc. of Physics by M. A. Guillet and published in the issue of May 1918.

THERMODYNAMICS

Heat Transmission

Heat and Heat Transmission. John R. Allen. Eng. & Contracting, vol. 50, no. 4, July 24, 1918, pp. 79-80. Constants for heat transmission, heat losses from infiltration, radiation and radiators, determining pipe sizes. From a paper before the Am. Soc. of Heat. & Vent. Engrs.

Latent Heat of Steam

Regnault's Latent Heat of Steam Investigations. Frank B. Aspinall. Engineer, vol. 125, no. 3260, June 21, 1918, pp. 525-527, 1 fig. A careful review of Regnault's apparatus, his fallacious assumptions and his erroneous conclusions.

See also Power Plants (Piping).

TIMBER AND WOOD

Fireproofing Wood

Fireproofing Mine Shaft of the Anaconda Copper Mining Co. E. M. Norris. Eng. & Min. Jl., vol. 105, no. 25, June 22, 1918, pp. 1126-1127, 1 fig. Fireproofing mine timbers by a cement coating on the timbers, which had been covered with metal lath. Cement applied with cement gun.

Relative Resistance of Various Hard Wood to Injection with Creosote. C. H. Teesdale. Railroad Herald, vol. 22, no. 8, July 1918, pp. 167-170, 1 fig. Results of experiments made at the Forest Products Laboratory, maintained by the Forest Service, U. S. Department of Agriculture, in coöperation with the University of Wisconsin.

Lumber Industry

The Uses of Wood. Hu Maxwell. Am. Forestry, vol. 24, no. 295, July 1918, pp. 419-427. Third of a series of articles covering the processes of logging, lumbering, transportation, milling, utilization and manufacture of wood.

Timber Industry. Percy Groom. Jl. of the Royal Soc. of Arts, vol. 66, no. 3424, July 5, 1918, pp. 515-524. Extent to which technical science can aid in promoting the timber industry and the utilization of the timber resources of the British Empire.

See also Engineering Materials (Wood); Railroad Engineering, Steam (Water Tanks).

VARIA

Cascade Method of Froth Flotation. W. A. Fahrenwald. Min. & Sci. Press, vol. 117, no. 3, July 20, 1918, pp. 87-88, 3 figs. Description of a new experimental method.

Comparative Analysis of Gravel Screens. Raymond W. Dull. Eng. & Contracting, vol. 50, no. 3, July 17, 1918, pp. 62-64, 10 figs. Theoretical comparison of the efficiencies of different types.

Economies in the Use of Tin. Metal Industry, vol. 16, no. 7, July 1918, pp. 307-308. Savings found in babbitt manufacture, other alloy castings and in solder.

Entire Blast Furnace Plant Salvaged. Iron Age, vol. 102, no. 4, July 25, 1918, pp. 197-199, 5 figs. War time economics applied in removal of a Midland stack and its reerection at Sault Ste. Marie.

Evolutionary Business Principles. L. P. Alford. Indus. Management, vol. 56, no. 1, July 1918, pp. 8-9. Lay the basis for determining the proper cost of a commodity with reference to the rights of the public.

New Contract System Which Stimulates Efficiency Gaining Favor. Henry D. Hammond. Eng. News-Rec., vol. 81, no. 3, July 18, 1918, pp. 118-120. Percentage and fee forms of contract which shift risks to owner and make certain that contractor will devote best efforts to work.

Perspective Sketching from Orthographic Views. Arthur B. Babbitt. Mechanical World, vol. 63, no. 1637, May 17, 1918, pp. 232-234. (Continued.)

Putting Car Wheels Under Shipbuilders. Elec. Ry. Jl., vol. 52, no. 5, August 3, 1918, pp. 186-192, 3 figs. Work of the Division of Passenger Transportation and Housing of Emergency Fleet Corporation.

Retrenchment by Reclamation. Millard F. Cox. Ry. Rev., vol. 62, no. 24, June 15, 1918, pp. 861-863, 6 figs. Discussion of economies through reclamation of materials.

Steam Ploughing and Cultivating Equipment. Engineer, vol. 125, no. 3260, June 21, 1918, pp. 527-530, 12 figs. A review of early, and description of modern, equipment.

The Advantages of the Storage of Water. M. C. Whipple. Fire & Water Eng., vol. 64, no. 6, August 7, 1918, pp. 94-95. Extract from a paper read before the Convocation and Four-day School of Public Health, Boston, Mass.

The Condensation of Zinc from its Vapor. C. H. Fulton. Trans. Am. Inst. Min. Engrs., no. 140, August 1918, pp. 1375-1394, 5 figs. Methods of investigating the distillation products from reduction of zinc ore and of the equilibrium of the resulting reaction in temperature range of condensation; requisites for successful condensation.

The Engineer's Opportunities in Foreign Trade. G. A. Harris. Monad, vol. 3, no. 8, August 1918, pp. 12-14. Extract from a paper read before the Am. Assn. of Engrs.

The Interest of American Machinery Manufacturers in Russia. Sterling H. Bunnell. Am. Mach., vol. 49, no. 4, July 25, 1918, pp. 155-157. Outlines the conditions in Russia today and makes suggestions as to the proper course for manufacturers to follow.

The Proper Basis for a Foreign Trade. John L. Harrison. Ry. Age, vol. 65, no. 4, July 26, 1918, pp. 183-185. Some views by one who has spent several years in Asiatic countries.

The Reform of British Weights and Measures. The Monthly Rev., vol. 26, no. 6, June 1918, pp. 99-101. History of proposals for the adoption of the metric system of weights and measures in the United Kingdom, from the final report of the Committee on Commercial and Industrial Policy After the War.

The Ruth Flotation Machine. Arthur J. Hoskin. Min. & Sci. Press, vol. 117, no. 4, July 27, 1918, pp. 119-121, 3 figs. Illustrated description.

Valuation of Public Service Property. A. S. B. Little. Gas Age, vol. 42, no. 2, July 15, 1918, pp. 57-59. A technical discussion of theories and practices employed in fixing values, from the viewpoint of a State Commission engineer.

Volume of Gas in High-Pressure Tanks. J. M. Spitzglass. Gas Jl., vol. 143, no. 2878, July 9, 1918, p. 69. Determination of a rule to find the volume of a gas at high pressure from the characteristic gas equation.

Would Rate State Highway Contractors on Past Performance. S. E. Fitch. Eng. News-Rec., vol. 81, no. 3, July 18, 1918, pp. 125-127. Proposes giving contractor part of saving under estimated cost and advantage in bidding proportionate to speed and efficiency shown.

WOOD

(See Timber and Wood.)

THE NATIONAL ENGINEERING SOCIETIES AND THE NATIONAL RESEARCH COUNCIL

By DR. GEORGE ELLERY HALE,[1] PASADENA, CAL.

DR. GEORGE E. HALE

IN an address delivered in the Engineering Societies Building on May 28, at the kind invitation of the Engineering Foundation, I briefly sketched "The War Activities of the National Research Council." The wide scope of my subject, calling for some reference to the work of the Council in the various branches of the physical and biological sciences, as well as in agriculture, medicine, and other arts, forced me to touch very lightly upon engineering. I therefore beg permission to return to this phase of the subject in the present paper.

As shown in the address just cited, the charter membership of the National Academy of Sciences, constituted in the midst of the Civil War, comprised a notable group of engineers. Indeed, engineering was the only one of the arts represented in the Academy, which based its elections, then as now, upon creative work and original contributions to knowledge. The war was the immediate stimulus that led to the establishment of the Academy, but the published opinions of well-known visitors from abroad indicate that there was urgent need for such a body in this country.

De Tocqueville, in a chapter entitled "How the example of the Americans fails to prove that a democratic people cannot possess aptitude and taste for science, literature and art," wrote in 1840 as follows: "It must be admitted that among the civilized peoples of our time there are few in which the higher sciences have made less progress than in the United States."[2] This he attributed to our Puritan origin, our pursuit of the wealth which is so easily acquired in a new country, and our dependence upon England for intellectual things. "I consider the people of the United States as that portion of the English people which is charged with the exploitation of the forests of the new world, while the rest of the nation, enjoying more leisure and less preoccupied with the material needs of life, may devote itself to thought and to the development of the human mind in every field."[3]

But although he regarded the United States as exceptional, he fancied that he recognized in all democracies conditions of disturbance and unrest which leave little opportunity for the quiet and repose essential to the cultivation of science. These he carefully distinguished, however, from great upheavals of the body politic. "When a violent revolution occurs among a highly civilized people, it cannot fail to give a sudden impulse to feeling and imagination."[4] Thus the French achieved their highest development in science soon after the revolution of 1789.

In 1863, when the National Academy was incorporated, De Tocqueville would probably have considered our intellectual dependence upon England to be materially less than at the time of his visit to the United States, thirty years earlier. Doubtless he would have attributed the improved condition of American science to the effect of the Civil War, and the considerable increase in wealth and leisure. In 1873, if we may judge from Tyndall's remarks in the concluding lecture of his American series, European opinion saw hope for the future of science in the United States, but recognized few important accomplishments. "If great scientific results are not achieved in America, it is not to the small agitations of society that I should be disposed to ascribe the defect, but to the fact that the men among you who possess the endowments necessary for profound scientific inquiry are laden with duties of administration, so heavy as to be utterly incompatible with the continuous and tranquil meditation which original investigation demands."[5] At this time Henry was secretary of the Smithsonian Institution, Barnard was president of Columbia College, and Rogers was president of the Massachusetts Institute of Technology. There was thus some justification for Tyndall's remark, though the amount of scientific research in progress was much larger than one would infer from his statement of the case. Moreover, though deprived by other duties of the privilege of personal work in the laboratory, these very men, charter members of the National Academy, were, nevertheless, laying the foundations of science in America. By uniting in one national body the representatives of research in both science and engineering they set an example which their successors should keep steadily in view.

The half century which elapsed before the United States was again stirred to its depths by another great war was a time of specialization, both at home and abroad. Once fairly launched, both science and the arts made rapid progress, but they inevitably grew apart. Indeed, the tendency toward specialization which divided the arts from the sciences also separated the sciences into many distinct groups and split the arts widely asunder. Thus in engineering many societies were organized, first those comprising the major fields of civil, mechanical, mining and electrical engineering, subsequently those dealing with the special problems of naval architecture, illumination, refrigeration, and still more narrowly limited branches. At the same time numerous major and minor societies were formed in the general field of medicine; others marked out special territories in the name of agriculture, forestry and fisheries; and the process of subdivision and separation still goes on.

It is plain that these effects of specialization, while natural and essential elements in the development of science and the arts, involve certain consequences which are far from advantageous. The underlying motive of the investigator, to advance knowledge and to improve practice through the utilization of new ideas, is common to all fields of action. His point of view is much the same, whether his problems be those of the biologist or the engineer. Moreover—and this is a matter of prime importance—the principles and methods of research developed in one field may be equally applicable in another.

[1] Chairman of The National Research Council. Director, Mt. Wilson Solar Observatory.

[2] De la démocratie en Amérique, 17th ed., vol. 3, p. 58.

[3] Op. cit. p. 60.

[4] Op. cit. p. 70.

[5] Six Lectures on Light, 2nd ed., p. 226.

Thus there is an essential solidarity of research which should bring into active cooperation the men engaged in all of its various branches. Recent experience, both in peace and war, has shown how effectively the physicist and chemist can join forces with the engineer: in fact, how men drawn from the most diverse fields can utilize their varied experience to common advantage.

The remarkable development of engineering in the United States is indicated by the success of the four great national societies, which aggregate more than 30,000 members. Nine-tenths of the work of the engineer is organization and construction rather than research. While the chief interests of the national societies thus lie in other fields, the importance of research is such as to demand a large measure of support from each of them. Moreover, great benefit will result from a joint effort, involving the coöperation of the national engineering societies with the National Academy of Sciences in a new and powerful movement to promote research in every branch of science and the arts. The establishment of the National Research Council, and the duties laid upon it by the President in his recent Executive Order, plainly indicate the steps to be taken.

It is natural that the first effective contact between the National Academy of Sciences and the national engineering societies should have been established through the Engineering Foundation, endowed by Mr. Ambrose Swasey, Past-President Am.Soc.M.E., a mechanical engineer who has contributed greatly to the progress of astronomy through the perfection of the powerful telescopes built by the firm of Warner and Swasey. It is equally natural that the engineers who, with Mr. Swasey, took leading parts in the movement toward a consolidation of interests were also men fitted by experience to appreciate both sides of the question. The National Academy owes a special debt of gratitude to Mr. Gano Dunn, Mem.Am.Soc.M.E., who immediately grasped the purpose in view and has worked unceasingly toward its accomplishment. Though prevented by his heavy responsibilities as a construction engineer from conducting research in a professional way, Mr. Dunn's private activities as an investigator are well known to his friends, who therefore understand how wholeheartedly he has devoted himself to the task of breaking down the artificial barriers between the engineer and the man of science. Others who were most active in the initiation of the movement, including particularly Colonel Carty and Dr. Pupin, also combine experience in research with exceptional capacity as engineers. With their effective aid, and with the active support of the officers of the Engineering Foundation and those of the national societies, the difficulties of the initial steps were soon removed and the way was prepared for the intimate coöperation subsequently realized.

The National Academy, probably because of the general tendency toward separate development of the arts and sciences already mentioned, failed to maintain on its rolls the same percentage of engineers with which it originally set out. At the annual meeting in April 1916, however, the following resolution, presented by the Council, was adopted by the Academy:

> That the Council express to the Academy the opinion that it is desirable that a section of engineering be developed which shall include men who have made original contributions to the science or art of engineering; that to this end the Council suggests to the Academy that the present section of physics and engineering be designated the section of physics, and that the Council, under the authority granted by section 4, article 4, of the constitution, nominate to the Academy, after inviting suggestions from the members of the Academy, two or three engineers each year until such time as it shall seem advisable to establish a separate section of engineering, any engineers elected as the result of such nominations being in the meantime assigned to that one of the existing sections to which their work is most closely related.

Since that time six eminent engineers have been elected to membership in the Academy, and the Section of Engineering will soon be established.

Another means of connection between the Academy and the engineering profession was initiated at the same meeting. Our relations with Germany, after repeated submarine attacks on merchant ships, were in a state of high tension, and the need of some preparation for coming war was plainly evident. The Academy's offer of service to the President was at once accepted, and the National Research Council was formed, at the President's request, for the purpose of federating the research activities of the country.[1]

The first duty laid upon the National Research Council by President Wilson in his Executive Order of May 11, 1918, reads as follows:

> 1 In general, to stimulate research in the mathematical, physical and biological sciences, and in the application of these sciences to engineering, agriculture, medicine and other useful arts, with the object of increasing knowledge, of strengthening the national defense, and of contributing in other ways to the public welfare.

This definition of the scope of the Council indicates its purpose to give equal attention to research in all branches of science and the arts. The Council fully recognizes the solidarity of research to which reference has already been made, and its efforts will be directed to promoting the closest coöperation between investigators in every field. It should be clearly understood that the National Research Council was not organized as an independent body, but as a means of federating existing research agencies.

War Duties

It is a matter of prime importance that in all researches bearing on the war the scientific and technical societies of the entire country should work in close coöperation, both to avoid unnecessary duplication and to insure the utilization of all ideas and facilities available for the solution of the most difficult problems. The National Research Council affords the necessary means of bringing representatives of these bodies together and into contact with the various technical bureaus of the Army and Navy and other departments of the Government. The advantages afforded by the Research Information Service, and the other facilities for international coöperation provided by the Council, are described below. Here we may observe how some of the work in engineering is conducted.

The appointment of Mr. Gano Dunn as chairman and Dr. W. F. Durand as vice-chairman of the Council's first Engineering Committee insured that its work would be ably directed. Mr. Dunn's engineering duties made it necessary for him to retain his headquarters in New York, but his close contact with the Engineering Foundation and the national societies proved very advantageous. His activities, in fact, led directly to the Council's first step in securing general coöperation in the organization of researches bearing on the submarine problem. In the initiation and development of many other undertakings he played an equally important part. Dr. Durand's joint duties in Washington, as vice-chairman of the Engineering Committee and as chairman of the National Advisory Committee for Aeronautics, gave him opportunity for valuable work in the organization and conduct of many in-

[1] See War Activities of the National Research Council.

vestigations of an engineering nature. When the Research Information Committee was established, Dr. Durand's qualifications for the position of scientific attaché and representative of the Research Council in Paris were so exceptional that he was transferred to this important post.

As a typical illustration of the work of the Engineering Committee, we may mention the organization and activities of the special Sub-Committee on Protective Body Armor, which includes in its membership the curator of arms and armor of the Metropolitan Museum of Art, representatives of the Ordnance Department of the Army, well-known metallurgists, and several able engineers experienced in different fields. The close coöperation of this sub-committee with the Ordnance Department enabled it to carry on its work very effectively, and to make all necessary tests of the special types of helmets and body armor that were devised. The form of the helmet was materially influenced by the extensive knowledge of ancient armor possessed by Dr. (now Major) Bashford Dean, who also went to France to familiarize himself with conditions of trench warfare. The value of this experience has been abundantly proven by the tests to which the helmets have recently been subjected. The metallurgical experiments were carried out in Dr. Howe's own laboratory. The results of the sub-committee's work promise to be of great practical importance in the protection of our troops.

Another illustration of the work of the Engineering Committee, which unfortunately cannot be given in detail because of the confidential nature of the problem, is the development of a special form of gun for the Ordnance Department of the Army. This involved the coöperation of several engineers, machine designers drawn from universities and other organizations, ordnance experts, and manufacturing establishments.

Without going into further details of many other research problems studied by the Engineering Committee, we may now turn to the work of the recently organized Engineering Division, which the natural development of the work of the Research Council has brought into existence. The constantly increasing demands upon Mr. Gano Dunn's time resulting from the large war contracts upon which his firm is engaged, and the departure of Dr. Durand for France, made it necessary to select new officers to carry on the engineering work in Washington. Dr. Henry M. Howe was accordingly made chairman, and Mr. W. J. Lester vice-chairman of the Engineering Division, the purpose of which is described in the following excerpt from the remarks of Dr. Howe at the first meeting of the Advisory Committee of the Division.

After referring to the establishment of the National Research Council, and speaking of its general purposes, Dr. Howe went on to describe the object of the meeting:

It is to consider how we may best carry out this general purpose of "coördinating the scientific resources of the entire country," as regards engineering and how we may best "secure the coöperation of all engineering agencies in which research facilities are available" that you have been called together. We are asked to do something wholly new, and, by the intentional breadth of our charter, we are in effect told to devise ways of doing it. We have a free hand.

Let me tell you what plans we have already made in this early and formative stage of our growth: Our most pressing duty is to help the existing governmental agencies in every possible way to win the war, taking the attitude that, however perfect their several organizations, after all they are finite, that is, limited, whereas the demands which the most rapid possible development of our military strength makes on them are unlimited. We therefore seek and welcome ways of helping them. In general our natural function here has been to develop ideas, often initially nebulous, far enough to make their usefulness clear to the military authorities, using this term broadly to include the land, sea, and air forces, and then to leave the active production to them. In many cases our work is confined strictly to perfecting the design, in other cases models have to be made. In this way the Division of Physics has developed a great number of very important instruments and devices relating to submarine, subterranean, aircraft, and other matters, and the Division of Medicine and Related Sciences, besides organizing many researches in medicine, has developed a system of psychological tests which have been adopted in the Army for both officers and privates.

Our own division has already formed five sections,—on mechanical engineering under Mr. W. J. Lester, prime movers under Prof. Lionel S. Marks, Mem.Am.Soc.M.E., metallurgy under Dr. Bradley Stoughton, Mem.Am.Soc.M.E., electrical engineering under Dr. Stoughton and Prof. C. A. Adams, Mem.Am.Soc.M.E., and military "tanks," and we ask your advice today about forming others on ordnance, clearing house, and the fatigue of metals. The National Advisory Committee for Aeronautics acts as our section on aircraft. Our section on metallurgy has two important committees, on helmets and on body armor under Major Bashford Dean, and on smelting ores of manganese under Mr. J. E. Johnson, Jr., Mem.Am.Soc.M.E.

How we may "secure the coöperation of engineering agencies," as President Wilson wishes, is illustrated first by our working in close coöperation with the Bureaus of Mines and Standards, the latter of which has placed a laboratory at my disposal, and second by our research on the saving of manganese in steel making by replacing it in part with deoxidizing agents.

Here the deoxidizing agents used must bear such a ratio to each other that the sum of the resultant oxides will be fusible at the steel-making temperature, and hence will coalesce and rise to the surface by gravity instead of remaining entangled in the steel to its great harm. But before we can do this we must learn what the fusible combinations of the oxides of available deoxidizing agents are. To this end we have secured the coöperation of the Geophysical Laboratory, whose Dr. R. B. Sosman is one of the first, if not the first, authority on this subject, to select the most promising field, and we are now seeking the coöperation of a large number of laboratories, industrial, educational, and governmental, in determining the actual melting points of large numbers of these combinations of oxides. We thus seek a truly scientific solution of the problem instead of one by trial and error. Here we may have as many as twenty separate institutions collaborating on this one problem, with corresponding saving of time.

It is to be hoped that our present coöperation with the Bureaus of Standards and Mines may be matched by like coöperation with the Naval Consulting Board, whose important work of sifting out the promising inventions from the great mass submitted to it seems to be well complemented by our natural work of developing promising ideas.

Dr. Howe then discussed the question of the men needed and the expenses involved in the proposed work. The Engineering Division of the Research Council already has $30,000 available for its office and organization expenses during the current year, and additional funds will probably become available in the near future.

Since that meeting the work of the Sections on Mechanical Engineering and on Metallurgy has developed rapidly. The former has taken over the laboratories and machine shop of the Carnegie Institution at Pittsburgh so as to control the construction of the devices which it is perfecting. Through its Committee on Fatigue, under the chairmanship of Prof. H. E. Moore of the University of Illinois, it has begun the systematic study of fatigue phenomena, having especially in view the requirements of aircraft crankshafts and welded ship plates. It has brought the development of two special types of guns so far that one is now ready for firing, while the other will probably be fired before this paper is in print. Beyond this it is actively developing ten devices, a special gun for use in aircraft, a special mechanism for controlling it, a new control for aircraft, aircraft fuel, tanks of various types, mechanism for controlling trucks, a new type of tractor, special telescopes, special balloons, parachutes, and a new type of aircraft engine.

The work of the Section on Metallurgy promises to develop chiefly through the creation and direction of committees which shall mobilize the latent skill and patriotism in the metallurgical works themselves and in their laboratories, metallurgical, chemical and mechanical, and in the laboratories of our institutions of learning. Thus in addition to the committees mentioned by Dr. Howe, this Section has organized, under the chairmanship of Col. W. P. Barba of the Ordnance Department, a committee containing the metallurgists of the great ordnance works, Bethlehem, Midvale, Standard and the United States Steel Corporation, to formulate detailed directions for the procedure in making and treating steel ingots for objects needing the very best quality, such as cannon, shells, armor and crankshafts. Under the chairmanship of Dr. George K. Burgess, of the Bureau of Standards, it is now organizing a committee to develop a pyrometer for determining the temperature of the molten steel in the open-hearth and electric steel processes. Other committees with aims of this general class are projected.

RESEARCH INFORMATION SERVICE

The organization and work of the Research Information Committee, which now has offices in Washington, London, Paris, and Rome, were described in the address previously cited. The subsequent action of the Secretary of War in issuing the following general order to all scientific and technical bureaus of the War Department has led to an important expansion of the work of the Committee.

1 The Secretary of War directs that you be informed as follows:

2 The Research Information Committee was formed to establish machinery by means of which the general staff of the Army, the various bureaus of the Army and Navy, the Scientific Organizations in the United States, who are working on problems connected with war production and invention, and the various committees of the Council of National Defense charged with work of this nature, may be put in touch with the developments and experimental work being carried on, not only in this country, but in Europe, and kept mutually informed of the state of development of work of this nature.

3 In pursuance of the order of the Secretary of War establishing this Committee and in order effectively to do this work, it is vitally necessary that the utmost of cordial coöperation be shown by each of the bureaus and committees in question with the Research Information Committee. To secure this the following is directed:

a All Military Bureaus requiring scientific and technical information are given official status on the Research Information Committee in Washington, D. C.

b Representatives of Military Bureaus or of research committees collecting information abroad will be instructed, by their chiefs, to put themselves into direct relationship with the joint committees of the Research Information Committee sitting in Paris or London, or later in Rome, in order that information be at once dispatched to the Research Information Committee at Washington, D. C. All communications of scientific investigations or research shall be routed through these channels, even though other channels are employed at the same time.

c Official means of intercommunication, such as memoranda, bulletins and the like, between Bureaus of the Army and Committees for research shall be developed to such a degree of efficiency by the Research Information Committee that the distribution of information shall be practically automatic.

d Before sending officers or civilians abroad for investigation work, all Army Bureaus or civilian research committees shall get in touch with the Research Information Committee at Washington, D. C., for information and guidance.

e The present method of routing information memoranda for file and distribution through the Military Intelligence Branch will not be discontinued.

f You will immediately notify this office and the Research Information Committee of the name of the officer who shall represent your Bureau before the Research Information Committee.

By order of the Secretary of War:
(Signed) PAUL GIDDINGS, *Adjutant General.*

In accordance with the principles embodied in this order of the Secretary of War, the organization of the Research Information Service has been expanded to include official representatives of all the military and naval bureaus, together with the more important Government civilian bureaus and committees. The present organization of the Washington and foreign offices is given below. A meeting of the Washington representatives was held on August 29, when plans for perfecting the operation of the service were developed.

PRESENT ORGANIZATION OF RESEARCH INFORMATION SERVICE

COMMITTEE IN CHARGE:

The Chief of the Military Intelligence Branch, Brig.-Gen. Marlborough Churchill.

The Director of Naval Intelligence, Rear-Admiral Roger Welles.

The Chairman of the National Research Council, who acts as general executive officer of the Information Service.

WASHINGTON BRANCH:

Officers:

Executive Secretary, Dr. Graham Edgar.

Representative of Physics and Engineering.

Representative of Chemistry and Chemical Technology, Dr Graham Edgar.

Representative of Medicine and Related Sciences, Dr. R. M. Pearce.

Representatives of Military Bureaus:

Division of Military Aeronautics, Capt. A. Ames.

Military Intelligence, Capt. P. M. Buck.

Bureau of Ordnance, Major C. J. Brown.

Quartermaster General, Major W. F. Dodd.

Office of the Signal Corps, Capt. G. F. Gray.

Chemical Warfare Service, Major S. P. Mulliken.

Tank Corps, Capt. Phil D. Poston.

Engineer Corps, Capt. L. D. Rowell.

Office of Surgeon-General, Col. F. F. Russell.

Bureau of Aircraft Production.

Representatives of Naval Bureaus:

Office of Naval Intelligence, Lieut.-Com. H. H. Whittlesey.

Bureau of Steam Engineering, Lieut. M. Pendleton.

Bureau of Construction and Repair, Capt. W. G. Du Bose.

Operations—Aviation, Ensign A. F. Lippmann.

Bureau of Ordnance, Ensign C. L. McCrea.

Representatives of Civilian Bureaus:

War Industries Board.

Bureau of Standards, F. J. Schlink.

Bureau of Mines, Dr. F. G. Cottrell.

Bureau of Chemistry, Dr. H. D. Gibbs.

Explosives Investigations Committee, Dr. C. E. Munroe.

Nitrate Investigations Committee, Dr. John Johnston.

National Advisory Committee for Aeronautics, Dr. W. G. Sabine.

Representatives of Foreign Missions

British Embassy and War Missions.

French Embassy and War Missions.

Italian Embassy and War Missions.

Japanese Embassy and War Missions.

Canadian War Mission.

LONDON BRANCH:

The Military Attaché.

The Naval Attaché.

Scientific Attaché, Dr. H. A. Bumstead.

Engineering Associate, Dr. S. J. Farnsworth.

Chemical Associate.

PARIS BRANCH:

The Military Attaché.

The Naval Attaché.

Scientific Attaché, Dr. W. F. Durand.
Physics Associate, Dr. K. T. Compton.
Chemical Associate.
Medical Associate, Dr. R. G. Perkins.

Rome Branch:
The Military Attaché.
The Naval Attaché.
Scientific Attaché, Mr. S. L. G. Knox.
Physics Associate, Dr. Edgar Buckingham.
Chemical Associate, Dr. H. S. Washington.

In this field there will necessarily be close coöperation between the National Research Council and the National Engineering Societies, already well begun through the acceptance of the offer of the American Society of Mechanical Engineers referred to in the address so frequently cited. The policy of the Information Service will be to render available to accredited persons all sources of information relating to research, both at home and abroad. Its chief function at present will relate to the war; but this naturally includes extensive duties of an industrial nature, in addition to more strictly military and naval work. Through the scientific attachés at the various embassies, the Army and Navy Intelligence Services, and the officers of the scientific and technical bureaus of the Government, and through various other agencies with which the National Research Council is in touch, a large collection of valuable information is being brought together and collated for easy reference.

International Coöperation in Research

The work of the Research Information Service, which has already led to the establishment of the position of Scientific Attaché by the State Department, is part of an extensive plan for international coöperation in research which is being developed by the National Academy of Sciences and the National Research Council. A detailed plan for coöperation among the Allies in all researches bearing on the war has been prepared by the Council of the National Academy, for submission at a meeting soon to be held in London, at which the United States will be represented by a delegation appointed by the National Academy.

It is evident that each of the national engineering societies, in addition to its special reasons for securing effective international coöperation in its particular field, has broader interests that necessarily involve joint action with the representatives of other branches of science and the arts. The plan prepared by the National Academy provides a means, through the Section of Foreign Relations of the National Research Council, by which such joint action can be arranged for. While the time is not yet ripe to enter into the details of the scheme, it is worthy of mention here because of its bearing upon the subject of this paper.

Industrial Research

I may conclude this paper with a brief reference to the common interests of the national engineering societies and the National Research Council in the promotion and organization of industrial research, already mentioned in my New York address. The members of the Advisory and Active Committees of the Industrial Relations Section of the National Research Council dined together in New York on May 29. Among the speakers who strongly emphasized the importance of promoting industrial research were Hon. Elihu Root, Mr. Theodore N. Vail, Col. J. J. Carty, Mr. Ambrose Swasey, Dr. Henry S. Pritchett, Mr. Pierre S. duPont, Mr. George Eastman, Mr. Arthur H. Fleming, Dr. L. H. Baekeland, President Richard C. Maclaurin, Dr. M. I. Pupin, and Dr. Willis R. Whitney. Mr. Theodore N. Vail was elected chairman of the Advisory Committee, and it was decided to organize the work of the Section and to begin the publication of a series of bulletins on the value of research and the advantages resulting from the establishment of research laboratories. The Active Committee, of which Dr. John Johnston is chairman, has stimulated the organization of several successful conferences on research in the industries, and the outcome of its work is very promising.

Here is a field where the engineering societies and the Research Council can coöperate to special advantage through the Engineering Foundation, which is already taking an active part. The possibilities of developing this work, through the establishment of special laboratories and by other means, are obvious, and advantage will be taken of the present exceptional opportunity to influence favorably the industries which have hitherto failed to appreciate the value of research.

THE RELATIVE CORROSION OF ALLOYS

By R. B. FEHR,[1] DAYTON, OHIO

In order that the results obtained by different experimenters may be comparable and lead to definite conclusions regarding laws of corrosion, standards should be adopted in regard to such matters as dimensions of specimens, preparation of surfaces, amount of corroding medium, method of suspension in medium, temperature, access of light, duration of test, diffusion, cleaning and weighing of specimen, method of expressing relative corrosion, and, perhaps most important of all, the nature of the corroding medium.

The ultimate aim should be to devise a comprehensive series of tests to which standard specimens of materials may be subjected, and by which the relative corrodibilities of these different materials may be predicted for certain service conditions. A great amount of systematic research work would have to be done before a satisfactory set of standards could be devised, but the problem is somewhat simplified by the fact that relative values of corrosion are desired rather than absolute values. Consequently, it will probably be found that a few tests will cover in a qualitative way the most usual conditions that are met with in practice.

One of the most important factors that would be involved in any proposed standard method is the time element. Al-

[1] Assistant Physicist, Recording and Computing Machine Company. Jun.Am.Soc.M.E.

For presentation at the Annual Meeting, New York, December 3 to 6, 1918, of The American Society of Mechanical Engineers. The paper is here printed in abstract form and advance copies of the complete paper may be obtained by members gratis upon application. The paper will also appear later as Bulletin No. 27 of the Engineering Experiment Station of Pennsylvania. All papers are subject to revision.

though the best test of the usefulness of a material is, of course, the actual service test during a long period of time, no engineer would think of building a machine or structure without first making strength tests of samples of the materials used; and in like manner he would prefer to have some comparatively simple means for determining the relative corrosion of materials before deciding upon the best one to use under the particular conditions involved, without having to wait for the test of time on his completed structure.

To meet this short-time requirement, various so called "accelerated" corrosion tests have been devised, the principal corroding media being sulphuric acid and sea water or other salt solutions. These methods have met with much opposition for the reason that they do not imitate and therefore cannot intensify natural corrosion influences, as they were intended to do. The results thus obtained are not in agreement with those obtained under practical service conditions. This is not surprising, for it is now becoming generally recognized that the relative corrodibilities of different materials vary with the nature of the corroding media. What may be highly resistant under one set of conditions may be highly corrodible under a different set of conditions.

Since accelerated tests are not regarded as trustworthy, and also since long-time tests are not feasible, it becomes necessary to adopt some compromise between the one- or two-hour period of accelerated tests and the many years of the actual service tests. Some preliminary tests conducted by the writer led to the conclusion that trustworthy results could be obtained within a period of a few weeks, provided analytical balances were employed and the same care exercised as in quantitative chemical analysis. Of course, small test specimens would have to be employed. The objection might be urged that small specimens would not be representative of the material, but duplicate or triplicate samples, combined with greater uniformity of preparation and accuracy in weighing would more than offset this nominal disadvantage.

Methods Previously Employed for Corrosion Tests

Not only is it necessary to adopt standard methods of testing, but it is equally important to agree upon some uniform method of expressing the results. The following methods have been employed:

a Loss of weight (specimens of practically the same original weight)

b Per cent loss of weight

c Loss of weight per unit area of exposed surface

d Appearance as judged by the naked eye or lens.

Methods *a*, *b* and *c* are satisfactory if the conditions of testing are exactly the same within experimental limits of accuracy. Methods *a* and *c* do not give correct relative values of the corrodibilities of materials that differ appreciably in density. Method *b* does not have this objection, but like *a* it does not take into account important differences in the ratios of exposed surface to volume. Method *d* is merely qualitative and depends upon personal judgment, but is useful for cases of unequal corrosion, or pitting, as will be noted later.

Proposed Method for Indicating Relative Corrodibility

Although experiments run under different conditions with respect to weight, density and exposed surface of the specimens can never be considered strictly comparable, a much better measure of the relative corrodibilities of materials can be gained by applying the following method of reasoning:

Suppose, by way of example, that a certain corroding medium gave the results on specimens of different materials having dimensions as noted in Table 1. This example is a somewhat extreme case, but it sometimes requires an extreme case to emphasize a point. A study of the results obtained by the three methods *a*, *b* and *c* is interesting in that they appear to indicate four, three, and two different values, respectively, for the relative corrodibilities, whereas in reality the four materials have the same corrodibility, as further consideration will easily show.

TABLE 1 ILLUSTRATIVE CORROSIVE RESULTS ON DIFFERENT MATERIALS

Specimen	Weight, grams	Volume, c.c.	Surface, sq. cm.	Sq. cm. c.c.	(*a*) Loss, gr.	(*b*) Loss, %	(*c*) Loss, gr./sq cm.
1	15	3	75	25	1.5	10.0	0.020
2	15	3	150	50	3.0	20.0	0.020
3	30	3	150	50	6.0	20.0	0.040
4	30	3	300	100	12.0	40.0	0.040

What really counts in corrosion is the volume of material removed in a given period of time on each unit of surface, and not the loss in volume per unit of volume, nor the loss in weight per unit of surface, etc., for these latter methods do not take into account the differences in density and exposed surface of the specimens, which differences are certainly no fault of the materials. For instance, specimen No. 2 has the same density, but twice the exposed surface of No. 1. If it were of the same material as No. 1 it would be expected to lose twice the weight, and yet it would be manifestly unfair to say that the relative corrodibilities are different, as indicated by methods *a* and *b*.

Again, No. 3 has twice the density of No. 2, and if it had the same corrodibility it should lose twice the actual weight, as well as twice the weight per unit of surface. Therefore, provided all other conditions were the same in these cases, the only method that would indicate equal corrodibility would be method *b*, on account of the cancelling out of the density factors.

Obviously, then, none of the methods employed thus far indicates the true relative corrosion values for specimens of different sizes from different materials. However, if the results obtained by method *b* in Table 1 are divided by the respective values for the ratio of surface to volume, the results will be 0.40 in each case, and thus a true measure of the relative corrodibility is obtained.

The algebraic derivation of this method is as follows:

Let a = area of *exposed* surface of test specimen, sq. cm.
v = volume of specimen, cu. cm.
d = density of material, grams per cu. cm.
w = original weight of specimen, grams
s = loss in weight in grams by method (a)
p = per cent loss in weight by method (b)
K = relative corrosion by proposed method, per cent of cu. cm. per sq. cm. of surface.

$$p = \frac{s}{w} \times 100$$

$$= 100\,\frac{\frac{s}{d}}{\frac{w}{d}} = 100\,\frac{\frac{s}{d}}{v} = \text{per cent loss of volume,}$$

since the volume equals weight divided by density.

$\frac{a}{v}$ = ratio of surface to volume,

and

$$\frac{p}{\frac{a}{v}} = 100\,\frac{\frac{s}{d}}{v} \times \frac{v}{a} = 100\,\frac{\frac{s}{d}}{a} = \text{per cent of cu. cm. lost per}$$

sq. cm. of surface. Therefore,

$$K = \frac{p}{\frac{a}{v}}$$

that is, the per cent loss in weight is to be divided by the ratio of surface to volume.

These values of K will then represent the true relative corrodibilities when the conditions of testing are the same except for the densities and dimensions of the specimens. But finally, in order to express in the simplest and most easily comprehended manner the relative values of different materials in regard to their *resistances to corrosion*, the reciprocals of the K values should be taken and compared with, say, the highest one which, for the sake of comparison, may be regarded as having a corrosion resistance of 100 per cent. Thus, if materials A, B, C, and D have values for K of 5, 10, 15, 20, respectively, the reciprocals or resistances to corrosion will be 0.2, 0.1, 0.067, and 0.05, while the relative "efficiencies" of resistance to corrosion will be 100, 50, $33\frac{1}{3}$, and 25, respectively.

This new method of expressing relative corrodibilities takes into account the obvious fact that corrosion varies directly as the exposed surface, other things being equal. The time element cannot be involved in any method of expressing corrosion, for it is a well-established fact that corrosion does not vary directly as the time, since the first layers of corrosion products may in some cases inhibit, and in other cases, accelerate, corrosion. In other words, the duration of all tests that are to yield comparative results should be a constant quantity.

A Series of Comparative Corrosion Tests

It is believed by the writer that careful tests of different sizes of specimens of various kinds of materials run under like conditions will justify the above proposed method of expressing the results, but as yet no such series of tests can be offered. Nevertheless, it may be of interest to report the results of a series of tests that were run for the purpose of ascertaining the consistency of results that could be obtained by exposing small-size specimens to tap water and solutions of sea salt for comparatively short periods of time. These tests are to be regarded as preliminary, and therefore the arbitrary conditions adopted will be subject to such future modifications or drastic changes as inconsistencies in results of these and succeeding series of tests may indicate.

A number of commercial alloys were supplied by various manufacturers who were interested in seeing a series of tests run by experimenters who had no interest in any industrial concern. The analyses of these alloys, as made by the manufacturers, are found in Table 2.

The alloys were supplied in the form of $\frac{3}{4}$-in. rolled stock, which was turned down in a lathe, and from which were cut disks of fairly uniform size. A $\frac{1}{8}$-in. hole was drilled in the center of each specimen in order that a glass hook could be inserted for suspending the specimen in the corroding medium. All the specimens were first roughly polished by emery cloth and then finished to uniform surface conditions by rouge cloth. The disks were then washed in ether to remove all grease, dried in a dessicator, and carefully weighed on analytical balances.

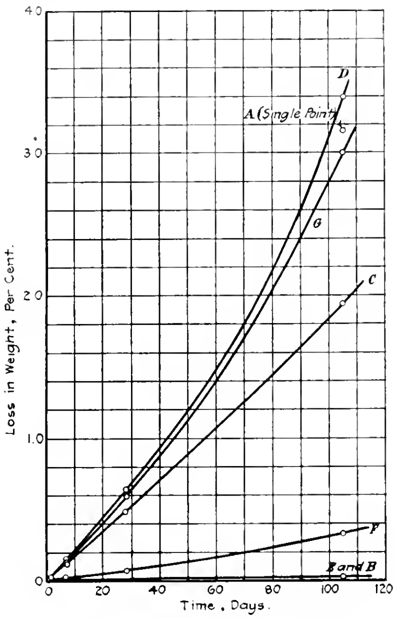

Fig. 1 Corrosion in Tap Water

The following solutions were employed:

1 Tap water
2 0.1 per cent sea-salt solution (one gram of sea salt per liter of tap water)
3 10 per cent sea-salt solution (100 grams of sea salt per liter of tap water).

TABLE 2 ANALYSES OF ALLOYS

	A	B	C	D	E	F	G
				Percentages			
Fe	99 84	2 30	98 473	98 697	Trace	67 405	99 647
C	0 01		0 78	0 479		0 19	0 04
Mn	0 025	$1\frac{1}{2}$–$1\frac{3}{4}$	0 594	0 74		1 35	0 26
Si	0 005		0 065	0 06		0 184	0 01
S	0 025		0 055	0 035		S and P less than 0 04	0 036
P	0 005		0 013	0 009			0 007
Cu	0 05	30 02			89 84		...
Ni	.	65 48				30 83	...
Al	.				9 96		.
Ti			0 02	.			

The tests on the various alloys and three solutions were run simultaneously with duplicate specimens. A 150-c.c. beaker filled with 100 c.c. of the corroding solution was provided for each individual specimen, which was suspended in the middle

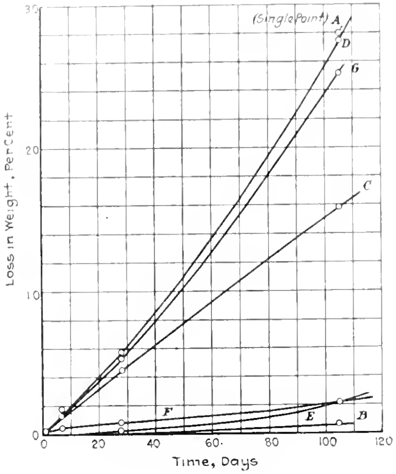

FIG. 2 CORROSION IN 0.10 PER CENT SEA-SALT SOLUTION

of the solution by means of a glass hook attached to a short piece of wood resting on top of the beaker. At the end of the one-day (24-hour) test the specimens were removed from the beakers, soaked for several hours in a solution of ammonium citrate in order to remove the rust, dried and carefully weighed to determine the loss in weight. The specimens were then polished so as to have new surfaces, cleaned, dried and weighed for the succeeding seven-day test, for which new solutions were employed. This procedure was maintained for

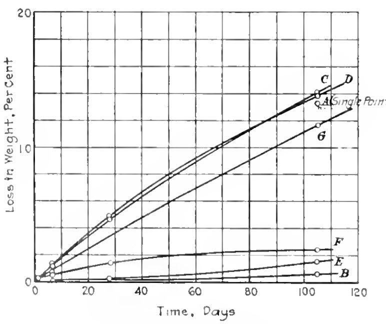

FIG. 3 CORROSION IN 10 PER CENT SEA-SALT SOLUTION

the 28- and 105-day tests. In all cases the beakers were placed in a glass case, and the daily maximum and minimum temperatures were observed.

RESULTS

In expressing the results of these tests, the percentages of loss by weight were plotted in Figs. 1, 2 and 3, rather than the values of K as proposed above, for the reason that the ratios of the surface to volume were practically the same, the average deviation from the mean being only 4.6 per cent. In Figs. 4, 5 and 6 are plotted the relative efficiencies of resistance to corrosion as previously explained in this paper, the alloy marked F being taken as the 100 per cent standard in this case. Alloys B and E exhibited such a slight amount of corrosion that they could not very well be used as a basis for comparison.

Among the points to be noted as a result of these tests are the following:

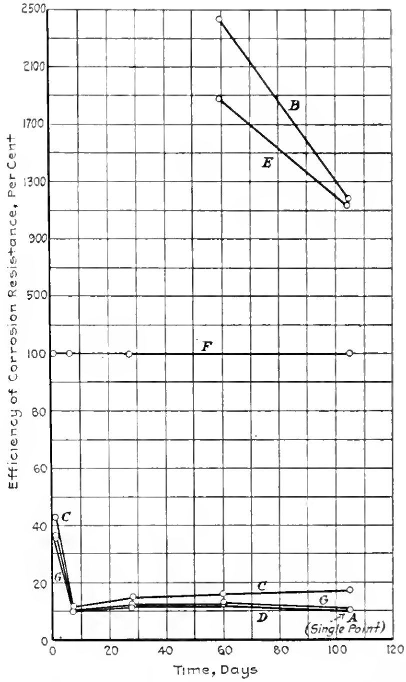

FIG. 4 RELATIVE EFFICIENCIES OF CORROSION RESISTANCE IN TAP WATER

1 The most impressive feature as seen in the curves of Figs. 1, 2 and 3 is the consistent grouping of the more corrosive iron and steel alloys A, C, D, and G, as against the highly resistant alloys B, E and F, in which copper and nickel are the most prominent constitutents. In the first group it should be noted that the steel C, in which titanium is employed as a cleanser, shows considerably less corrosion than the other steels in tap water and weak salt colutions. In the second group the copper-nickel alloy B was in most cases superior and in no case inferior to all the other alloys. This was the only alloy that exhibited its original appearance after being cleaned in the ammonium citrate solution.

2 Perhaps the next most impressive fact brought out by these tests is the decreased corrosion of the more corrosive group of alloys as sea salt is added to tap water. This effect is not observed in the non-corrosive group of alloys, for the reason that it is probably masked by experimental errors in determining the very slight losses in weight. This decreased corrosion with increased concentration of the salt solution is

in harmony with the results of other experimenters, notably Friend and Barnet.[1]

3 The practically pure iron *A*, which was received in time for only the 105-day test, gave very disappointing results, since in all three corroding media it showed practically the same corrosion as the ordinary carbon steels, *D* and *G*. However, in fairness it should be pointed out that rust may either accelerate or inhibit corrosion. If the metal is homogeneous, sound, dense, and free from occluded gases, the rust will probably be dense and closely adherent and will thus offer some degree of protection. If the metal is non-homogeneous and contains a considerable amount of occluded gases, the latter upon escaping will cause the rust to become spongy and porous, and will therefore permit the electrolyte to come more readily into contact with the metal. In the case of the practically pure iron *A* only one test (105 days long) was run, and consequently no curve of results could be obtained.

4 A study of the data points to the conclusion that when corrosion specimens are fairly uniform in density, area of exposed surface and volume, the method of expressing the relative corrosions by per cent loss in weight gives results as consistent as those obtained by the newly proposed method, for the average deviations of both methods are practically equal. It should be kept in mind, however, that the use of the new method, in cases where the specimens vary considerably among themselves with regard to density or ratio of surface to volume, will serve to give a much better basis for comparison than any other method.

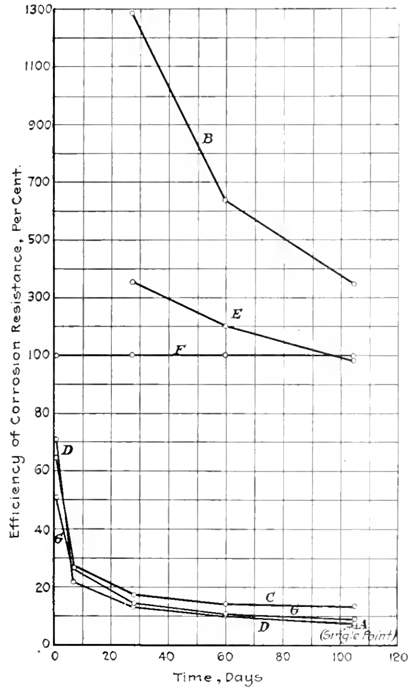

Fig. 5 Relative Efficiencies of Corrosion Resistance in 0.10 Per Cent Sea-Salt Solution

5 The relative efficiencies of corrosion resistance as shown graphically by Figs. 4, 5 and 6 indicate that very consistent results can be obtained by the method of testing employed in these series, when the duration of the test is one week or more for the more corrosive alloys and about two months or more for the less corrosive alloys. In fact, one day is quite sufficient to classify groups of alloys in the order of their corrodibility for such corroding media as will cause enough loss in weight to be determined by analytical balances. Nevertheless, before any final conclusion can be drawn as to the best method of testing relative corrosion, a vast amount of work will have to be done, especially with reference to the results of service tests as compared with laboratory tests similar to those described in this article. For the present, however, it seems proper to conclude that very consistent results (at least among themselves) can be obtained by using small specimens and employing refined methods, but without using "accelerating" conditions.

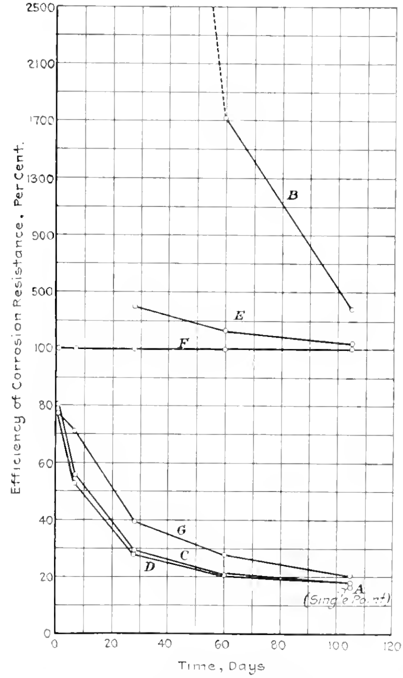

Fig. 6 Relative Efficiencies of Corrosion Resistance in 10 Per Cent Sea-Salt Solution

Acknowledgment

The writer wishes to record his appreciation of the assistance and coöperation of Dr. J. P. Jackson, formerly Dean, and of Prof. R. L. Sackett, the present Dean of the School of Engineering; to Prof. J. A. Moyer, and to Prof. M. M. Garver. He also desires to acknowledge the services rendered by M. P. Helman and G. S. Long, who prepared the specimens and obtained much of the data; and by E. F. Grundhoeffer, who, with the assistance of A. A. Bawiec and L. S. Longenecker, made most of the calculations and drew the curves.

[1] The Corrosion of Iron in Aqueous Solutions of Inorganic Salts, by J. Newton Friend and Peter C. Barnet, *Journal of the Iron and Steel Institute*, 1915, I, p. 336.

RECOVERY OF GASOLINE FROM CASING-HEAD AND NATURAL GAS

By PAUL DISERENS,[1] CINCINNATI, OHIO

CASING-HEAD gasoline is gasoline which passes off in the form of vapor with natural gas accompanying the flow of an oil well, where oil and gas are found in the same field. In many localities this gas is wasted because of the difficulty of handling it, or because no market exists for its sale, due to its relatively small volume. Often, however, the recoverable gasoline in the gas is worth as much as 20 per cent of the oil produced.

The practice of pumping casing-head gas to develop a vacuum on the well and thus to stimulate the flow of oil is, at this time, rapidly increasing and it is where this is done that plants for the recovery of casing-head gasoline are most profitable. In some fields, particularly California and Wyoming, gas is handled which comes directly from the wells under rock pressure or where the gas comes directly from gas wells. Such gas, however, yields relatively small quantities of gasoline.

TABLE 1 VAPOR PRESSURES AND CORRESPONDING TEMPERATURES AT WHICH CERTAIN HYDROCARBONS WILL CONDENSE

Temperature, Deg Fahr.	Vapor Pressure, Lb. per Sq. In.				
	Propane C_3H_8	Butane C_4H_{10}	Pentane C_5H_{12}	Hexane C_6H_{14}	Heptane C_7H_{16}
32	72.5	15.9	3.5	0.9	0.2
40	84.6	19.9	4.4	1.0	0.3
50	100.7	24.1	5.4	1.4	0.4
60	115.4	30.0	6.8	2.0	0.5
70	130.1	36.7	8.2	2.5	0.7
80	147.2	44.1	9.9	2.9	0.9
90	165.0	53.2	11.9	3.2	1.1

The process most used in the recovery of casing-head gasoline is a physical one and involves only the alternate compression and cooling of the gas. As already stated, it will be understood that gasoline in the form of vapor constitutes part of the gas as it comes from the well or casing head. If the gas were saturated, gasoline would be immediately precipitated when compressed, provided it could be kept at a constant temperature, but since the heat of compression increases its temperature, the gasoline is still retained as vapor. When it is cooled, however, gasoline is thrown down in the form of condensate, and if the gas is cooled to its original temperature the gasoline still retained in it as vapor will only be in the proportion of its initial and final volume, or very approximately so. Since there are always present a great number of condensable fractions, each a different hydrocarbon of the paraffin series, the precipitate of each depends upon the partial pressure of each.

The vapor pressures at which some of the hydrocarbons of the paraffin series constituting casing-head gas will condense for various temperatures are shown in Table 1. It is never practical to determine exactly which of these hydrocarbons occur in the particular casing-head gas to be handled, or in what proportions they are found. It is not possible, therefore, to predict what total pressure it will be best to carry. Generally, however, it is found advisable to carry not less than 250 lb. and it seldom is profitable to carry more than 300 lb.

The application of the principle as briefly stated requires the installation of a two-stage gas compressor with suitable intercooler and aftercooler. Vacuum pumps for bringing the gas from the wells to the plant are also required. The intercooler and aftercooler are of the open-coil type, and assuming that the surface available is large, the efficiency attainable depends upon the temperature of the cooling water. It is of great importance, therefore, to make provision for an ample supply of water. For this purpose cooling towers are generally provided, since in most oil fields fresh water is obtainable only in limited quantities. With cooling towers, even of the best design, it is impossible to attain low temperature during the hot weather, which prevails during a large part of the year. As a means, therefore, of supplying additional cooling effect, an expander refrigerator is installed, the function of which is to reduce further the temperature of the gas itself after having passed through the cooling coils. It consists of a cross-compound expansion engine driving a gas compressor. The compressed gas coming from the aftercooler is used in this expansion engine, and because of the work done in its cylinders is expanded adiabatically, or, in other words, in such a manner as to reduce its temperature. The cold gas is then returned through double pipe coils where its refrigerating effect is utilized to further cool the compressed gas. The amount of refrigeration thus available is in direct proportion to the amount of work done in the compression cylinders driven by the expander, and is proportioned to the total number of expansions; that is, to the ratio between its initial and final pressure, provided, of course, the cylinders of the expander are properly proportioned. The expander produces this refrigeration without the expenditure of additional power, and the energy in the compressed gas, which otherwise would of necessity be wasted, is available for useful work in compressing additional gas used in the process.

Fig. 1 shows a plan and elevation of a gasoline plant. The gas is delivered by means of vacuum pumps, reference to which will be made later, to the tank *A*, where such gasoline as will be precipitated under ordinary conditions of temperature and atmospheric pressure or even slight vacuum is collected. The suction line to the low-pressure compressor is taken from the top of the so-called drip tank and leads to the low-pressure compressor *F*, where it is compressed to approximately 40 lb. gage pressure. It is then delivered to the cooling coils *C*. The condensation collected in these coils is drawn off through a trap and the dry gas returned to the suction of the high-pressure compressor *E*, where it is compressed to about 250 lb. and again passed through cooling coils *G*. The condensed gasoline in these coils is also removed by means of a trap and delivered to suitable storage tanks.

The original design of the plant as shown provided for the expansion of the compressed gas through a so-called Tripler tube *D*. This tube is similar in design to the ordinary double-pipe ammonia coil, the expanded gas passing around

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and surrounding the internal tube through which the compressed gas from the high stage is passed. The expansion of the high-pressure gas in this tube brings about a temperature reduction of the high-pressure gas and additional gasoline is precipitated. The impossibility of expanding gas adiabatically through a nozzle is well understood and for this reason it never has been possible to effect any great temperature reduction in this Tripler tube. As long as the expanded gas retains its high velocity the temperature is relatively low, but as soon as it comes to rest it rises very rapidly.

When the high-pressure gas expanded through the reducing valve in the Tripler tube contains appreciable quantities of gasoline in the form of mist rather than as a vapor, a considerable amount of cooling will be realized when this gasoline flashes into vapor as soon as the reduction in pressure takes place. This is explained, of course, by the fact that the heat of vaporization must come from the gas which carries the gasoline. A well-designed plant, however, should be equipped with accumulator tanks of sufficient size to separate practically all entrained liquid, and if this is done, the high-pressure gas will be practically dry when it reaches the expansion valve. Thus, if considerable refrigeration is actually brought about in the Tripler tube, it only signifies that the design of the plant is faulty. By the use of a Tripler tube some of this loss may be recovered in shape of refrigeration. The net result, however, will be a definite loss.

In order to bring about a greater temperature reduction through the expansion of this high-pressure gas, an expander compressor was installed. In the plant shown, a small single-stage expander was installed after the plant as just described was put in operation. The high-pressure gas after passing through the double pipe coil is admitted to the expansion cylinder of the expander compressor at approximately 250 lb. pressure and is exhausted against a back pressure of 15 to 20 lb. through the collecting tank B, and thence through the outside of the double pipe coil D, where it serves to cool the compressed gas within the inner tubes. The power developed in the expansion engine is used to compress additional gas, and this gas is delivered to the same intercooler and aftercooler, C and G, used by the main compressors.

The general piping arrangement in the plan as shown is rather crude, but is fairly representative of most plants which have been in operation for two or three years. In some of the more modern plants a much more convenient and flexible arrangement will be found.

Even with a single-stage expander as installed in this plant, a very great increase in the yield of gasoline has resulted.

The successful operation of this small single-stage expander was not easily accomplished. The collection of ice around the valves, together with the difficulty of lubricating them, made necessary numerous shutdowns. It was soon found, however, that by using glycerine in very small quantities as a lubricant and by applying this directly to the rubbing surfaces, the machine could be operated almost continuously. Whenever it was possible to reduce the temperature of the compressed gas approximately to the freezing point, all water vapor contained in it was frozen and thus removed before entering the expander. In very warm weather the amount of refrigeration available was not sufficient to bring about so great a temperature reduction, and at these times, after continued operation, the ice collecting in the exhaust ports and in the valve chest seriously interfered with its operation. It was found necessary to thaw out the expander at regular intervals, generally once in 24 hours. For this purpose a bypass pipe leading directly from the high pressure compressor was used to bring high-pressure gas, before being

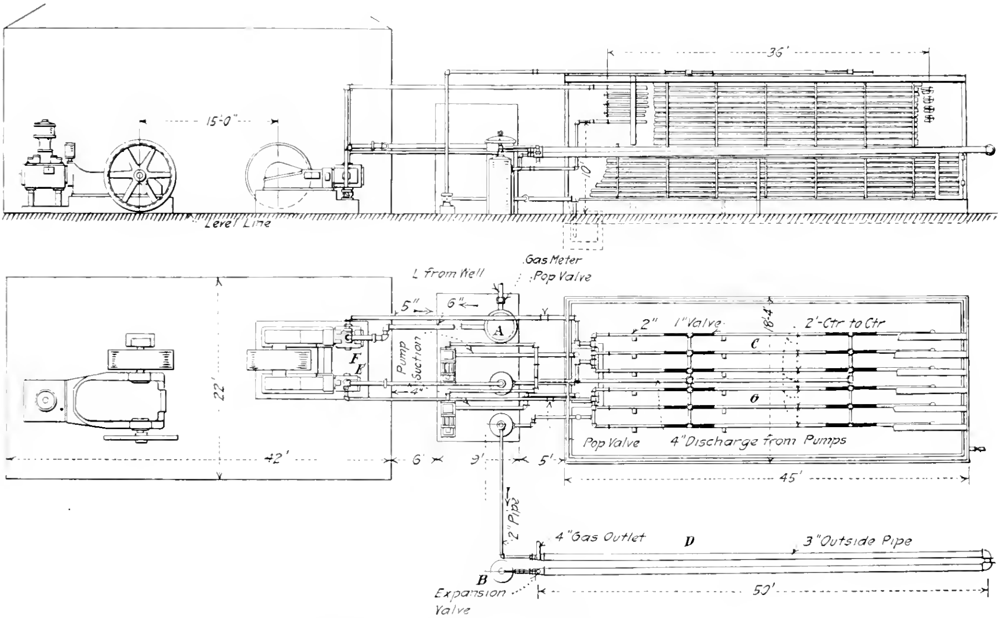

Fig. 1 Plan and Elevation of Feather Valve Compressor

cooled by the water coils, directly to the expansion cylinder. The temperature of this gas was sufficient to thaw out the ports in a very short time.

In order to overcome to a certain extent many of these difficulties in operation and in order to secure considerably lower temperatures, the expander compressor is now made a cross-compound machine. It is possible, therefore, to carry the expansion much further and to reduce the temperature of the gas to a far greater extent.

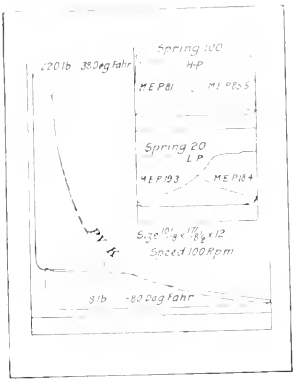

FIG. 2 TYPICAL INDICATOR CARDS FROM EXPANSION CYLINDERS OF GAS EXPANDER

No insulating material was used in this installation, and therefore the very low temperatures obtained were shown in a very spectacular manner. Frost and ice cover the cylinders and exhaust pipes to a depth of 6 to 10 in. The machine has expansion cylinders 10 in. and 18 in. in diameter with compression cylinders 17 in. and 8½ in. in diameter, respectively; the stroke is 12 in. Indicator cards taken from the expansion cylinders (Fig. 2) show the performance of this machine. These cards are of particular interest. It will be seen that the expansion line follows very closely an equilateral hyperbola and therefore is not nearly so steep as the adiabatic, as might be expected. The explanation, however, is quite evident, since the gas handled is not a dry gas but is in fact a mixture of dry gas and numerous condensable vapors of the various hydrocarbons referred to above. As soon as this mixture enters the cylinder and comes in contact with the very cold walls and ports, initial condensation takes place and as expansion proceeds, reëxpansion occurs exactly as in the case of the steam engine. The initial condensation, however, is very much greater and it is necessary to provide suitable drains in both cylinders to take care of the gasoline thus precipitated.

The initial temperature of the gas entering the high-pressure expansion cylinder in the plant in which these cards were taken, averaged about 38 deg. fahr., while the temperature at the exhaust of the low-pressure expansion cylinder was 80 deg. below zero. The temperature of the high-pressure gas before entering the double pipe coils, through which the exhaust gas from the expander is taken, was 90 deg. If there had been no condensation in the expander cylinders and if the interchange of heat within the double pipe coils had been accomplished without loss by radiation, the final temperature of 80 deg. below zero should have been sufficient to reduce the temperature of the incoming gas to zero instead of 38 deg. above zero, since the compressed and expanded gas are of the same weight.

In order to bring about more complete interchange of heat and in order to limit initial condensation, in one of the most recent installations the two-stage expander was arranged so as to exhaust first from the high-pressure expander cylinder through a set of double pipe coils and then after further expansion in the low-pressure cylinder through another set of double pipe coils. By this means the range of temperature is, of course, greatly reduced and because of this fact there is considerably less initial condensation and, therefore, a greater interchange of heat. The general arrangement for such an installation is shown in Fig. 3.

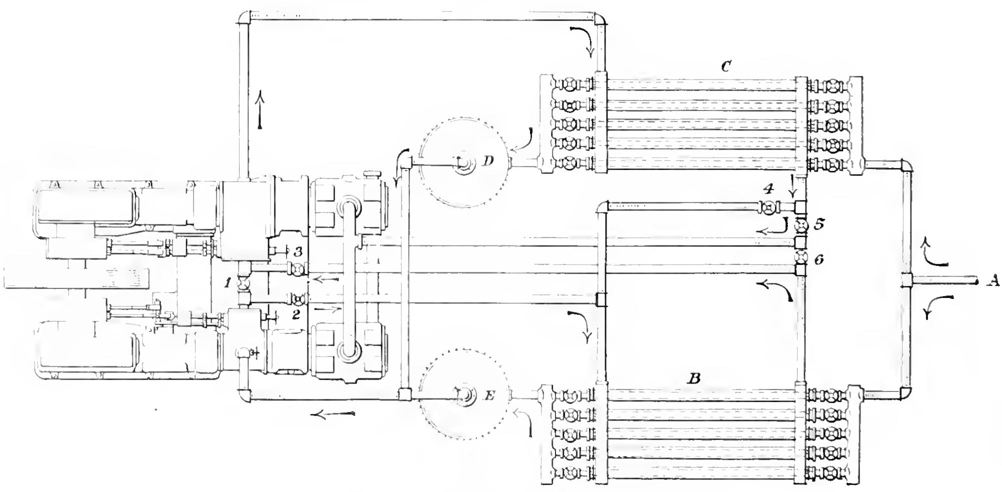

FIG. 3 HEAT EXCHANGER FOR TWO-STAGE EXPANDER

The practical operation of these two-stage expanders is

considerably simpler than that of the single-stage expanders originally installed. The reason is, of course, because of the considerably greater refrigerating effect obtained. In many plants it is easily possible to operate the expander continuously for indefinite periods, but in particularly warm climates and where the gas is very rich in condensable vapors, the temperatures even with a two-stage machine are not sufficiently low to prevent accumulation of ice within the cylinders. By using hot gas at regular intervals to thaw out the pipes, these plants can be operated very successfully.

Next to the expander the vacuum pump is, perhaps, the most interesting apparatus used in a gasoline plant. When the production of relatively old wells begins to fall off, it has been found that the flow of oil can be very materially increased by developing a vacuum in the casing. Until recently this was done by attaching a rather crude direct-acting pump directly to the rigging of the well. With a pump of this kind it is seldom possible to develop a vacuum of more than 10 in. to 12 in. of mercury. Competition between owners of adjoining leases to carry the highest possible vacuum, in order to get their full share of the oil, has recently brought about a demand for vacuum pumps of much greater efficiency, and so within the last few years a great number of high-speed, high-efficiency vacuum pumps driven by gas engines have been installed.

While there are now on the market two or three vacuum pumps of relatively high efficiency, the newest and perhaps the most novel in design is found in the Laidlaw feather-valve vacuum pump. Its construction and performance will therefore be of interest.

This vacuum pump depends for high efficiency upon close clearance and its distinguishing feature is found in the use of voluntary valves of the feather type. Each valve consists of a number of thin, flexible strips of spring steel, working on a flat seat and opening against a slotted guard. The ends of the valves never leave the valve seat, the opening being accomplished by continuous bending of the valve strip itself. The valve, therefore, in closing, seats through gradual contact from the ends of the valve toward the center and not by direct impact. This makes it possible to give the valve a relatively high lift and consequently relatively large valve area. Because of the extreme flexibility of the valve strips used, even the very light pressures incident to vacuum-pump work are sufficient to hold the valve to the seat with extreme tightness.

A vacuum pump of this type can easily develop a vacuum on closed suction of 29½ in. of mercury, or in other words, within ½ in. of the barometer. This, of course, determines the volumetric efficiency of the vacuum pump at any working vacuum, for assuming that the volumetric loss in a vacuum pump is directly proportional to the number of compressions under any working conditions, the volumetric loss will be the ratio of this number of compressions to that obtained with the pump working on a closed suction, since under this condition of operation the volumetric efficiency will be zero, in other words, when the volumetric loss exactly equals the capacity of the pump. With this assumption it is possible to express algebraically the actual capacity of any vacuum pump for any given working condition. For example, the actual capacity of a vacuum pump having a displacement of D cu. ft. per min. that will deliver Q cu. ft. of free gas per 24 hours, is expressed in the following formula: $Q = 1440\ D \times (C - V)/B$, where B is the barometric pressure, V the actual working vacuum and C the vacuum developed on closed suction. The relationship thus defined gives a very simple means of determining the size of pump required for any particular service, for it is only necessary to know the amount of gas available, the vacuum at which it is to be handled and the vacuum which the pump will develop with its suction closed.

In order to facilitate the choice of a pump for any particular service, the chart shown in Fig. 4 will be useful. This

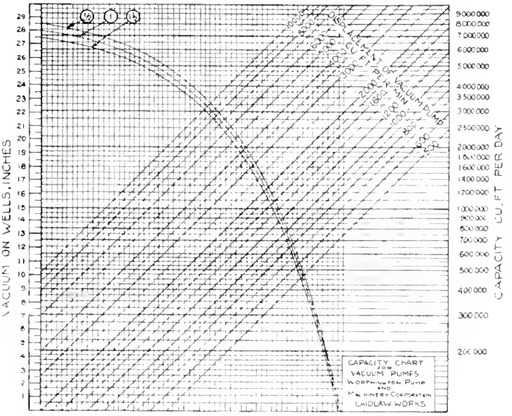

Fig. 4 Capacity Chart for Vacuum Pumps

chart shows the capacity of vacuum pumps having any displacement ranging from 500 cu. ft. per min. to 10,000 cu. ft. per min. and working under any degree of vacuum up to 28½ in. of mercury, referred to a barometer reading of 29½ in. On this chart are shown three efficiency lines, corresponding to pumps capable of maintaining ½, 1 and 1½ in. of mercury absolute on a closed suction.

The use of this chart is illustrated by the following example: If it is required to select a pump capable of handling 500,000 cu. ft. of free gas per day at 21 in. of vacuum, proceed as follows: Select the horizontal line marked "21 inches" at the left of the diagram; follow this line in a horizontal direction to its intersection with the curved efficiency line marked "one-half inch." On the vertical line passing through this intersection, proceed vertically until the horizontal line marked 500,000 on the extreme right of the diagram is reached. The diagonal line passing through this intersection represents the displacement in cubic feet per minute of the vacuum pump, which will give the required service. It will be seen in the example selected that the vacuum pump must have a displacement of 1200 cu. ft. per min.

The results of a test on one of these vacuum pumps to determine its actual volumetric efficiency are shown in this diagram. The quantity of air handled was measured by means of a low-pressure orifice, using Professor Durley's coefficients; the results are plotted as volumetric efficiency for various working vacua. The heavy line shown in this diagram represents the volumetric efficiency calculated from the chart already shown. The actual test results coincide with a fair degree of accuracy with those estimated from the chart.

Another method of recovering gasoline from natural gas or casing-head gas is by what is known as the absorption process. This process is used primarily where the gas treated is lean, that is, when its gasoline content is small.

In the absorption process the wet gas, together with the absorbing oil (usually mineral-seal or straw oil), is forced

under pressure into the absorber where the two come into intimate contact, the proportions of gas and oil being so controlled that the oil, when leaving the absorber, will be approximately saturated with condensable vapor from the gas. On leaving the absorber the saturated oil is passed through suitable heat interchangers, where its temperature is raised by means of hot return oil from the still. The hot saturated oil is then led to the still, where additional heat is applied, and the gasoline

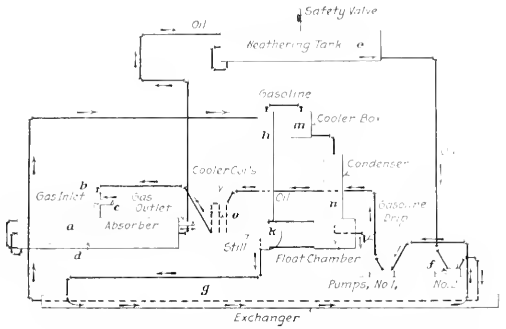

FIG. 5 GENERAL ARRANGEMENT OF SMALL GASOLINE ABSORPTION PLANT (BULLETIN 120, BUREAU OF MINES)

driven off in the form of vapor. These gasoline vapors are condensed in water-cooled coils and delivered to suitable blending and storage tanks. The residue-absorbing oil is then returned to the heat interchanger, where it gives up a great part of its heat to fresh saturated oil, as described above, after which it is passed through a cooler similar in design to the water-cooler coils of the compression plant, where its temperature is reduced to the lowest possible point. After cooling the oil is returned directly to the absorber. It will be seen that the process is a continuous one, and that the absorbing oil is used over and over again.

Fig. 5 shows diagramatically the general arrangement of a small absorption plant. The natural gas, which is brought in from a pipe line under pressure, enters the absorbing tank

tower h of the steam still k, where the gasoline is distilled from the oil with live steam. The cooler m separates the water (condensed steam) from the gasoline, which is condensed in the condenser and flows out of the system at the gasoline drip.

The hot oil after having been freed of its gasoline is pressed through the heat exchanger g and heats the oil passing to the still and from No. 1 pump it is forced through the cooling coils o, on which running water drops. The cooled oil then passes into the absorber a to receive another charge of gasoline.

In the absorption method it will be seen that a very considerable amount of gas must be burned under boilers to generate sufficient steam to operate the steam stills. Since in nearly every instance absorption plants are installed as an adjunct to a gas-pumping station used to supply gas for domestic service, the diversion of any considerable amount of gas to operate boilers instead of pumping it through the mains where it has a market value of probably 30 or 40 cents per 1000 cu. ft., operates to greatly reduce the profits to be derived from the gasoline plant. Any system, therefore, which will do away with the necessity of separating the gasoline from the absorbing oil by means of steam stills is greatly to be desired. While as yet no such plants have been installed, a very interesting solution of the problem has been proposed in a combination of the absorption and compression processes. The plan contemplates the absorption of the gasoline in the usual way, as already described, and then introducing the resulting blend of absorbing oil and gasoline into a closed vessel in which a high vacuum is maintained. The gasoline will, of course, immediately volatilize, and may be removed by means of vacuum pumps, passed through cooling coils and condensed.

The general arrangement of such a plant is shown in Fig. 6. It will be seen that it consists of three elements, an evaporator, a vacuum pump, and a bank of cooling coils with suitable accumulator tank. The saturated oil from the absorbers is pumped into the evaporator through spray nozzles which deliver it in a finely divided mist. Because of its relatively low boiling point the gasoline must of course come from the absorbing liquid, and thus the process brings about a refrigerating effect and the oil itself is cooled. This is an item of extreme importance, since the oil upon its return to the ab-

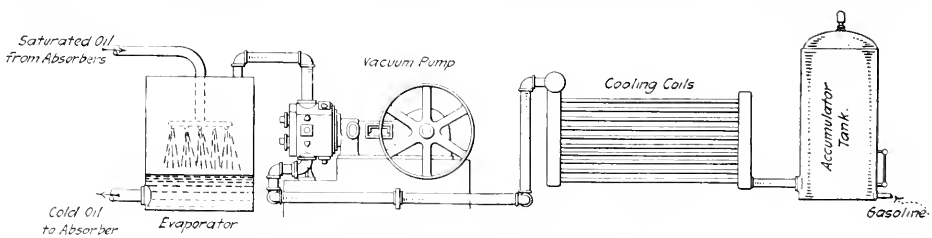

FIG. 6 COMBINED ABSORPTION AND COMPRESSION PLANT

at e and the oil enters at b. They pass into the T-pipe d, and the mixture passes from there through many small holes into the oil contained in the absorber. The gas bubbles up through the oil and passes out of the absorber as shown and returns to the pipe line.

The oil charged with gasoline passes first to the weathering tank e, where the lighter parts of the gasoline are released through the safety valve. Next the oil enters the pump f and is pumped through the heat exchanger g into the rock

sorbers will be at a temperature low enough to bring about most effective absorption. In the ordinary absorption plant the principal factor which limits its efficiency is this temperature, and great pains are always taken to keep it as low as possible. The vacuum pump serves not only to maintain the required vacuum within the evaporator, but also to remove the gasoline vapors. These are delivered to the cooling coils, which may be in every way similar to those used in the compression process.

THE INCOME TAX—AN ENGINEER'S ANALYSIS

By CARL G. BARTH,[1] PHILADELPHIA, PA.

In view of the revenue bill now pending before Congress, involving a revision of the present income-tax law, a paper presented by Carl G. Barth at the February 26, 1918, meeting of the Philadelphia Section of The American Society of Mechanical Engineers is of timely interest.

In a telegram from Washington, published by the Chicago *Herald* in August 1917, which gave the status at that time, in the Senate Finance Committee, of the personal income-tax law, Mr. Barth observed that reference was made only to the incomes to be taxed at various rates, and being impressed with the lack of regularity in the increases at which incomes were taxed with increasing tax rates, as well as in the tax rates themselves, he decided, inasmuch as the term "graded or graduated tax" seemed to imply a tax or tax rate that would gradually increase with increase of income, to investigate the matter mathematically in the same way he was accustomed to deal with practical engineering problems, leaving to others the consideration of its broader financial and economic aspects. It appeared to him that the framers of the law, having had in mind to devise a scale of tax rates increasing in proportion to the incomes to which they were applied—a problem altogether mathematical, since it involved the determination of a series of numbers—had nevertheless selected a scheme of graded taxation with arbitrary steps of percentages.

Two of the results of Mr. Barth's investigations are presented below—his analysis of the present law by comparison with an approximate mathematical expression which may be said to represent the intention of the law, and the general formula he recommends as suitable and convenient for the determination of a graded tax.

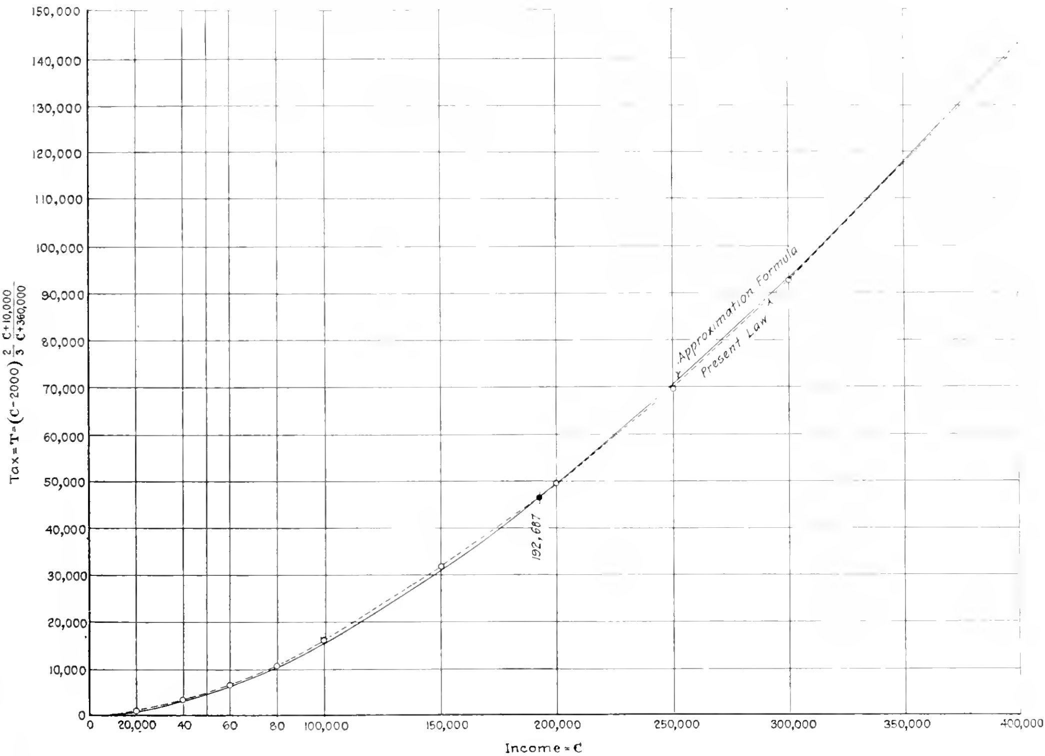

Fig. 1 Comparison of the Income Tax Law as Represented by the Dotted Line, With Its Approximation Formula [1] as Represented by the Full-Line Curve

The empirical formula

$$T = (C - 2000) \cdot \tfrac{2}{3} \cdot \frac{C + 10{,}000}{C + 360{,}000} \quad \ldots\ldots\ldots\ldots [1]$$

according to Mr. Barth, expresses very closely the relation between the net taxable income C and the tax T as determined for married men by the present law.

The equation of the full-line curve in Fig. 1 is Formula [1].

[1] Senior member, Carl G. Barth & Son. Mem.Am.Soc.M.E.

The paper is here presented in abstract. The complete paper has been reprinted in pamphlet form by The Engineers' Club of Philadelphia.

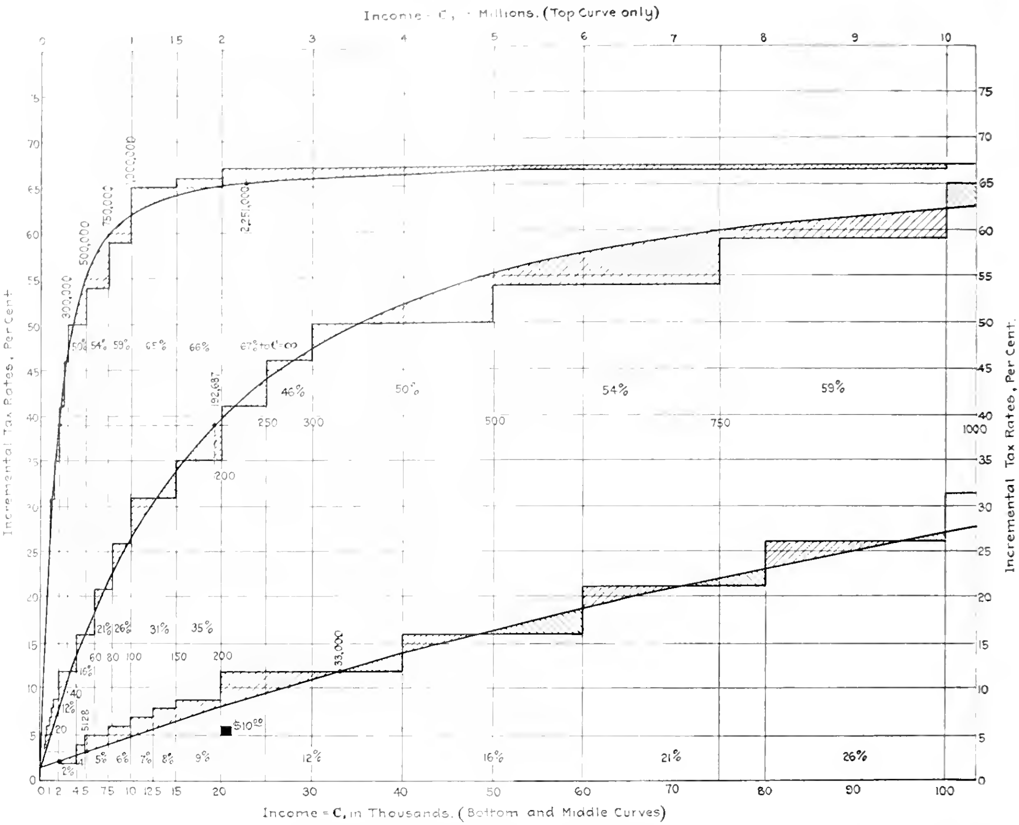

FIG. 2 GRAPHICAL REPRESENTATION OF THE DISCREPANCIES BETWEEN THE INCOME TAX LAW AND FORMULA [1]. THE SHADED AREAS ABOVE THE SMOOTH CURVE INDICATE FIELDS OF OVERTAXATION; THOSE BELOW, FIELDS OF UNDERTAXATION

The dotted line was obtained by drawing a smooth curve through the points marked with a circle, the coördinates of these points representing corresponding values of income and tax as determined by the present law.

A more conspicuous comparison of the law and the formula is shown in Fig. 2, where the bottom field covers incomes up to \$100,000, on a comparatively large scale; the middle field, incomes up to \$1,000,000, on a scale equal to one-tenth of the former; and, finally, the top field, incomes up to \$10,000,000, on a scale equal to one one-hundredth of that of the bottom field; while in all three fields the scale is the same for the percentage of tax levied in the various fields of incomes.

In the main bottom field of Fig. 2 at the income \$2000 where taxation begins at 2 per cent, the \$40 of tax between 0 and \$4000 is represented by the little rectangle in which 2 per cent is written, such that half of this rectangle similarly represents the tax up to \$3000. Similarly, the rectangle between the incomes \$4000 and \$5000, the upper part of which is shaded and in which four is written, represents tax on \$1000 at 4 per cent, or an additional \$40. Again, the rectangle between the incomes \$5000 and \$7500, the upper part of which is also shaded and in which 5 is written, represents a further additional tax on \$2500 at 5 per cent, or \$125, and so on through the whole diagram, such that the total area covered by all the rectangles from the income \$2000 up to any other income, represents the total tax on such latter income. The curve, the area between which and the upper limit of each rectangle is shaded, represents the gradually increasing tax rate that corresponds to Formula [1].

That area between the base line of the diagram and this curve which lies between any two incomes, accordingly represents that tax between these incomes which is called for by the formula. The shaded areas that lie above the curve represent the overtaxation of the law in the various fields, while the shaded areas that lie below the curve similarly represent the undertaxation of the law, such that, when once understood, the diagram most clearly and conclusively demonstrates not only the lack of continuity, but also the lack of regularity in the attempted compromises in the present law. It also most clearly shows that there is a relative undertaxation from \$2000 up to \$4000, and relative overtaxation all the way from \$4000 to \$33,000, such that the undertaxation below \$4000 is exactly balanced by the overtaxation between \$4000 and \$5128. Between \$33,000 and \$192,687 over- and undertaxation so alternate, with the excess undertaxation so great between \$150,000 and \$192,687 that at this latter income the net result is again

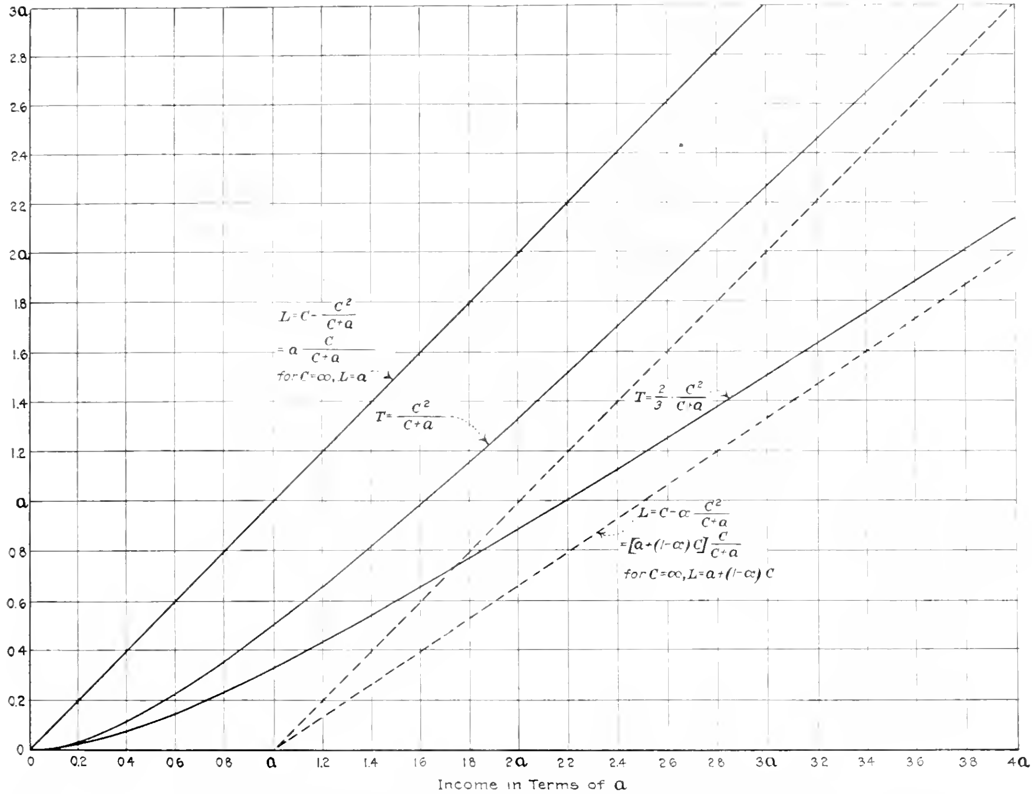

FIG. 3 GRAPHICAL REPRESENTATION OF FORMULÆ [2] AND [4]. UPPER FULL-LINE CURVE CORRESPONDS TO FORMULA [2] FOR $\alpha = 1$; LOWER FULL-LINE CURVE, TO THE SAME FORMULA FOR $\alpha = 2/3$

a coincidence with the formula. Between \$192,687 and \$350,000 the alternating undertaxation and overtaxation will be seen to balance each other pretty well; but from \$350,000 up to \$1,000,000 the whole field will be seen to be undertaxed to an extent that amounts to a veritable discrimination in favor of all incomes between these limits.

From his discussion of Fig. 2, Mr. Barth concludes that a scheme of graded taxation with definite steps of percentages is subject to unavoidable minor injustices, and that full relative justice can be meted out only by taxing according to a continuous formula. He proposes, therefore, for any scheme of graded taxation, the adoption of the general formula

$$T = \alpha \frac{C^2}{C+a} \quad \ldots\ldots\ldots\ldots\ldots\ldots [2]$$

where T is the tax, C the income, and α and a are constants to be determined from the fundamental economic and social conditions of the country. His discussion of the possibilities of this general Formula [2], according to the values given to the coefficients α and a, follows:

If α is made 1, the formula becomes

$$T = \frac{C^2}{C+a} \quad \ldots\ldots\ldots\ldots\ldots\ldots [3]$$

and in this form it may be considered as representing an ultimate limit in a graduated-taxation scheme, and as such must be fully understood and consulted before a rational selection can be made of values for either α or a in Formula [2].

In Fig. 3, Formula [3] is represented by the upper curve against which any income and its corresponding tax are read in terms of a. The upper, full line, being at an angle of 45 deg., reads an income against the vertical scale as well as against the horizontal scale, so that the vertical distance between this line and the curve represents the difference between an income and its tax, or what is left the taxpayer; and this amount more and more approaches the value a, which is the constant vertical distance between the full 45-deg. line and the dotted 45-deg. line which parallels it. Designating what is left the taxpayer by L, this amount may be written

$$L = C - T = C - \frac{C^2}{C+a} = \frac{aC}{C+a} = a\frac{C}{C+a}$$

which, as C gradually becomes greater and greater, approaches the value a as a limit, as $\frac{C}{C+a}$ then approaches 1 as a limit: which is thus a proof of the statement just made above. It is because of this property of Formula [3] that it may be considered as expressing an ultimate limit in a graduated-tax scheme; for, actually applied in practice, it would mean the practical confiscation of all large incomes, except for an amount which can never reach the value a. For a practical

taxation formula it is therefore necessary to assign a value to α in the general Formula [2] which is less than unity. In this case

$$L = C - T = C - \alpha \frac{C^2}{C + a} = \frac{C[C(1 - \alpha) + a]}{C + a}$$

$$= [a + C(1 - \alpha)] \frac{C}{C + a} \ldots\ldots\ldots\ldots\ldots [3]$$

which, as C becomes greater and greater, approaches the value $L = a + C(1 - \alpha)$ as a limit. That is to say, when α is assigned a value less than unity, a taxpayer of infinitely great income, and who as such would be left proportionately the smallest part of his income, would be left a certain definite fraction of his income in addition to the amount a. While under no circumstances should Formula [3] be used directly for tax purposes, it nevertheless suggests a rational relation of a single-man's tax to that of a married man.

Mr. Barth's recommendation is the adoption for a graded income, or other graded tax, of the general formula:

$$T = \alpha \frac{C^2}{C + a} \ldots\ldots\ldots\ldots\ldots\ldots\ldots [2]$$

to be applied directly to single men, and modified to

$$T = \alpha \frac{C^2}{C + a + b\left(1 + \dfrac{N}{m}\right)} \ldots\ldots\ldots\ldots [5]$$

for married men, in which N = number of children, and m a number which will depend on what consideration the number of children are deemed worthy of as compared with a wife. In the present law, which allows an exemption of \$200 for each child, five children have the same consideration as their mother. Values for a, b, and m might well be assigned to serve their purpose for any period, however long, during which the fundamental economic and social conditions of the country do not undergo any radical change, such that the value of α alone would be subject to change as often as the financial condition of the government might require more or less tax to be levied. However, in fixing relatively permanent values for a, b, and m, their significance when α is made 1 should have the most careful consideration.

As a matter of purely theoretical interest, Formula [5] may be written thus:

$$T = \alpha \frac{C^2}{C + a + b\left(n + \dfrac{N}{m}\right)}$$

in which n = number of wives, with only two alternative possible values in Christian countries; namely, 0 for single men and 1 for married men. With $n = 0$, N must also be 0, in which case the formula reverts to Formula [2].

Mr. Barth concludes his paper with a mathematical discussion of Formula [2] in combination with Pareto's law of incomes.

By a study through a term of years, of the income-tax returns of a number of European and other countries, the Italian economist Vilfredo Pareto discovered that the distribution of a nation's total income among its taxpayers is by no means a matter of chance only, but is subject to a very definite law which holds very closely except for the highest and the lowest individual incomes.

Mr. Barth reduces the mathematical expression for Pareto's law to

$$N = A/C^{1.5}$$

where A is a constant for any one country at any one time in its economic development, C any individual income, and N the number of individuals that enjoy incomes in excess of C.

From this and Formula [2] he finally derives the value for Y_t, the total tax of a nation when levied by Formula [2]:

$$Y_t = 3A(\alpha/\sqrt{a})\,[\tan^{-1}\sqrt{X/a} - \tan^{-1}\sqrt{M/a}]$$

in which M and X are the minimum and the maximum individual incomes, respectively.

FIRE PROTECTION IN MANUFACTURING PLANTS

By CHARLES E. RIGBY,[1] PROVIDENCE, R. I.

THE protection of factories against fire is nothing less than their conservation, which is vital to the maintenance of the national interests in the present emergency. Facilities for extinguishing fires, however, are only a part of the means needed to secure proper control of the fire hazard, and it is necessary to take also into consideration the construction, the character and arrangement of the processes, the protection, and last, the hazard from nearby property and safeguards against this.

Construction

In designing a building the purpose for which it is to be used must be kept in mind. What might be considered good construction for one occupancy, such as a heavy machine-shop building—one story high with gallery and with roof of plank on exposed steel—would be poor for another occupancy, such as a cotton mill. The ideal factory is one having a single story, because in structures several stories high each floor is exposed by the others. It is interesting to note that while around the Civil War period it was the practice to build factories about six stories high, with a tendency later toward one-story structures, today, on the whole, we seem to have struck an average between the two.

Mill Construction. The construction that first commands our attention is the slow-burning or mill-construction type, in which the walls are usually of brick and the floors and roof of heavy plank supported by wooden beams strong enough to permit their being spaced 8 to 10 ft. apart. On the plank floors there is a thickness of boards to serve as a wearing surface, and often an intermediate layer put down diagonally for the sake of stiffness. Columns preferably are of wood, although cast iron gives acceptable results. This method of factory construction results in assembling the wooden parts in large units, the strength of which is not easily destroyed by fire. To prevent a fire from traveling from one floor to another, care must be taken that all openings through the floors are protected. This is best accomplished by locating stairs, elevators and belts in brick towers with any openings protected by automatic fire doors. This is not always possible, particularly in buildings already erected, but for these cases the protection outlined should be approximated by enclosing stairways with partitions of two thicknesses of boards laid to break joints, by providing automatic self-closing hatches at

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Abstract of paper presented at a meeting of the Connecticut Section, Meriden Branch, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, February 14, 1918.

the elevators, and by protecting the beltways with metal lath and plaster partitions or with substantial metal boxing easily removable for repairs.

Steel Construction. In steel construction the designer must keep in mind the likelihood of its quick failure, in the event of a fire, from bending or buckling. Fireproofing of steel in construction work is especially needed for columns in buildings several stories high, where the failure of a column in a lower story would bring down all above. Where there is to be a considerable amount of combustible stock it is also necessary to fireproof the beams, but for favorable occupancies, such as metal working, this is not always necessary except for important girders. For one-story buildings used for foundry and work of like nature, the use of exposed steel both for columns and girders is allowable.

Concrete Construction. The use of reinforced concrete makes possible a very safe factory, as each floor can be made a horizontal fire wall. It is unquestionably the type of construction best suited for use in congested sections. The cost, and sometimes the nature of business carried on, does not always warrant its adoption, although where loads are heavy and wide spans are desired, it is frequently not more expensive than other types of construction. Reinforced-concrete structures stood a severe test at the Edison Phonograph Works fire ot 1914. These contained much inflammable material, which furnished fuel for an intense fire. The buildings were badly damaged by spalling and splitting of the columns, collapse of a small portion, and expansion causing pilasters at the ends to shear off. The point of interest is that the buildings were repaired at 20 per cent of the original cost.

Poor Construction. Of the several types of construction that should be avoided, the first to be considered here is the so-called joisted type, which gives for floors and roofs one or two thicknesses of boards supported by joists 2 in. thick and a foot or two on centers. In many cases sheathing or plaster is attached to the under side of the joists, but in so doing concealed spaces are formed in which a fire is hard to fight. The open type cannot readily be protected by hose streams or sprinklers, as can the mill-construction floor. Contrast the strength of the two under a fire. If an inch is burned off from each side of the large beams used in mill construction, three-fourths of the strength is left, while if this same amount is burned from the joists, there is nothing left. In the joisted construction there is two or three times as much wooden surface exposed to the fire as under the mill-construction method.

Beware of *temporary* light frame buildings. Every insurance man knows that buildings so designated stay in service until they burn or are about ready to fall down. Not only are these structures poor risks in themselves but they frequently constitute a menace to neighboring property. If it is really thought that eventually a building will have to be removed to make way for some other unit, expanded metal and cement on iron framing will give satisfaction at moderate expense.

In old mills steep joisted roofs supported by trusses are sometimes found on buildings otherwise well constructed. Their use was dictated doubtless by the lack of satisfactory coverings for flat roofs. These steep roofs of light construction have proved to be fire traps, and it is worth while to replace them with flat mill construction, the gain in floor space alone being often sufficient recompense for the outlay.

Hollow tile is a poor material for building walls. When subjected to a fire the rapid heating of the exposed face of the tile causes it to expand and break away from the cooler portion.

The use of double floor beams has frequently been resorted to, but this should be avoided wherever possible. If they are located an inch or two apart it leaves a space where, experience shows, it is difficult to extinguish a fire. On the other hand, if the beams are bolted together the possibility of dry rot is increased.

Fire walls should not be omitted because a good protective equipment is to be provided. The protection may be out of service when a fire starts, on account of repairs or accident, and strong fire walls are needed to minimize the possibility of a total loss.

In recent years there has been more or less trouble because of dry rot or fungus growth, due to an inferior quality of wood. Timber so affected ignites more easily than sound wood and falls more quickly in event of fire on account of the rotting away of the ends. This disease is most likely to be found in damp places and investigations show that trouble from this source can be largely eliminated. Much good results from heating a building to a temperature of 115 deg. fahr. for a day or two as soon as it has been completed, and for wet occupancies, soaking the timber in a solution of corrosive sublimate is well worth the expense.

Occupancy

The arrangement of processes carried on in a manufacturing plant must meet two requirements: efficient production and the safety of the factory. This means, so far as possible, eliminating causes of fire and preventing small fires from becoming large ones.

Isolation of Severe Hazards. The first move is to locate the departments in which fire or explosion hazards are known to be serious in detached or well-cut-off buildings. This means boiler rooms at any plant, picking rooms of textile mills, the japanning room in a metal-working shop, the engine-testing room in an automobile factory, the dipping rooms in agricultural-implement plants, etc. In cities it is not always possible, on account of limited amount of land available, to provide separate structures to house these special hazards, and they are necessarily located in main buildings. In such cases it is well to fireproof the ceilings with metal lath and cement and separate the rooms from the main rooms by fire-retarding walls.

A point that should not be overlooked is that processes requiring materials or machines susceptible to water damage should not be located under rooms where fires are likely to occur.

Storage. A fire in a manufacturing building should involve only the stock that is in process of manufacture at the time. To accomplish this separate buildings are needed for storage of raw materials, finished goods, patterns, etc. The floor area of such structures should not be large and the buildings should be the equivalent of substantial mill construction. They should be only about eight feet from floor to floor in order that stock cannot be piled high, making it impossible for hose streams or sprinklers to do effective work.

Waterproof floors are desirable for some occupancies. For mill construction these may consist of two-ply felt laid between plank and wearing surface and mopped thoroughly with a waterproof compound, with special provisions at the edges and columns. Scuppers should be provided for carrying off the water. Where separate buildings for storage are not possible, the storage may be placed in the upper stories, as it is not then subjected to water loss if fires start in the manufacturing rooms, where fires are more to be expected than in storage areas. If it is necessary to locate storage in the lower part

... a building, the floors above can be waterproofe... described.

Oils. The danger which fuel oils bring can be ... great measure by careful handling. Storage should ... underground tanks and delivery by pumping. Gra... is highly objectionable, as is also air pressure for forc... oil from the storage tanks. Wherever possible, gasoline ... be handled by a hand pump. Fig. 1 shows a safe arrange-

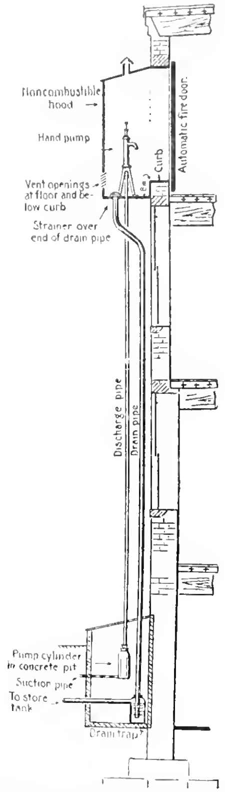


FIG. 1 ARRANGEMENT FOR FORCING GASOLINE TO AN UPPER STORY

ment where the oil is to be delivered to an upper story. Fuel oil is best delivered to the burners by a rotary pump, which can be driven by the same power that operates the blower furnishing the air for atomizing, insuring the automatic cessation of the flow of oil in case of failure of the air supply. The furnaces should be located in one-story buildings well cut off from the main plant.

Quenching-oil systems used in heat-treating plants have received considerable attention during recent years. A cooling system is desirable to keep the temperature of the oil below its flash point. Automatic covers and a quick-acting valve for drainage purposes are practical safeguards that are often neglected in oil tanks.

Kerosene has been used to a considerable extent in cutting oils. This introduces an unnecessary hazard, as careful investigations show that the work can be done as efficiently by emulsions or by selecting the right kind of oils. In a test made a few months ago a pan 30 in. by 48 in. was filled with straight cutting oil, and a bunch of cotton waste placed in the center and lighted. After 35 min. the fire had not spread from the waste to the oil. The same test was made with a mixture of 25 per cent kerosene and 75 per cent cutting oil, and in less than 1 min. the fire had spread over the pan.

Celluloid, although not an oil, needs as careful treatment. Burning celluloid is really a gas fire and needs to be treated as such. The amount in a factory should be limited to a day's supply, and this should be stored in a non-combustible cabinet such as that shown in Fig. 2, well vented to take care of the rapid generation of gases.

Housekeeping. A clean factory is essential. Waste materials must be removed daily and attention given to towers, corners, and out-of-the-way places. The advisability of keeping oily waste in metal cans is now generally recognized. A common source of trouble is from stock in contact with steam pipes. Charcoal is subject to spontaneous combustion and a piece of wood charred from long contact with a steam pipe will ignite. The best place to locate heating pipes is overhead. It is a bad practice to use sawdust on floors to absorb oil because of the danger of rapid oxidation.

PROTECTION

Automatic Sprinklers. The foremost method of factory protection is the automatic sprinkler, which is simply a $\frac{1}{2}$-in. opening with the valve held closed by various arrangements of links and levers and operated by the melting of a fusible link. A sprinkler was developed in 1875 that operated automatically in a practical way, although it took several minutes to work. Before that period perforated pipe protection, in which the pipes were perforated by small holes about eight inches apart, was in use. In case of fire it was necessary to open the valve controlling the water supply. This did not really meet the need because of delay in getting the water on the fire, and the wetting down of the entire room. This led to the development of the automatic sprinkler equipment, a sort of combination of the perforated pipe system and the fire-door-link principle.

An ideal arrangement of piping for a sprinkler system is shown in Fig. 3. This calls for a central feed and short branch lines. These two points are important because friction loss has to be reckoned with and it counts up fast in view of the large amount of water used. The sketch shows an equipment of 200 heads.

With the inlet from the yard main coming in at the center of the building, and assuming that all sprinklers are opened, 2700 gal. of water would be required and a pressure in the street pipe of 78 lb. If the riser is located in the corner, 3400 gal. of water and a street pressure of 119 lb. are necessary in order that the end head may have a fair working pressure.

At the beginning automatic-sprinkler protection was applied mostly to the danger points in textile mills, but gradually the mills became 100 per cent protected and the use of sprinklers was taken up by other industries.

Storehouse properties were the last to receive protection, as many of these structures are not heated, and this led to the development of the dry-pipe system, in which the danger of trouble by freezing is eliminated by permitting the pipes in the building to be filled with air. When a fire starts, the pressure in the piping is reduced as the air discharges through the sprinklers that have opened, and tripping of the air valve follows promptly, letting water into the system. This apparatus was viewed with suspicion for a time, but is giving a good account of itself and is now freely used.

The fact that a building is of non-combustible construction

is no excuse for the omission of sprinkler protection, and experience has shown the need of this wherever combustibles are present in the construction or contents. In very rare cases sprinklers may be safely omitted. Power houses and foundries, unless there is an objectionable amount of wooden flasks, fall in the class where it is sometimes logical to omit sprinkler protection if the construction is non-combustible.

One sprinkler under conditions as they are found will protect from 60 to 100 sq. ft., depending on the occupancy, spacings of beams, and water pressure available. For some very special hazards extra sprinklers are needed. Celluloid is one of these, requiring a spacing so close that shields have to be provided to prevent one sprinkler from playing on its neighbor and keeping it from operating. Generally sprinklers are so located that the splash plates come from 3 to 10 in. below the ceiling and under ordinary conditions are in an upright position. This enables the system to be completely drained in case of need and gives no chance for the head to become a small settling basin, as it would be if inverted. Sprinklers in dry-pipe systems should never be placed pendant. In rooms where conditions are favorable for corrosion, heads with a coating to prevent or retard this action can be secured.

Water Supplies. The value of sprinkler protection is largely governed by the strength of the water supply. This was curiously brought out by the Salem conflagration. A wooden factory building that passed through the fire had complete sprinkler protection supplied by city water and a 30,000-gal. tank. After water from the tank was exhausted the top story burned, but the city pressure was just sufficient to save the two lower stories without any assistance from the fire department. A specimen fire-protective layout is shown in Fig. 4. A connection with a good public water system gives the most satisfactory primary supply. Gravity delivery is best, while direct pumping systems must be looked on with suspicion. Sprinklers are most useful at the start of a fire and must have water instantly to do their work, a requirement which the direct pumping systems frequently do not meet. The initial pressure available is not of great interest, but we do need to know what the effective pressure will be if sprinklers requiring 1000 gal. of water or more a minute are opened by a flash fire.

When a satisfactory water supply cannot be obtained from a public water system, the customary resource is a gravity tank preferably erected on a steel trestle in the yard, but sometimes supported by one of the building towers.

The best of public water systems or gravity tanks are out of service at times to permit repairs or extensions, and while the gravity water supply may give sufficient pressure for sprinklers, it is not always strong enough for high-pressure hose streams; or, again, pressure in the public water mains may be reduced by use of hose streams, leaving nothing for the sprinklers. Therefore, a second water supply is required for the average factory. This frequently consists of the combination of the above two sources of gravity supply, but if conditions make it feasible, an Underwriter fire pump taking suction from some river, harbor or artificial reservoir built in the factory yard is still better. Steam, rotary, and centrifugal fire pumps have been designed especially for fire service. They are not built to obtain a high efficiency, although there are certain requirements in this respect, but the chief object is to secure a rugged pump that can be counted on for a long run. One or two pumps are needed, depending on the conditions and size of plant. In this connection it is well to remember that two 750-gal. pumps give a greater degree of safety than a 1500-gal. unit, as in case of accident to one of them the plant is not entirely without fire-pump service. The standard sizes of fire pumps are 500, 750, 1000, and 1500 gal. per min.

The type of pump to be used will depend largely on the power available. Rotary pumps are usually driven from water wheels, and if these are used there must be assurance that the power can be counted on the year round. If steam pumps are employed the power house must be cut off from the main plant by a fire wall, otherwise it might not be possible to run the boilers in case of fire; also the boiler feed should be from two independent sources, possibly one of them direct from the fire pump for emergency use only. The centrifugal fire pump

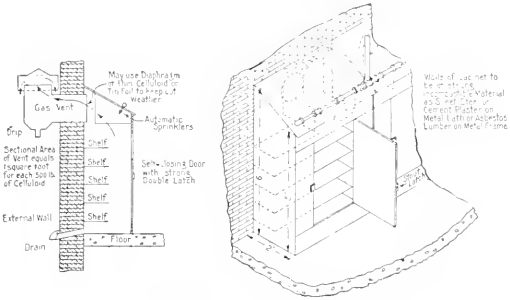


Fig. 2 Non-Combustible Cabinet for Storing Celluloid

is ordinarily driven by a motor. The current for power must be good and, unless there are some particularly favorable conditions, it needs to come from two independent sources to be the equivalent of the steam-pump equipment.

A fire pump must have a good foundation and good suction and it will then do reasonably well under very adverse conditions, but it is unsatisfactory if these two items are neglected. Long suction lines should be avoided and the intake defended by double removable screens. Centrifugal pumps should take water under a head if possible, but when this cannot be arranged priming facilities will have to be very carefully worked out and a foot valve of good design provided.

Yard Pipes, Hydrants and Standpipes. The pipes must have sufficient capacity to carry all the water available to any point in a factory yard without excessive friction loss, or at least as much water as will be needed to supply both sprinklers and hydrants for the property to be protected. Six-inch pipe is the smallest that should be used. For a factory of moderate size an 8-in. loop is usually sufficient, but for large properties pipe 12 in. or more in diameter is often required.

It is true that water can generally be used to the best advantage through the sprinklers, as these put it directly on the fire, while only a small portion of water from a hose stream might reach a fire. Nevertheless hydrants are needed as a reserve because a number of accidents might happen to the sprinkler system. Where yard room permits, hydrants should be located 40 or 50 ft. from the buildings, and should be in sufficient number so that hose lines over 150 or 200 ft. long will not be required. Faith should be placed in the sprinklers and the large hose stream not brought into use until it is certain that it is needed.

Hose for outside use in mill yards should be $2\frac{5}{8}$-in. cotton, rubber-lined. This should be kept in well-ventilated houses erected over the hydrants, which should also contain a supply of nozzles, spanners and similar equipment. The nozzles should have $1\frac{1}{8}$-in. smooth tips and swivel handles. Shut-off nozzles are not recommended for factory fire brigades.

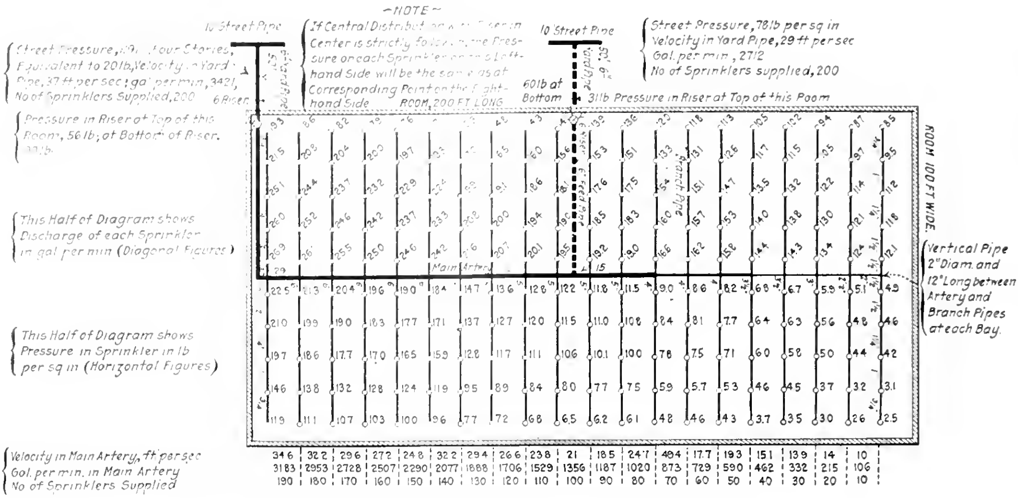


FIG. 3. IDEAL ARRANGEMENT OF PIPING FOR A SPRINKLER SYSTEM

Piping by schedule of November 1895, with new piping and central distribution. Figure shows water pressure that must be maintained at each sprinkler in room, if all the sprinklers are open, for the sprinkler in the farthest corner to receive an efficient supply.

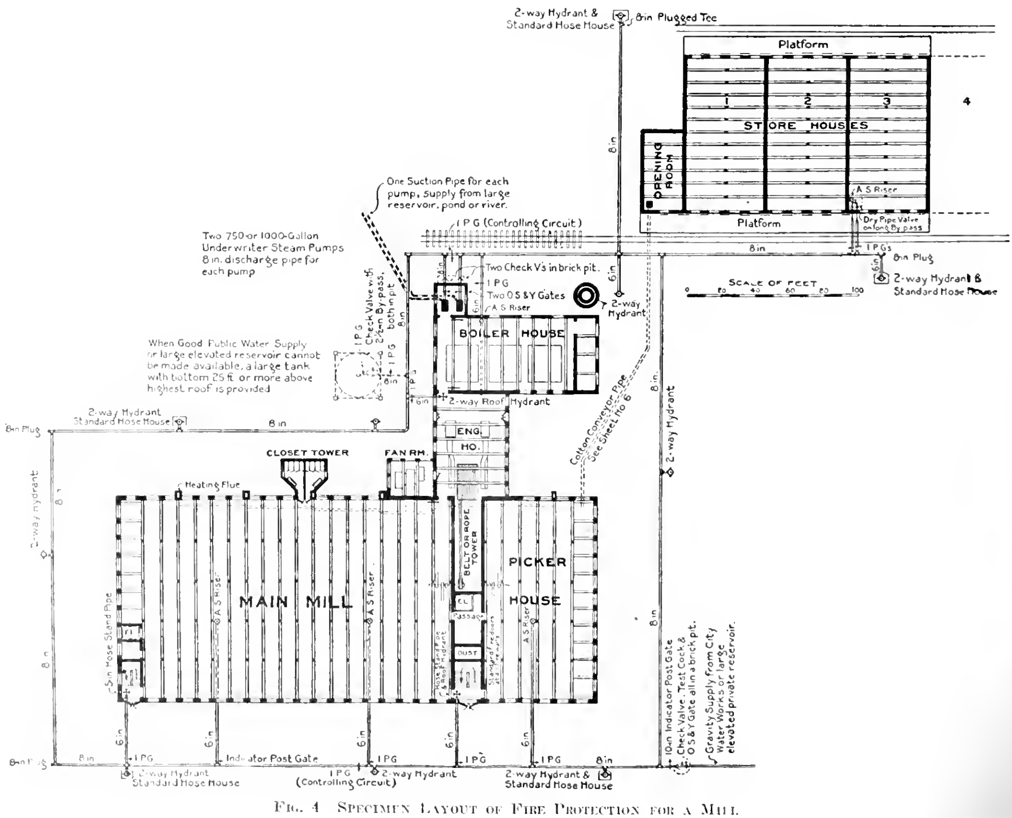


FIG. 4 SPECIMEN LAYOUT OF FIRE PROTECTION FOR A MILL

For buildings several stories high, hydrants should be supplemented by hose standpipes in the towers with $2\frac{5}{8}$-in. hose connections at each floor. Where there are other buildings in the yard, it is an advantage to extend the standpipes through the roof and provide roof hydrants. The towers are suggested as the best locations for the standpipes, as then a fire can be fought to the last minute without running a chance of having to leave without shutting off the water. Linen hose should be used for inside work, as the rubber-lined deteriorates rapidly when kept in warm rooms.

Indicator post valves in the yard should be placed on the branches supplying sprinklers. Inside valves should not be employed as their use is likely to prove disastrous in two ways: First, a fire may happen when the valve is closed and inaccessible because of fire or smoke; second, a fire may have gone beyond control by the sprinklers, or the sprinkler piping may have been broken, and unless the controlling valve can be reached the entire water supply may be wasted through the open pipe. A few section valves in the yard mains, to permit repairs to be made without shutting off the entire protective equipment, are worth while.

First Aids. It is claimed that the water pail has put out more fires than any other extinguishing apparatus, and it should not be omitted. Any man, woman or child knows what it is for and can use it. Small hose is also very useful and should, wherever possible, be attached to some pipe system other than that of the sprinklers. The ordinary liquid extinguisher gives good service. It is better than the fire pail for some conditions, such as fires in concealed spaces and in buildings where all there is to burn is the ceiling and this is too high above the floor to be reached by water pails. Generally speaking, however, the water pails are to be preferred. Dry-powder extinguishers have usually not proved as efficient for general duty. Comparatively recent investigations show that fires in dip tanks of moderate size can be handled more easily by use of sawdust than by sand because the sand sinks, but sawdust will float, forming a blanket which excludes the air. The efficiency of this method is increased by mixing sodium bicarbonate with the sawdust.

Watchman. For more than half the time the factory is in the hands of a watchman. This duty should not be given to an old employee in lieu of a pension, but to a strong man with ability to think quickly. It is desirable that records be made of the rounds on a suitable clock, and rounds should be made as often as once an hour, and should be arranged for at all times when the factory is not in operation.

Fire Brigade. An efficient, well-organized and drilled fire brigade is also essential for city properties, as well as isolated plants, for in any plant a certain number of men must be fully acquainted with the fire-protective equipment, and there is no better way to arrange for this than by means of a fire brigade. Again, there is the possibility that the public fire department may be busy fighting a large fire at some other point when a fire breaks out in a given plant. Frequent inspections by the chief and members of the public fire department should be encouraged, as by doing this they can become acquainted with the hazards and with what help the plant can be counted upon to give to control a fire. Unquestionably there are a large number of fires that should be handled by the men at the plant, who are entirely familiar with the processes and know fully what they have to contend with.

Care of Equipment. The greatest danger to a factory built and protected along the above lines is the possibility that the protective apparatus may be out of commission through neglect, accident or malicious design. The duties of the members of the fire brigade should therefore include an efficient oversight of the protective equipment. Every attention should be given to sprinkler valves, which should be listed on a report blank, and a copy of this taken when a tour of inspection is made. When protective equipment is necessarily shut off for repairs a member of the fire brigade should be stationed at the closed valve ready to open it if a fire breaks out, and other members should patrol the areas without automatic protection.

Exposures

Dangers that there may be from outside sources must be analyzed and safeguards provided. Outside hazards may consist of some fire trap only a few feet away, may be the possibility of a general fire in the section in which the factory is situated, may come from a forest, or may even appear by water if there happen to be some large oil tanks upstream. Of course, good building laws and their enforcement are fundamental aims. Perhaps this problem would not be so serious if we had the old French law making a property owner responsible for the damage done to his neighbor's property resulting from a fire originating in his own.

The best safeguard to minimize this danger is a solid brick fire wall on the exposed side. Good protection may be had by means of tin-clad wood fire shutters—never iron ones—by wire-glass windows in metal frames, by an equipment of open sprinklers over the windows to give a water curtain, or, for severe cases, by a combination of two of these methods. Combustible cornices should be removed or protected by open sprinklers, and there should be no wooden roof structures.

It is to be anticipated that the pressure in public water systems will fall off rapidly in a general conflagration because of waste through broken pipes in addition to the water used for fire fighting. It is very important, therefore, that the private fire-pump service be very strong where the exposures are severe, in order that there may be sufficient water available for hose streams, inside sprinklers and the water curtains. Much has been accomplished along this line by adjoining factories cross-connecting their fire-protective piping, making it possible to concentrate the pump service of all at any point. Private fire protection of this kind is a help to the community in checking the spread of a conflagration.

Conclusion

Does it pay to protect factory properties against fire loss or interruption to production because of fires? Two facts will be sufficient answer. The methods described are substantially the basis on which the New England factory mutual fire-insurance companies have been operating since their organization. Fifty years ago, before the day of automatic sprinklers and development of other fire-protective methods which we have been considering, the average cost of insurance in the Blackstone Mutual Fire Insurance Co.—one of the factory mutuals—was \$650 a year for \$100,000 insurance. Today, for the two companies in the Blackstone office, it averages less than \$65 for the same amount. Otherwise expressed, the fire waste in factories so protected and maintained has been reduced 90 per cent!

The methods of fire protection that have been applied have been as successful in safeguarding lives as property. Insurance amounting to over four billion dollars is now carried in the Factory Mutual Companies, which means that there are many hundred thousands of employees in the factories under their jurisdiction. The loss of life since automatic sprinklers were developed has averaged about one every other year!

SOME FACTORS IN FUEL ECONOMY IN BOILER PLANTS

By ROBERT H. KUSS,[1] CHICAGO, ILL.

THE total bituminous coal production in the United States during 1917 was close to 542,000,000 tons, and in the same year 90,000,000 tons of anthracite were marketed. The uses to which the bituminous coal was put have been estimated as given in Table 1. Forty per cent of the anthracite production was consumed by locomotives, and the remainder mostly by domestic users.

TABLE 1 BITUMINOUS COAL CONSUMPTION IN THE UNITED STATES, 1917

Kind of Plant	Tons	Per Cent
Stationary steam.	215,000,000	40
Railway locomotives	190,000,000	35
Households	135,000,000	25
	540,000,000	100

It is easy to see from Table 1 that 60 per cent of the total coal production in the United States during 1917 was applied to non-productive uses: namely, 35 per cent for steam locomotives plus 25 per cent for household use; or, to put it more strikingly, while the railways hauled all of the coal output it took 35 per cent of the coal production to conduct the entire business of hauling. Although impossible to form a coal budget for 1918, competent authorities seem to agree that the production must be increased by not less than one hundred million tons of bituminous coal.

Much needless transporting of coal has been practiced, and therefore the Fuel Administration's order restraining coal shipments within areas of natural consumption was good judgment. The hardships follow owing to the necessity of using a grade or quality of coal in equipment designed for a more distant product. This of course is particularly evident in the domestic field where West Virginia coal has been shipped in vast quantities to the larger population centers at a considerable distance.

With a fixed system for transporting coal and with added demands for its use, it is manifestly necessary to transport all coal possible during the summer months, thus compelling storage in vast quantities. The difficulties of storage, such as the likelihood of spontaneous combustion, are well understood and can be avoided.

While it is not possible to fix a definite figure or even range representing the ratio of heat absorption to that of possible heat evolution, or, stated otherwise, the efficiency, for the respective groups of manufacturing, locomotive and domestic use, it is nevertheless desirable to look into this phase of the matter. The average estimates which appear in Table 2 are accordingly submitted by the writer for what they are worth and have to do with the performances of the several groups applied to a year's period, all losses being charged.

Granting that all of these figures are merely speculative, they still show that the largest possibilities rest within the province of the duties naturally supervised by men such as ourselves. With respect to the large avoidable losses in burning domestic fuel, it must be borne in mind that even were the reclamation or saving of coal by more economical use larger than the estimates in Table 2 indicate, the difficulties attending a proper dissemination of knowledge to effect the possible economies are extreme.

Dealing with a single furnace the particular features needing consideration are:

a The character and physical condition of the coal

b The manner of introducing the coal into the furnace

c The shape, size and construction of the grate

d The shape and size of the chamber in which evolved gases burn

e The facilities for introducing air either through or above the fuel bed.

Any means which tend to cause the gases of combustion to be evolved or distilled uniformly are in the direction of complete combustion, and this is especially affected by the character of the coal and the method of introducing it. Manifestly, with a uniform gas distillation the cubical capacity of a furnace need not be as large as for variable distillation to obtain the same effect, for the determining factor in the complete distillation of fuel is sufficient air adequately mixed with the evolved gases and maintained at a high temperature long enough to insure the completion of the combustion process before encountering relatively cool surfaces.

TABLE 2 ESTIMATED PERCENTAGE EFFICIENCIES WHEN USING BITUMINOUS COAL

	Stationary Plants		Railway Locomotives	Domestic
	High-Pressure	Low-Pressure		
Poor practice.	50	40	60	30
Fair practice.	64	56	66	40
Good practice.	72-74	62	70	50
Available practice	76	68	72	55
Available increase.	12	14	9	15
Available savings, tons	25,800,000		17,100,000	20,250,000
Total tonnage saving on 1917 basis.				63,150,000

Air that does not enter into the actual combustion process is a source of loss whether the process is complete or not. Complete combustion does not argue economy, for the air admitted to bring it about may, and frequently does, exceed the amount required and be introduced in such places or in such ways as to offer itself as a vehicle for absorbing heat without assisting in its generation. Fundamentally, then, the items of importance are the rate and degree of uniformity of gas distillation. The usual failures in these particulars are due to the fact that the grate surfaces employed and air facilities provided are disproportionate to the steam demands, thus resulting in improper fuel beds and making it extremely difficult to cause the furnace to function as stated. Such conditions result in oversupplying air in certain sections, undersupplying it in others and in failing both to mix the air and gases and maintain them at a high temperature within the capacity of the furnace.

Referring to a particular design and condition of equipment, it happens that boilers perform at about the same efficiencies throughout their ranges of duty. In other words, clean, enclosed heating surface will absorb about the same

[1] Consulting M.E., Mem.Am.Soc.M.E.

Abstract of paper on the subject of coal conservation presented before the Detroit Section of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, May 3, 1918.

percentage of heat without regard to the quantity supplied to it within the range commonly encountered in practice, say, up to 250 per cent of builders' rating. This does not mean that all boilers are equally good or equally good heat absorbers; it has to do with the proposition that for a given design or shape of heating surface it is not essential to be concerned with the amount of heat delivered to envelop it, for the proportion absorbed will be practically the same in any case. On the other hand, the conditions surrounding boilers do play a big part in the resulting efficiencies and divide themselves mainly into cleanliness of both sides of the heating surface and the condition of the enclosing structure or setting of the boiler.

Boiler and furnace efficiency depend on the manner in which draft facilities are provided and utilized. In connection with draft there are the following points to bear in mind:

1 There must be provided a surplusage of draft intensity capable of being exerted at the fuel-bed end of the installation, so that momentarily greater steam demands may be met or temporary faults of fuel-bed construction overcome

2 Good judgment demands that the chimney or fan shall not have its purposes partially defeated by tortuous, ill-shaped breechings or faulty passages through the settings

3 Not only must the facilities for creating air movement through the fire be adequate, but the room delivering air to the system must have provision for the introduction of the volume of air needed for the combustion processes

4 Causes which tend to reduce draft intensity, as by soot deposits and air infiltration, not only bring about losses of their own accord but tend to destroy the available elasticity of furnace operation, which is more serious

5 Furnace draft should at all times be ample to overcome the resistance of the fuel bed

6 The rate of failure of furnace parts is inseparably tied up with the ability of the draft forces to carry away the heated gases as rapidly as evolved.

When several boilers are combined for service, there is usually a wide choice given in selecting the number to be run. Assume an ordinary plant containing eight 400-hp. boilers equipped with stokers adapted to the fuel being supplied. Suppose the draft facilities are ample and the load variation between 2500 and 2800 hp., momentarily going as high as 3000 hp. By ample draft is meant sufficient to burn without serious furnace injury enough coal (or more) on each grate to generate 760 hp. or 90 per cent overload. The ordinary way to run the plant would be to place six or seven boilers in service, keeping two or one down for general cleaning, and meet the load changes by altering damper positions, grate speeds, etc.

In Fig. 1 the line *AA* represents what may be termed the maximum combined efficiency over the range of operating rates. The mere fact that it is possible to attain these efficiencies at the different ratings does not secure their attainment. As a matter of fact, the lower the rate of operation the greater the opportunity for improper draft adjustments, poor fuel beds, uncleanliness and air leakages to go on unchecked and uncorrected. The effect is to obtain on the average a performance somewhat as represented in the efficiency curve *BB*. This has the characteristic of rising to a maximum height between 150 and 160 per cent of boiler rating. The conclusion is that it is best to run the boiler at around 150 and 160 per cent for normal loads.

Applying this judgment to the problem, take 2650 b.hp. as the mean point of service demanded and divide by 640, the latter figure being the product of 400 and 1.60. Thus four boilers will ordinarily carry the load if means are taken to operate the units at this rating. Now, how shall the momentary loads beyond be handled? By bringing up one unit at a time to its maximum capacity as the load increases up to the 3000 hp. of the original problem. In a like manner, when the load decreases, first one unit is reduced to, say, 110 per cent of rating, and if that reduction is not enough, a second unit is taken in hand, and so on. In other words, here is an attempt to push the operating forces to a place where they dare not neglect their duties lest they lose their grip on the steam pressure. When it is considered that fewer units are being

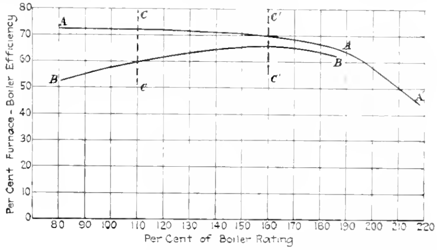


FIG 1 EFFECT OF VARIOUS RATINGS OF THE BOILER ON COMBINED EFFICIENCY

AA Available efficiency.
BB Usual operating efficiency.
CC—*C'C'* Proposed range of operating units.
C'C' Proposed rate of operating units for normal loads.
AA' Drop in efficiency due to insufficient furnace capacity.

watched and less fuel is handled, the net result is favorable to the operatives. The scheme advanced has many advantages for its application, as borne out by experience.

The above is a mild case and thus far only the immediate benefits in the way of economy have been stated. The corollary benefits no less important are: less blowing down; less soot accumulation and less effort and steam for its removal; less brick maintenance per ton of coal burned; less coal loss at the closing periods of the operating day and at other slow-down periods; greater time for inspection, overhauling, cleaning and repairs; and less percentage loss due to unavoidable losses such as radiation.

The ability to apply this system to its logical and best conclusion depends upon whether the available draft is adequate. If deficient, thus not permitting the attainment of a curve such as *AA*, then the opportunity for effecting the larger efficiencies is excluded, but the principle is still applicable. If the furnace capacity is inadequate, thereby causing its efficiency to fall rapidly at the higher rates, then the limits through which the scheme can be successfully applied are correspondingly reduced. If the plant is hand-fired (or even stoker-fired) and has less units than that mentioned in the problem, perhaps the exclusion of one whole unit may be impracticable; in that case each grate size should be reduced. Naturally it is extremely important to know just what the possible performance of each boiler unit may be throughout its range of working; also, what is expected of the plant as a whole in the way of steam demands.

Few instruments are needed for an ordinary plant, but those must be regularly used and the records reviewed and studied. Every boiler setting should have a draft gage or draft-gage system capable of instant or constant indication of boiler uptake and furnace drafts, and there should be accurate water-measuring and coal-weighing apparatus. Each chief engineer of a plant of, say, 600 b.hp. should possess a standard Orsat or gas-analyzing set and an indicating pyrometer.

REPORT OF THE COMMITTEE ON STANDARDIZATION OF FLANGES AND PIPE FITTINGS

To the Council of the American Society of Mechanical Engineers:

Your Committee on the Standardization of Flanges and Pipe Fittings has agreed on the following additions to existing standards comprised in its report known as The American Standard for Pipe Flanges, Fittings and Their Bolting, issued in 1914, and herewith presents them for your consideration and action:

Standardization of angle elbows and special angle fittings: From 1 deg. to 45 deg., use center-to-face dimensions of standard 45-deg. elbows, American Standard, and over 45 deg., use center-to-face dimensions given for 90 deg. American Standard elbows.

The following new standards have also been agreed upon:

1 A standard to be known as American Low-Pressure Standard for 50 lb. working pressure, tabulation of flange data at-

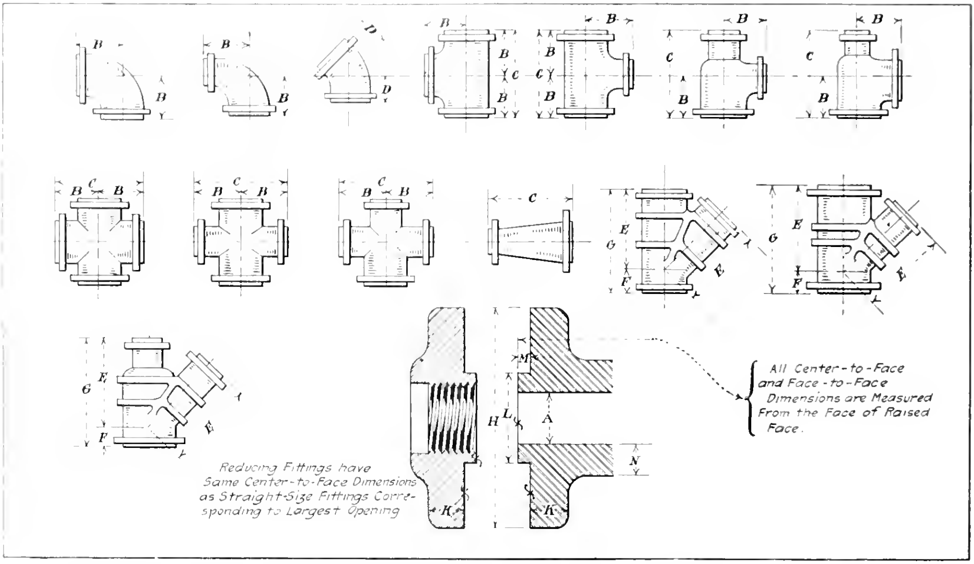
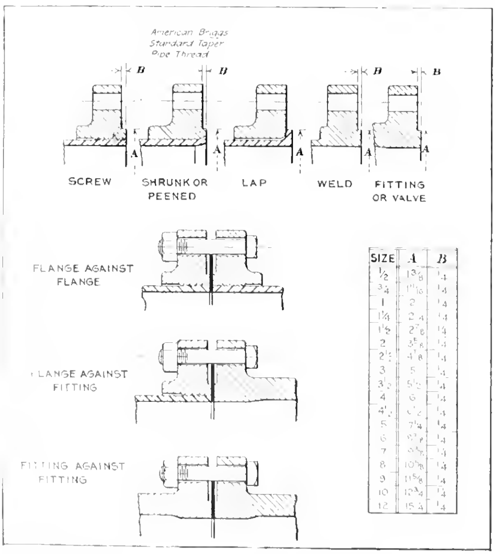
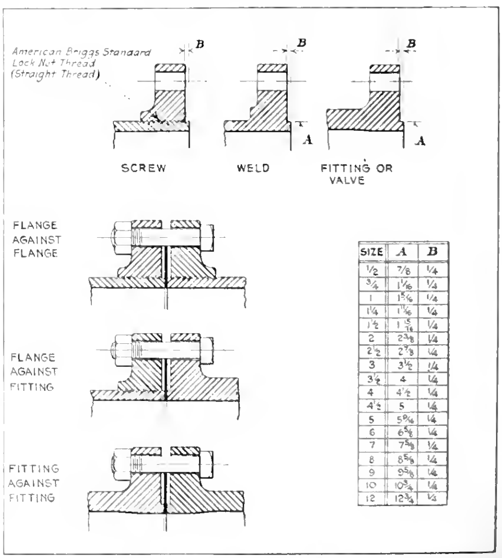


Fig. 1 Hydraulic American Standard Flanges and Flanged Fittings Dimensioned in Tables 2, 3 and 4



SIZE	A	B
½	1⅜	¼
¾	1^{11}/16	¼
1	2	¼
1¼	2¼	¼
1½	2⅞	¼
2	3⅝	¼
2½	4⅛	¼
3	5	¼
3½	5½	¼
4	6	¼
4½	6½	¼
5	7¼	¼
6	[illegible]	¼
7	[illegible]	¼
8	10⅞	¼
9	11⅝	¼
10	12¾	¼
12	15¾	¼

Fig. 2 Flange Joints and Methods of Attaching Flanges to Pipe, 800-Lb. and 1200-Lb. Hydraulic American Standard



SIZE	A	B
½	7/8	¼
¾	1 1/16	¼
1	1 5/16	¼
1¼	1 11/16	¼
1½	1 15/16	¼
2	2⅜	¼
2½	2⅞	¼
3	3½	¼
3½	4	¼
4	4½	¼
4½	5	¼
5	5 9/16	¼
6	6⅝	¼
7	7⅝	¼
8	8⅝	¼
9	9⅝	¼
10	10¾	¼
12	12¾	¼

Fig. 3 Flange Joints and Methods of Attaching Flanges to Pipe, 3000-Lb. Hydraulic American Standard

TABLE 1 PROPOSED LOW-PRESSURE STANDARD FOR END FLANGES, BOLTINGS AND BODY THICKNESS—50 LB. WORKING PRESSURE

Size	Diameter of Flange	Flange Thickness	Bolt-Circle Diameter	Number of Bolts	Size of Bolts	Body Thickness	Size	Diameter of Flange	Flange Thickness	Bolt-Circle Diameter	Number of Bolts	Size of Bolts	Body Thickness
12	19	1 1/4	17	12	3/4	5/8	56	68 3/4	3	65	48	1 1/4	1 5/8
14	21	1 3/8	18 3/4	12	3/4	11/16	58	71	3 1/8	67 1/4	48	1 1/4	1 5/8
15	22 1/4	1 3/8	20	16	3/4	11/16	60	73	3 1/8	69 1/4	52	1 1/4	1 11/16
16	23 1/2	1 7/16	21 1/4	16	3/4	3/4	62	75 3/4	3 1/4	71 3/4	52	1 1/4	1 3/4
18	25	1 9/16	22 3/4	16	7/8	3/4	64	78	3 1/4	74	52	1 1/4	1 3/4
20	27 1/2	1 11/16	25	20	7/8	13/16	66	80	3 3/8	76	52	1 1/4	1 13/16
22	29 1/2	1 13/16	27 1/4	20	7/8	7/8	68	82 1/4	3 3/8	78 1/4	56	1 1/4	1 7/8
24	32	1 7/8	29 1/2	20	7/8	7/8	70	84 1/2	3 1/2	80 1/2	56	1 1/4	1 15/16
26	34 1/4	2	31 3/4	24	1	15/16	72	86 1/2	3 1/2	82 1/2	60	1 1/4	1 31/32
28	36 1/2	2 1/8	34	28	1	1	74	88 1/2	3 5/8	84 1/2	60	1 1/4	2
30	38 3/4	2 1/8	36	28	1	1	76	90 3/4	3 5/8	86 1/2	60	1 1/4	2 1/16
32	41 3/4	2 1/4	38 1/2	28	1	1 1/16	78	93	3 3/4	88 3/4	60	1 3/8	2 3/32
34	43 3/4	2 5/16	40 1/2	32	1	1 1/8	80	95 1/4	3 3/4	91	60	1 3/8	2 1/8
36	46	2 3/8	42 3/4	32	1	1 1/8	82	97 1/2	3 7/8	93 1/4	60	1 3/8	2 3/16
38	48 3/4	2 3/8	45 1/4	32	1 1/8	1 3/16	84	99 3/4	3 7/8	95 1/2	64	1 3/8	2 1/4
40	50 3/4	2 1/2	47 1/4	36	1 1/8	1 1/4	86	102	4	97 3/4	64	1 3/8	2 1/4
42	53	2 5/8	49 1/2	36	1 1/8	1 1/4	88	104 1/4	4	100	68	1 3/8	2 5/16
44	55 1/4	2 5/8	51 3/4	40	1 1/8	1 5/16	90	106 1/2	4 1/8	102 1/4	68	1 3/8	2 3/8
46	57 1/4	2 11/16	53 3/4	40	1 1/8	1 3/8	92	108 3/4	4 1/8	104 1/2	68	1 3/8	2 3/8
48	59 1/2	2 3/4	56	44	1 1/8	1 7/16	94	111	4 1/4	106 1/4	68	1 3/8	2 7/16
50	61 3/4	2 3/4	58 1/4	44	1 1/8	1 1/2	96	113 1/4	4 1/4	108 1/2	68	1 3/8	2 1/2
52	64	2 7/8	60 1/2	44	1 1/8	1 1/2	98	115 1/2	4 3/8	110 3/4	68	1 3/8	2 1/2
54	66 1/4	3	62 3/4	44	1 1/8	1 9/16	100	117 3/4	4 3/8	113	68	1 3/8	2 9/16

Note

1 For sizes 10 in. and smaller, use regular 125-lb. American Standard flange dimensions and templets.

2 For sizes 12 in. and larger, use 125-lb. American Standard flange diameters, bolt circles, and number of bolts, using bolt diameters as shown above, thereby maintaining interchangeability with 125-lb. American Standard flanges.

3 Screwed companion flanges should not be thinner than 125-lb. American Standard thickness.

tached. This standard was recommended after an agreement with the Committee of the Manufacturers' Association.

2 Three standards for hydraulic fittings, to be known as:

800-Lb. Hydraulic American Standard
1200-Lb. Hydraulic American Standard
3000-Lb. Hydraulic American Standard.

Tabulations and data for each of these standards with joint designs are submitted for your consideration. These are given in Tables 1 to 4 inclusive, and Figs. 1, 2 and 3.

Your Committee deems it inadvisable at this time to outline or recommend a standard for 600 lb. steam pressure with superheat, partly because there is at present no demand for fit-

TABLE 2 800-LB. HYDRAULIC AMERICAN STANDARD FLANGES AND FLANGED FITTINGS, 12 IN. AND SMALLER, FOR FULL-WEIGHT WROUGHT PIPE. SEMI-STEEL AND CAST STEEL. (See Fig. 1)

800 Lb. Cold Water Working Pressure — Hydrostatic no shock
500 Lb. Cold Water Working Pressure — shock
800 Lb. Air or Gas Working Pressure — Temperature Not Exceeding 100 Deg. Fahr

See Fig. 1	Size	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	3 1/2	4	4 1/2	5	6	7	8	9	10	12
A	Inside diameter of port	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	3 1/2	4	4 1/2	5	6	7	8	9	10	12
B	Center to face, ell, tee, cross	3 1/4	3 3/4	4 1/4	4 1/2	4 3/4	5 3/4	6 1/2	7	7 1/2	8 1/2	8	10	11	12	13	14 1/2	15 1/2	16 1/2
C	Face to face, tee, cross, reducer	6 1/2	7 1/2	8 1/2	9	9 1/2	11 1/2	13	14	15	17	18	20	22	24	26	29	31	33
D	Center to face, 45-deg. ell	2	2 1/4	2 1/4	2 3/4	3	4 1/4	4 1/2	5	5 1/2	6	6 1/2	7	7 1/2	8	8 1/2	9	9 1/2	10
E	Center to face, lateral	5 1/2	6	6 1/4	7 1/2	8 3/4	11	12 1/2	13 1/2	14 1/2	16 1/2	17 1/2	19 1/2	21	22 1/2	24 1/2	27 1/2	29 1/2	31 1/2
F	Center to face, lateral	1 1/4	2	2 1/4	2 1/2	2 3/4	3 1/2	3 1/2	4	4 1/2	4 1/2	5 1/2	6	6 1/2	6 1/2	7	7 1/2	8	8 1/2
G	Face to face, lateral	7 1/4	8	9	10	11 1/2	14 1/2	16	17 1/2	19	21	23	25 1/2	27 1/2	29	31 1/2	35	37 1/2	40
H	Diameter of flange	3 1/2	4	4 1/2	5	6	7	7 1/2	8 1/2	9 1/2	10 3/4	11 1/2	13	14	15	16 1/2	18 1/2	20	22
K	Thickness of flange { Semi-steel	9/16	5/8	11/16	3/4	13/16	1 1/4	1 3/8	1 1/2	1 5/8	1 7/8	2	2 1/8	2 1/4	2 3/8	2 1/2	2 3/4	2 7/8	3
	{ Cast steel						1	1 1/8	1 1/4	1 3/8	1 1/2	1 5/8	1 3/4	1 7/8	2	2 1/8	2 3/8	2 1/2	2 5/8
L	Diameter of raised face	1 3/8	1 11/16	2	2 1/4	2 5/8	3 5/8	4 1/8	5	5 1/2	6	6 1/2	7 1/4	8 5/8	9 5/8	10 5/8	11 7/8	12 3/4	15 1/4
M	Height of raised face	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4
N	Minimum metal thickness { Semi-steel	7/16	7/16	1/2	1/2	1/2	9/16	5/8	5/8	3/4	7/8	1	1 1/8	1 1/8	1 1/4	1 3/8	1 1/2	1 5/8	1 3/4
	{ Cast steel						1/2	9/16	9/16	5/8	11/16	3/4	13/16	7/8	1	1 1/16	1 1/8	1 1/4	1 3/8
	Diameter of bolt circle	2 3/8	2 7/8	3 1/4	3 3/4	4 1/2	5 1/4	5 7/8	6 1/2	7 1/2	8 1/2	9 1/4	10 1/2	11 1/2	12 1/2	13 3/4	15 1/2	17	19 1/4
	Number of bolts	4	4	4	4	4	4	8	8	8	8	8	8	12	12	12	16	16	20
	Diameter of bolts	7/16	1/2	1/2	1/2	5/8	3/4	3/4	3/4	7/8	7/8	7/8	1	1	1	1 1/8	1 1/8	1 1/4	1 1/4
	Length of bolts { Semi-steel	2 1/4	2 1/2	2 1/2	2 3/4	3	4	4 1/4	4 1/2	4 3/4	5 1/4	5 1/2	6	6 1/4	6 1/2	7	7 1/2	7 3/4	8
	{ Cast steel						3 1/2	3 3/4	4	4 1/4	4 1/2	4 3/4	5 1/4	5 1/2	5 3/4	6 1/4	6 3/4	7	7 1/4

These fittings are recommended for pump columns, oil-transmission lines, gas lines and other hydraulic service where shock is negligible for a maximum working pressure of 800 lb. and a maximum temperature of 100 deg. fahr. Where subject to shock they are recommended for a maximum working pressure of 500 lb.

The diameter of port is nominal size.

Reducing fittings carry same dimensions center to face as straight-size fittings corresponding to largest opening.

Flanges may be attached to the pipe by any of the following methods: Screw flanges; lap flanges; shrunk, peened or riveted flanges; flanges welded to pipe.

Flanges on fittings and valves, also all companion flanges except those for lap joint, should be furnished with 1/4-in. raised face, as shown in dimension table, Fig. 2, unless otherwise specified.

Bolt holes are 1/8 in. larger in diameter than bolts. Bolt holes straddle center lines. Unless otherwise specified, bolt holes in cast-steel fittings should be spot-faced.

Square-head bolts with hexagonal nuts are recommended. Hexagonal nuts on sizes 8 in. and smaller can be conveniently pulled up with open-end wrenches with minimum-design heads. Hexagonal nuts on sizes 9 in. and larger can be conveniently pulled up with box wrenches.

When flanges are screwed, shrunk, peened or riveted on the pipe, it is recommended that the end of the pipe and flange be refaced.

Gaskets extending from the inside of the pipe to the inside edge of the bolts are recommended. The ultimate compressive strength of the gasket must be sufficient **to** prevent its being crushed when bolts are pulled up.

Where long-radius elbows are desired, the use of pipe bends is recommended.

TABLE 3 1200-LB. HYDRAULIC AMERICAN STANDARD FLANGES AND FLANGED FITTINGS, 12 IN. AND SMALLER, FOR EXTRA STRONG WROUGHT PIPE. SEMI-STEEL AND CAST-STEEL (See Fig. 2)

1200 Lb. Cold Water Working Pressure — Hydrostatic (no shock)
800 Lb. Cold Water Working Pressure — Shock
1200 Lb. Air or Gas Working Pressure — Temperature Not Exceeding 100 Deg. Fahr.

See Fig.	Size	½	¾	1	1¼	1½	2	2½	3	3½	4	4½	5	6	7	8	9	10	12
A	Inside diameter of port	[illegible]	[illegible]	[illegible]	1¼	1½	1⅞	2¼	2¾	3¼	3¾	4¼	4¾	5¾	6¾	7⅝	8¾	9¾	11¾
B	Center to face, ell, tee, cross	3½	4	[illegible]	5	5¾	6½	7	7½	8½	9	10	11	12	13	14½	15½	16½	17½
C	Face to face, tee, cross, reducer	7	8	9	10	11½	13	14	15	17	18	20	22	24	26	29	31	33	35
D	Center to face, 45-deg. ell	2½	3	3½	4	4¼	4½	5	5½	6	6½	7	7½	8	8½	9	9½	10	11
E	Center to face, lateral	7	8	9	10	11	12½	13½	14½	16½	17½	19½	21	22½	24½	27½	29½	31½	34½
F	Center to face, lateral	2	2½	2½	3	3½	3½	4	4½	4½	5½	6	6½	6½	7	7½	8	8½	9
G	Face to face, lateral	9	10½	11½	13	14½	16	17½	19	21	23	25½	27½	29	31½	35	37½	40	43½
H	Diameter of flange	4¼	4⅝	5¼	6	6¾	8	8½	9½	10¾	11½	13	14	15	16½	18½	20	21½	24
K	Thickness of flange, Semi-steel	[illegible]	[illegible]	1	1⅛	1¼	1⅜	1½	1⅝	1⅞	2	2⅛	2¼	2⅜	2½	2¾	2⅞	3	3⅜
	Thickness of flange, Cast steel						1⅛	1¼	1⅜	1½	1⅝	1¾	1⅞	2	2⅛	2¼	2⅜	2½	2¾
L	Diameter of raised face	1⅜	1 11/16	2	2½	2⅞	3⅝	4⅛	5	5½	6	6½	7¼	8¾	9⅜	10⅝	11⅝	12¾	15¼
M	Height of raised face	¼	¼	¼	¼	¼	¼	¼	¼	¼	¼	¼	¼	¼	¼	¼	¼	¼	¼
N	Minimum metal thickness, Semi-steel	½	½	9/16	9/16	⅝	¾	⅞	1	1 1/16	1⅜	1½	1⅝	1¾	1⅞	2	2⅛	2¼	2½
	Minimum metal thickness, Cast steel						⅝	11/16	13/16	⅞	1	1 1/16	1⅛	1¼	1⅜	1½	1⅝	1¾	1⅞
	Diameter of bolt circle	3	3¼	4	4⅜	4⅞	6	6½	7½	8½	9¼	10½	11½	12½	13¾	15½	17	18½	21
	Number of bolts	4	4	4	4	4	4	8	8	8	8	8	8	12	12	12	16	16	20
	Diameter of bolts	½	½	⅝	⅝	¾	⅞	⅞	⅞	1	1	1⅛	1⅛	1⅛	1¼	1⅜	1⅜	1⅜	1⅜
	Length of bolts, Semi-steel	2¼	3	3¼	3½	4	4¼	4½	4¾	5½	5¾	6¼	6½	6¾	7	7¾	8	8¼	8½
	Length of bolts, Cast steel	.				.	3¼	4	4¼	4¾	5	5½	5¾	6	6¼	7	7¼	7½	7¾

These fittings are recommended for pump columns, oil-transmission lines, gas lines and other hydraulic service where shock is negligible for a maximum working pressure of 1200 lb. and a maximum temperature of 100 deg. fahr. Where subject to shock they are recommended for a maximum working pressure of 800 lb.

The diameter of port is approximately the same as the inside diameter of Extra Strong Pipe.

Reducing fittings carry the same dimensions center to face as straight-size fittings corresponding to largest opening.

Flanges may be attached to the pipe by any of the following methods: Screw flanges; lap flanges; shrunk, peened or riveted flanges; flanges welded to pipe.

Flanges on fittings and valves, also all companion flanges except those for lap joint, should be furnished with ¼-in. raised face, as shown in dimension table, Fig. 2, unless otherwise specified.

Bolt holes are ⅛ in. larger in diameter than bolts. Bolt holes straddle center lines. Unless otherwise specified, bolt holes in cast-steel fittings should be spot-faced.

Square-head bolts with hexagonal nuts are recommended. Hexagonal nuts on sizes 8 in. and smaller can be conveniently pulled up with open-end wrenches with minimum-design heads. Hexagonal nuts on sizes 9 in. and larger can be conveniently pulled up with box wrenches.

When flanges are screwed, shrunk, peened or riveted on the pipe, it is recommended that the end of the pipe and flange be refaced.

Gaskets extending from the inside of the pipe to the inside edge of the bolts are recommended. The ultimate compressive strength of the gasket must be sufficient to prevent its being crushed when the bolts are pulled up.

Where long-radius elbows are desired, the use of pipe bends is recommended.

tings for this pressure and because your Committee feels that it should be guided somewhat by experience in the field with the pressures and temperatures now in use, namely, 300 lb. pressure and 250 to 275 deg. superheat.

Your Committee, however, is ready to advise that for 400 lb. steam pressure and not exceeding 250 deg. superheat the 800-Lb. Hydraulic American Standard in steel is adequate.

These recommendations bring the work of your Committee up to date so far as any requests that they have before them for consideration are concerned.

TABLE 4 3000-LB. HYDRAULIC AMERICAN STANDARD FLANGES AND FLANGED FITTINGS, 12 IN. AND SMALLER, FOR DOUBLE EXTRA STRONG WROUGHT PIPE. CAST STEEL. (See Fig. 1)

3000 Lb. Cold Water Working Pressure — Hydrostatic (no shock)
2000 Lb. Cold Water Working Pressure — Shock
3000 Lb. Air or Gas Working Pressure — Temperature Not Exceeding 100 Deg. Fahr

See Fig. 1	Size	½	¾	1	1¼	1½	2	2½	3	3½	4	4½	5	6	7	8	9	10	12
A	Inside diameter of port	⅜	½	¾	15/16	1¼	1½	1⅞	2¼	2¾	3¼	3¾	4¼	4¾	5¾	6¾	7⅝	8¾	10¾
B	Center to face, ell, tee, cross	3½	4	4½	5	5¾	6½	7	7½	8½	9	10	11	12	13	14½	15½	16½	17½
C	Face to face, tee, cross, reducer	7	8	9	10	11½	13	14	15	17	18	20	22	24	26	29	31	33	35
D	Center to face, 45-deg. ell	2½	3	3½	4	4¼	4½	5	5½	6	6½	7	7½	8	8½	9	9½	10	11
E	Center to face, lateral	7	8	9	10	11	12½	13½	14½	16½	17½	19½	21	22½	24½	27½	29½	31½	34½
F	Center to face, lateral	2	2½	2½	3	3½	3½	4	4½	4½	5½	6	6½	6½	7	7½	8	8½	9
G	Face to face, lateral	9	10½	11½	13	14½	16	17½	19	21	23	25½	27½	29	31½	35	37½	40	43½
H	Diameter of flange	4¼	4⅝	5¼	6	6¾	8	8½	9½	10¾	11½	13	14	15	16½	18½	20	21½	24
K	Thickness of flange	¾	⅞	1	1⅛	1¼	1⅜	1½	1⅝	1⅞	2	2⅛	2¼	2⅜	2½	2¾	2⅞	3	3⅜
L	Diameter of raised face	⅞	1 1/16	1 5/16	1 11/16	1 15/16	2⅜	2⅞	3½	4	4½	5	5 9/16	6⅝	7⅝	8⅝	9⅝	10¾	12¾
M	Height of raised face	¼	¼	¼	¼	¼	¼	¼	¼	¼	¼	¼	¼	¼	¼	¼	¼	¼	¼
N	Minimum metal thickness	7/16	½	½	9/16	9/16	⅝	¾	⅞	1	1 3/16	1⅜	1½	1⅝	1¾	1⅞	2	2⅛	2⅜
	Diameter of bolt circle	3	3¼	4	4⅝	4⅞	6	6½	7½	8½	9¼	10½	11½	12½	13¾	15½	17	18½	21
	Number of bolts	4	4	4	4	4	4	8	8	8	8	8	8	12	12	12	16	16	20
	Diameter of bolts	½	⅝	⅝	¾	⅞	⅞	⅞	1	1	1⅛	1¼	1¼	1¼	1⅜	1½	1½	1½	1½
	Length of bolts	2¼	3	3¼	3¼	4	4¼	4½	5	5½	6	6¼	6½	6¾	7¼	7¾	8	8¼	8½

These fittings are recommended for hydraulic service where shock is negligible for a maximum working pressure of 3000 lb. and a maximum temperature of 100 deg. fahr. Where subject to shock they are recommended for a maximum working pressure of 2000 lb.

The diameter of port is approximately the same as the inside diameter of Double Extra Strong Pipe.

Reducing fittings carry same dimensions center to face as straight-size fittings corresponding to largest opening.

Flanges may be attached to the pipe by either of the following methods: Screw flanges; flanges welded to pipe.

Flanges on fittings and valves should be furnished with ¼-in. raised face, as shown in dimension table, Fig. 3, unless otherwise specified.

Screw flanges are furnished with plain face and are threaded with American Briggs Standard lock-nut threads. The pipe should be threaded with American Briggs Standard lock-nut threads, and the end of the pipe should be faced off square. The pipe should be screwed through the flange until the end projects about ½ in. beyond the face of the flange and bears against the gasket.

When flanges are welded on the pipe the end of the pipe should project through the flange and should be faced off square to form the raised face.

Bolt holes are ⅛ in. larger in diameter than bolts. Bolt holes straddle center lines. Unless otherwise specified, bolt holes should be spot-faced.

Square-head bolts with hexagonal nuts are recommended. Hexagonal nuts on sizes 5 in. and smaller can be conveniently pulled up with open-end wrenches with minimum-design heads. Hexagonal nuts on sizes 6 in. and larger can be conveniently pulled up with box wrenches.

Gaskets extending from the inside of the pipe to the inside edge of the bolts are recommended. The ultimate compressive strength of the gasket must be sufficient to prevent its being crushed when the bolts are pulled up. Soft metallic gaskets at least 1/16 in. thick are recommended.

Where long radius elbows are desired, the use of pipe bends is recommended.

It is the desire of the Manufacturers' Association that the standards herein outlined be made effective at the earliest possible date. Your Committee, therefore, respectfully invites your early action.

Respectfully submitted,

Arthur R. Baylis, *Acting Chairman*
Stanley G. Flagg, Jr.
E. M. Herr
Arthur M. Houser
Julian Kennedy
E. A. Stillman
A. S. Vogt
W. M. White

Committee on Standardization of Flanges and Pipe Fittings

Received by the Council, April 23, 1918, and ordered printed. For presentation at the Annual Meeting, December 1918, of The American Society of Mechanical Engineers, 29 West 39th Street, New York. This paper was prepared under the direction of J. P. Sparrow, deceased, the late Chairman of the Committee. All papers are subject to revision.

THE WORK OF THE BOILER CODE COMMITTEE

The Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York City.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretations, in the form of replies, are then prepared by the Committee and passed upon at a regular meeting of the Committee. These interpretations are later submitted to the Council of the Society for approval, after which they are issued to the inquirer and simultaneously published in The Journal, in order that any one interested may readily secure the latest information concerning the interpretation.

Below are given the interpretations of the Committee in Cases Nos. 194-199, inclusive, as formulated at the meeting of July 31-August 1, 1918, and approved by the Council. In this report, as previously, the names of inquirers have been omitted.

Case No. 194

Inquiry: Is the reservoir or tank of a steam storage locomotive built with running gear exactly similar to an ordinary steam locomotive, but having instead of a boiler, a storage tank filled about 80 per cent with hot water at 180 lb. pressure, to be considered as a steam boiler and thus subject to the rules of the Boiler Code, or as an unfired pressure vessel, and thus exempt therefrom? The tank has no fire box nor staying nor other features which are responsible for corrosion and scale, and it is usually designed for a factor of safety of 4, being fitted with a safety valve of ample proportions.

Reply: It is the opinion of the Committee that the unfired reservoir of such a locomotive is not subject to the rules of the Code.

Case No. 195

Inquiry: Is it necessary, under the requirements of Par. 185, to plane down to ½ in. on the top of the shell the portions of the plates forming the laps of girth joints of an h.r.t. boiler with setting of the third-pass type?

Reply: Par. 185 of the Boiler Code requires that the portions of plates, exceeding ⅝ in. in thickness, which form the laps of girth joints in h.r.t. boilers, shall be planed or milled down to ½ in. in thickness wherever exposed to the products of combustion.

Case No. 196
(Annulled)

Case No. 197

Inquiry: An interpretation is requested relative to the application of Par. 9 of the Boiler Code to handhole covers and plates. Are they considered as a part of the boiler proper so as to come under the requirement of Par. 9, or may they be considered as fittings and thus permissible of cast-iron construction under Par. 12?

Reply: The Boiler Code does not prohibit the use of cast-iron for handhole plates except for certain temperature limits as specified in the Code. See Par. 12.

Case No. 198

Inquiry: Is the plain unstayed circular furnace, 16⅜ in. outside diameter by 16 in. high, of a vertical tubular boiler, subject to the requirements of Par. 239 of the Boiler Code, with proposed revisions, which will allow it a reasonable working pressure, or to Par. 241*a*, which will allow it a pressure of only 70 lb.?

Reply: It is the opinion of the Boiler Code Committee that the formulæ given in Par. 239 should be employed for computing the allowable pressure of this furnace.

Case No. 199

Inquiry: Is the requirement of Par. 265 covering a washout hole in the front head applicable to the railroad locomotive type of boiler which is so obstructed by the dry pipe, spark arrester screen, and other smoke box equipment as to render it absolutely inaccessible without dismantling the locomotive?

Reply: It is the opinion of the Boiler Code Committee that the requirement of Par. 265 applies only to locomotive type boilers in traction, portable or stationary service and not to railroad locomotive boilers.

Case No. 190 (Reopened)

Inquiry: Is it the intention of the interpretation in Case No. 190 to include vertical firetube boilers as well as boilers of the Manning type which differ from the vertical tubular type only in the use of the Manning OG ring?

Reply: The original reply in Case No. 190 was so worded as to cover the vertical joint of any form of internal furnace where the joint is fully supported by staybolting.

Case No. 191 (Reopened)

Inquiry: Does the interpretation formulated in Case No. 191 permit the steel manufacturer to cut butt straps as called for by the customer, or if the customer expresses no preference, then to cut the butt straps in whatever direction his judgment and convenience may dictate, and make the tests from the plate as rolled, as provided in the specifications for boiler plate steel?

Reply: The steel manufacturer is privileged to shear butt straps from the plate as rolled in whichever direction the orders of the customer or the manufacturer's convenience may dictate, the tests to be made from the plate as rolled, as provided in the specifications for boiler plate steel.

The Canadian Engineering Standards Committee has been organized with official representation from the government departments, the Canadian Manufacturers' Association and several technical organizations. Its objects are to secure interchangeability of parts, to reduce cost of manufacture by the elimination of multiplicity of designs, and to effect improvements in workmanship and design.

The following officers were elected: Chairman, Sir John Kennedy; vice chairmen, H. H. Vaughan, Mem.Am.Soc.M.E., and Capt. R. J. Durley; honorary secretary-treasurer, Dr. John B. Porter; secretary, Frank S. Keith. The headquarters will be at 176 Mansfield Street, Montreal.

CORRESPONDENCE

CONTRIBUTIONS to the Correspondence Departments of The Journal by members of The American Society of Mechanical Engineers are solicited by the Publication Committee. Contributions particularly welcomed are suggestions on Society Affairs, discussions of papers published in The Journal, or brief articles of current interest to mechanical engineers.

Suggestions for the Conservation of Tin

To the Secretary:

Concerning the matter of Tin Conservation which has recently been referred to our Sub-Committee on Bearing Metals, we most heartily approve of the work already done by the various agencies in the field of tin conservation, now in general coöperation with the Government. It is evident that in order to accomplish most effective results in this field a very general whole-hearted coöperation should exist between all users and consumers of tin. Fortunately this condition is evident throughout the entire country.

We fully realize that it is impossible to lay down hard and fast recommendations to govern all cases, since so many exceptions and special requirements must always exist. We feel, therefore, that our suggestions at this time should be of a purely technical nature such as will prove of permanent and lasting value.

In general, we would call the designing engineer's attention to the fact that the tin-base babbitts are far more generally used than necessary, and that where service conditions permit the use of a lead-base babbitt, the most satisfactory results are obtained by such use.

In general, tin-base babbitts should be restricted to bearings subjected to extreme service conditions, to those under excessive loads, repeated impacts and severe shocks. However, even under these conditions it is possible to reduce the tin consumption by an improved construction in which the layer of babbitt is made thinner. This is accomplished by sweating a thin layer of babbitt into a steel backing or shell made of tubing, and thus producing a very superior construction, while at the same time accomplishing the purpose of conserving tin.

It seems advisable that the use of tin-base babbitts be restricted to those having the following two limits of composition: namely, from 0 to 21 and from 76 to 88 per cent of tin. Those falling within the lower limits should be used far more generally than those of the higher limits.

At this time, also, it seems opportune to call attention to an old bronze formula: namely, 88 copper, 10 tin and 2 zinc, commonly known as gun metal or ordnance bronze. This should be entirely superseded by a composition having substantially 90 copper, 6.5 tin, 1.5 lead and 2 zinc, which is a superior composition in every respect. In general, it is stronger and more reliable; is more economical in foundry production; is easier and more satisfactorily machined; for hydraulic work is less liable to leaks; in steam service it is from 5 to 40 per cent stronger than the old composition; while at the same time this substitute formula offers a saving of $3\frac{1}{2}$ per cent of tin, which is always wasted in the old formula incident to the production of an inferior alloy.

A copper-tin bronze having more than a minute trace of phosphorus should be used for bearing purposes only when the corresponding bearing member is made of hardened or high-carbon heat-treated steel. A copper-tin bronze containing no lead and whose tin is 9 per cent, or more than that of its copper content, should never be used with the softer low-carbon machinery steels. A copper-tin bearing bronze in which the tin is as high as 9 per cent of its copper content, or higher, and at the same time which contains zinc, should also contain lead in amount not less than its zinc content.

We would also call attention to the fact that where exacting chemical conditions and flowing requirements do not exist, solders having a low percentage of tin can be used far more generally, and in many cases even produce a superior product. The composition of 60 lead and 40 tin is the strongest and most plastic alloy of these constituents, having a melting point of 39 deg. fahr. higher than a 50-50 solder. For many purposes it has been found that the lead can be increased even beyond this point, and thereby still effect a very satisfactory economy.

Respectfully submitted,

C. H. Bierbaum, *Chairman*
J. A. Capp
H. Diederichs
Sub-Committee on Bearing Metals.

September 12, 1918.

Fuel Administration in Missouri

Prof. H. Wade Hibbard, Mem.Am.Soc.M.E., of the University of Missouri, who has recently been appointed District Engineer of the United States Fuel Administration for the North Central District of Missouri, has sent interesting information regarding his work in the district. He expresses the hope, which the editor earnestly seconds, that others who are actively engaged in the work of winning the war should contribute to The Journal accounts of their experiences.

Professor Hibbard refers to the great usefulness of Bulletin No. 1 of the Advisory Committee of the Massachusetts Fuel Administration, a portion of which was reproduced in The Journal for August, page 692. He states that his district is 140 miles long north and south, and 133 miles long east and west, with 83 public-service utilities and several times that number of other plants and factories. He is engaged in organizing the work and stimulating local patriotic sentiment along the lines of fuel and power conservation.

Every man wants to be doing something in the war and owners and operators too old or otherwise unable to "make" the Army, are still able to send substitutes to the Army. The power-plant operator or factory owner who can save one coal-miner's annual output of coal is in effect sending a "substitute" to carry a rifle *over there*. In our Civil War a man could *hire* a substitute to go in his place; but the *miner-substitute* is a very different and much finer idea.

It is expected to have fuel and power committees in each plant and an advisory committee to unify and help the work in each town, and also a county advisory committee in each county. The largest city in the county is made a conservation center.

Mr. J. A. Whitlow, Mem.Am.Soc.M.E., Administrative Engineer, is in charge of this work in Missouri. His connection for years with the public-service work forms an especially favorable circumstance for the quick and effective organization of the state, he being already personally acquainted with all of the public utilities and their operators and with most of the engineers.

ENGINEERING SURVEY

A Review of Progress and Attainment in Mechanical Engineering and Related Fields, Including Abstracts of Articles in Current Technical Periodicals

Waste Reclamation

A meeting was recently held by Hugh Frayne, member of the War Industries Board and chairman of its War Prison Labor and Reclamation Section, with various section chiefs in the War Industries Board and representatives of other agencies concerning the important matter of the reclamation of waste materials. A general plan was outlined for uniformity of method and coöperation among the various agencies in reclaiming materials much needed in the Government's war program.

As an illustration of the value of reclamation work that can be done, Mr. Frayne pointed out that during June and July 17,000 soldiers were completely outfitted with shoes, hats and clothing from material which other soldiers had discarded. All of this material was disinfected, renovated, and repaired or remade, instead of being allowed to go to the junk pile. This work was done through the reclamation division of the Quartermaster's Department, of which Col. J. S. Fair is in charge. (*Official Bulletin*, August 13, 1918, p. 15)

Plant to Make "Carbocoal"

It is stated by the Fuel Administration that the U. S. Government has become interested in the establishment of a plant at Clinchfield, Va., for the manufacture of "Carbocoal," a smokeless briquetted fuel produced from bituminous coal. This has developed as the result of tests on the briquets made by the Navy Department and two railroad companies. The plant, which is now in the preliminary stages of construction, is expected to be in operation early in 1919 and will have a capacity of treating several hundred thousand tons of bituminous coal annually.

A new process of low-temperature distillation is used by which coal is so treated as to recover greater quantities of the valuable by-products, such as toluol, sulphate of ammonia, and valuable oils. The briquets are made from the residue. Tests of carbocoal disclose that it contains less than 4 per cent of volatile matter, rendering it practically smokeless, and that it is satisfactory where there is limited grate area and restricted boiler capacity. (*Official Bulletin*, August 27, 1918, p. 8)

New Department of the Engineer Depot

Few realize the immense volume of work accomplished by the General Engineer Depot at Washington in supplying the engineering equipment required by the Army in this country and abroad. The fact that its various departments have often accomplished the seemingly impossible is indicated by the slogan of the Depot, "It can't be done, but here it is." Specifications have been issued and orders placed for supplies to the extent of $5,700,000 by a single department in a single day. The personnel of the Depot comprises a staff of 3600 situated in different parts of the country, with 150 engineers of the first class. Thirteen of the Washington staff are members of this Society.

Announcement has been made of a new division of the Depot on Investigation, Research and Development, of which Major O. B. Zimmerman, Mem.Am.Soc.M.E., is in charge, covering the following subjects: Searchlights; surveying; map production; sound ranging; engineer equipment; testing mechanical and optical devices; physical and chemical research and tests; coöperation and coördination; information sources and patents; heavy-equipment developments.

Among the functions of this division are:

1 To review, follow up and initiate improvements in the military equipment and supplies of the Mobile Army, in coöperation with purchasing officers of corresponding equipment and with cognizance of manufacturing facilities and available materials.

2 To conduct or follow chemical and physical tests of material and equipment; and to conduct efficiency tests.

3 To assist in the creation of suitable specifications and advise on technical questions.

4 To assist officers of the Depot to develop their ideas into patentable form in order to protect the Government against the payment of royalties for ideas originating in the Depot.

Prevention of Accidents in Government Nitro Plant

The United States Employees' Compensation Commission issues the following:

A remarkably low accident record has been effected during the construction of the United States explosive plant C, at Nitro, W. Va., which was begun the early part of January 1918. This is attributed directly to forethought and careful planning in the elimination of accident hazards through concerted effort in modern methods of safety engineering.

This plant covers approximately 1600 acres of land, upon which are constructed hundreds of buildings to be used in the manufacture of smokeless powder. In addition to the plant acreage there are about 900 acres of land, upon which are being constructed thousands of homes in which the operators will live.

No records in the United States accident statistical record books, past or present, have been more wonderful than those now shown at this Government powder plant, where, to date, there has been but two-tenths of one per cent of the number of working hours lost by injuries resulting from accidents causing absence of employees.

But six fatalities have occurred at this plant during the past eight months of its construction period, where upward of 19,000 employees have been working overtime and Sundays to complete this gigantic project. Only 8 accidents per 10,000 employees per day have occurred, entailing loss of one day or more.

The supervision of this accident-prevention work has been done by a well-organized safety department which, representing the United States Employees' Compensation Commission, at Washington, D. C., has been under the direction of C. B. Hayward, safety engineer in charge. Its activities, coupled with the assistance and coöperation of the officials down to the workmen, have made it possible to create this new mark in accident-prevention work. (*Official Bulletin*, September 4, 1918, p. 7)

British Scientific Products Exhibition

This exhibition was formally opened at Kings Co[illegible], London, on August 11, and remained open every week[illegible] September 7. It was organized under the auspices [illegible] British Science Guild with the assistance and coöperation [illegible] large number of scientific technical societies and institu[illegible]s, as well as various official and municipal authorities and [illegible] manufacturers.

The exhibition was not intended to be a direct meeting ground between purchaser and manufacturer but rather to enlighten the public as to the scientific and industrial strength and adaptability of the country, as well as to stimulate confidence in the national capacity to meet not only the needs of the present but also the demands of the future. It was intended also to make clear the value of scientific research to the arts and industries and to show how much, in this regard, had been successfully achieved since the beginning of the war, which, in many directions, revealed an appalling dependence of Great Britain on foreign products and instruments.

Many things done in the last four years could not be exhibited for reasons of military secrecy, but it proved possible to make a very good showing even in such lines, as, for example, in aeronautical progress, where military considerations are predominant. One of the difficulties encountered was to find a sufficient number of men that could be spared from actual war work and still be competent to answer questions of visitors. This difficulty was solved by making arrangements by which college students were used as demonstrators.

During the course of the exhibition lectures and demonstrations were given. Sir William Tilden spoke on Recent Progress in Industrial Chemistry and representatives of the Munitions Invention Department demonstrated the oxidation of ammonia.

Engineering, from which the above data were taken (vol. 106, no. 2746, August 16, 1918, pp. 177-178), gives an extensive serial account of the exhibition, of which the article referred to above in the issue of August 16 is the first installment.

Explaining the Fuel Regulations

The fundamentals of the national program of fuel conservation in power plants are (*a*) personal inspection of every power plant; (*b*) rating and classification of every plant, in classes, depending on the thoroughness with which the owner conforms to the recommendations of the Fuel Administration; (*c*) at the discretion of the Administration the supply of coal to any needlessly wasteful plant may be stopped.

For the carrying out of the second stage of this program, the Fuel Administration, through its advisory engineer, Mr. David Moffat Myers, Mem.Am.Soc.M.E., has prepared standard recommendations regarding measuring and recording fuel, heating feedwater, regulating air supply, cleaning heating surfaces, maintaining and insulating settings, supervision of boiler and engine plants and of plants in buildings and shops.

As explained by Mr. Myers, this part of the work represents only one side of the fuel-conservation work, but it is the side which most concerns engineers and upon which the Fuel Administration looks to the engineer for coöperation. Mr. Myers has consented to appear before the members of the Society at the Indianapolis joint section meeting on October 25 and 26 and tell those present just what the Fuel Administration expects of the engineer. At this same meeting, too, Dr. P. B. Noyes, Department of Publicity and Education, will give an explanation of the regulations of the Fuel Administration. Full particulars appear elsewhere in this issue.

Standard Symbols in Mechanics

A great deal of work has been done by the Society for the Promotion of Engineering Education in attempting to secure uniformity of practice in the use of uniform symbols and abbreviations used in technical literature. Prof. John T. Faig, Mem.Am.Soc.M.E., has taken an active interest in this useful work and has furnished for publication the following symbols for formulae in mechanics which were approved by the S. P. E. E. on June 28, 1918.

Concept	Symbol.
Acceleration, angular	α (Alpha)
Acceleration due to gravity	g
Acceleration, linear	a
Area	A
Breadth	b
Center of rotation	O
Coefficient of friction	f
Coefficients and constants	C, K
Deflection of beam	y
Depth	d
Diameter	D
Distance passed over	s
Distance of extreme fiber from neutral axis	c
Eccentricity of application of load	e
Efficiency (hydraulic, mechanical, volumetric)	e_h, e_m, e_v
Force	F
Force, moment of	M
Friction, coefficient of	f
Head	H
Height	h
Horsepower	$hp.$
Hydraulic radius	R_h
Inertia, polar moment of	J
Inertia, rectangular moment of	I
Length	L
Load, eccentricity of application of	e
Mass	m
Modulus of section	Z
Modulus of elasticity, Young's	E
Moment of force	M
Moment of inertia, polar	J
Moment of inertia, rectangular	I
Quantity of liquid flowing	Q
Radius	r
Radius of gyration	k
Reactions	R
Revolutions per unit of time	N
Stress, unit	S
Time	t
Torque	T
Velocity, angular	ω (Omega)
Velocity, linear	v
Volume	V
Weight	W
Young's modulus of elasticity	E

U. S. Munition Output

Official report of newspaper interview with the Acting Secretary of War (condensed):

I will give you the facts about the big gun plant we are constructing at Neville Island. We signed a contract with the United States Steel Corporation to build and operate without profit this plant for guns of the larger calibers. This is the biggest plant of this kind ever conceived. The site is just below Pittsburgh and covers about 1000 acres. The housing will be on the hills south of the Island. The amount of money involved is $150,000,000. This plant will handle a tremendous amount of material.

Q. Will this plant be available for other uses after the war?

A. The plant will always be able to make steel and heavy forgings. A great deal of the machinery is special for large-gun manufacture.

Q. Will the plant be available for naval guns after the war?

A. The Government will retain it after the war.

Q. How large will the guns be from the Neville plant?

A. A 14-inch will be the minimum.

Q. Can you tell about the maximum?

A. No.

Q. What plants besides the Bethlehem are now building big ordnance?

A. About 12 finishing and 12 forging plants. This number includes Bethlehem.

Q. Did you say we had shipped two hundred and fifty 155-mm. guns?

A. Yes, to France.

In reply to further questions Mr. Crowell stated: We are producing between 25,000 and 30,000 machine guns per month. Of the Browning heavy we are producing 6000 to 7000, and the Browning light automatic rifle from 8000 to 9000 per month.

Tractors: We are getting production, but it is not nearly what it should be. We are making about 1200 per month.

Rifles: The production has been steady, about 200,000 per month.

Pistols and Revolvers: We produce between 50,000 and 60,000 per month. We are expediting this.—(*Official Bulletin*, Sept. 4, 1918, pp. 1 and 6).

Meetings of Other Societies

Smoke Prevention Association

About fifty delegates, including municipal smoke inspectors, fuel supervisors and inspectors, and others, were present at the thirteenth annual convention of the Smoke Prevention Association held at Newark, N. J., August 20-22.

Several addresses were made on topics of general engineering interest. Newell W. Roberts, Vice President, International Coal Products Corporation, explained that "carbocoal" (mentioned elsewhere in this number), consists primarily of fixed carbon and contains only 1½ to 4 per cent of volatile matter. In combustion the fuel is smokeless, igniting with comparative ease and burning freely and completely under all ordinary draft conditions. The fuel, shaped by a briquet machine to insure a maximum density, is uniform in size and quality, dustless and clean. In structure it is hard and tough, permitting ordinary handling and transportation for long distances without disintegration. In color it has a resemblance to coke, being grayish black and with a density closely similar to that of anthracite coal.

Frank W. Casler, General Superintendent of Production, Public Service Corporation of New Jersey, in a paper termed Experience in Burning a Million Tons of Coal a Year, and How We Supervise It, said that the method of procuring a coal supply today has changed very materially from what it was in pre-war times. Then the contracts called for coal to be delivered to hand-fired plants where the smoke abatement was an important factor of not more than 17 or 18 per cent volatile matter; but now the average volatile matter ranges from 23 to 25 per cent. In purchasing coal the Corporation specifies that the average ash for any one month shall not exceed a certain percentage; sufficient leeway is allowed for reasonable variation, and should it exceed this amount penalties are applied, but no premiums are paid if the average falls below what is specified in the contract, the object being to maintain a fuel supply of uniform quality.

H. D. Savage, Vice President, Locomotive Pulverized Fuel Co., referred to results attained with pulverized fuel on the Atchison, Topeka & Santa Fe R. R., the Hudson & Delaware Co. and the Central Railway of Brazil. As regards its use in stationary plants, he pointed out the possibilities for the commercial employment of such fuels as Rhode Island graphite anthracite, lignite coal of the South and Northwest, and the anthracite culm and slush, in Pennsylvania. A series of tests made in June, 1918, with an Edge Moor boiler, using Illinois and Indiana screenings, showed an efficiency of boiler and furnace of 83.33 per cent, during a 12-hour period. The increase in efficiency over using the same grade and quality of fuel on grates or in retorts was 15 per cent, with a value of fuel saving during the period of run, at $5 per ton, of $0.80. The one difficulty manifest in the use of pulverized coal is that it cannot be stored for long periods without danger of spontaneous combustion.

W. S. Bartholomew, Locomotive Stoker Co., presented a résumé of Mechanical Stoking of Locomotives as Related to Smoke Prevention Problems. Up to the present time 4500 mechanical stokers are in service on the railroads distributed over locomotives with from 50,000 lb. to 100,000 lb. tractive effort. The United States Railroad Administration has ordered mechanical stokers for application to all locomotives now in course of construction with a tractive effort of 50,000 lb. or over, and mechanical coal passers for smaller locomotives to be built.

Other papers were, Boiler Room Efficiency, by A. H. Blackburn; Smokeless Combustion with Chain Grate Stokers, by Thomas A. Marsh, and Bituminous Coal for Heating Boilers, by William A. Pittsford. (From the report of the Convention given in *Power*, September 10, 1918.)

Association of Iron and Steel Electrical Engineers

The twelfth annual convention of the Association of Iron and Steel Electrical Engineers was a well-attended meeting, held at Baltimore, Md., September 11-14. Besides several technical papers, two important committee reports were discussed on Rules for Safe Operation of Electric Cranes; and Methods of Education for Electrical Employees.

The first report outlines explicitly the duty and authority of each employee in matters of safety and calls attention to the reasonable requirement of the law that employees should be instructed in the hazards of their work, and to the fact that this requirement cannot be complied with more effectively than by supplying each employee with a printed copy of such instructions, which without abrogating the obligation of those in authority to give verbal instructions, will preclude the possibility of denying that full instructions have been given.

The second report is based on suggestions offered by various manufacturers and from a consideration of these the committee proposes the following two-years' course to be given by the electrical departments of steel plants:

First Year: Shop mathematics, magnetism, line and resistance calculations, diagrams and blueprint reading, d.c. machinery, motors and generators, a.c. machinery, motors and generators, inside wiring, conduit work, automatic control, and methods of braking.

Second year: Power-station layouts, switchboards and wir-

ing of same; and laboratory work comprising a conduit job complete, meter repairing and testing, motor testing and connecting, automatic control boards, curve-drawing instruments, illumination tests and calculations, meter transformers and connections, and armature winding.

A paper by D. D. Pendleton presented some considerations on Condensers and Condenser Engineering Practice, in which was a very good summary of well-known principles applying to the selection of condenser equipment and its installation and use.

A great deal of discussion was brought out by a paper on Automatic Engine Stops by Walter Greenwood. He held that automatic stops could well be extended to blast-furnace engines and to other types in mill work where they would prevent wrecks.

H. H. McLain discussed Bridge Motors for Overhead Cranes. An abstract of his paper is given in this number.

Denver Meeting of the American Institute of Mining Engineers

The 117th meeting of the American Institute of Mining Engineers was held at Denver and Colorado Springs, September 1 to 6. During the meeting many trips were made to points of interest including the electric ferromanganese furnaces of the Iron Mountain Alloy Company at Utah Junction, which it is said are being used experimentally for war purposes preparatory to larger developments; to the mining interests at Cripple Creek and Pueblo and to the works of the Colorado Fuel and Iron Company at Minnequa. This latter plant has enormous by-product coke-oven capacity and Bessemer and open-hearth furnaces and is heavily engaged upon war work. Some 6000 men are employed and the maximum monthly production of steel has reached 55,000 tons.

The papers presented at the several sessions for the most part were in the field of metallurgy and highly technical. The following titles are of greatest interest to the mechanical engineer: The Manufacture of Ferro Alloys in the Electric Furnace, R. M. Keeney (reviewed in this number); The Metallography of Tungsten, Zay Jeffries; The By-Product Coke Oven and Its Products, Wm. H. Blauvelt; The Use of Coal in Pulverized Form, H. R. Collins; Carbocoal, C. T. Malcolmson; Price Fixing of Bituminous Coal by the U. S. Fuel Administration, Cyrus Garnsey, R. V. Norris and J. H. Allport; Radium, R. B. Moore; Engineering Problems Encountered During Recent Mine Fire at Utah-Apex Mine, Bingham Canyon, Utah, V. S. Rood and J. A. Norden; Gaging and Storage of Oil in the Mid-Continent Field, O. U. Bradley.

During the convention a memorial service was held for the late Dr. James Douglas, former president of the Institute, an account of whose life appeared in THE JOURNAL for August 1918. In opening the meeting, President Sidney J. Jennings said that Dr. Douglas was an engineer, a scientist, a litterateur with a charming sense of style, a benefactor with a singularly wide variety of interests, and a man who had acquired wisdom and understanding, which surpass very great riches. E. P. Matthewson spoke of Dr. Douglas' Canadian associations and of his benevolence toward educational institutions of Canada; McGill University was highly favored by Dr. Douglas, and Queens University, from which latter he graduated. Altogether, the sums given by him to Canadian institutions would be probably up in the millions, but he was so retiring in his disposition that he seldom allowed his name to be used in connection with these matters. He also referred to the broadmindedness of Dr. Douglas in introducing the open door into metallurgy, by allowing every one to come to the plant and visit the mines with which he was connected, contrary to the usual policy of metallurgists.

W. R. Ingalls told of the well-merited business and financial success of Dr. Douglas, a remarkable feature of which was that he did not fully attain to these until nearly 50 years of age. Although he lived to the age of 81, his great accomplishments were achieved during the late years of his life. Although a captain of industry, his habits were simple and his mind was absorbed mainly in those studies most directly affecting the welfare of humanity.

A memorial service was also held in honor of the 15 members of the Institute known to have made the supreme sacrifice in the war. A service flag of the Institute showing 845 in service hung from the stage and as Secretary Stoughton read the records of those who had died in service, their pictures were thrown upon the screen.

Besides the professional sessions, the program included many interesting features, on the list of which was a banquet at Colorado Springs with the State Food Administrator as toastmaster. Among the speakers was Capt. Louis Benett, representative of André Tardieu, French High Commissioner to the United States, who won his audience by stating that the present need is not for transportation or food but "to put as many tons of steel as you have on the heads of your enemy."

At other times motion pictures were also shown, one being a Canadian film showing the adaptation to industry of soldiers crippled or disabled in the war, and another, a series of pictures showing mining and milling methods and welfare work by the Inspiration Consolidated Copper Company at Inspiration, Ariz.

Other Societies

At an enthusiastic meeting of the American Society of Marine Draftsmen, held in Philadelphia, June 29, Joseph A. Steinmetz, Mem.Am.Soc.M.E., S.A.E., Member National Research Council, Engineering Division, Member Submarine Defense Association, generously offered a cash prize of $50 to the member of the American Society of Marine Draftsmen who contributed the most original and practical paper on The Defense of Vessels Against Submarine Attack. In this connection it is interesting to note that at the December 11, 1917, meeting of the Philadelphia Section of this Society, Mr. Steinmetz presented a paper on Offensive Against the Submarine, with annotations to the suggestions to inventors made by the Naval Consulting Board of the United States regarding the submarine and kindred problems. This paper appeared in abstract in THE JOURNAL of March 1918.

At a "Win-the-War" convention of the New England Water Works Association, held at Boston, Mass., September 11, Mr. Charles T. Main, President Am.Soc.M.E., presented a paper on the fuel situation in New England, in which he said that water-works plants using fuel or purchased power might well form a Fuel and Power Committee similar to those established in manufacturing plants. Another speaker estimated that in a total of 155 cities canvassed a saving of one per cent of water through reduction of leakage or otherwise would mean an annual saving of 5200 tons of coal.

REVIEW OF ENGINEERING PERIODICALS

SUBJECTS OF THIS MONTH'S ABSTRACTS

For Articles on Subjects Relating to the War, see Aeronautics, Engineering Materials, Machine Tools, Munitions, Varia

Air Machinery (See also Lubrication)

TEST OF TIRE PUMPS. A test has been made at the testing laboratory of the Automobile Club of America in New York of the Cassco power tire pump, mainly for the purpose of determining the time required for inflating different sizes of tires to certain definite pressures and also the power required for operating the pump.

The pump has a single cylinder, the cylinder and crankcase being of cast iron in two parts with a fiber gasket placed between them. It has a 2.5-in. bore and a 15/16-in. stroke.

The article gives the data expressed in the form of curves. The figures for the horsepower determinations are not claimed to be correct, as the power consumed was very small in comparison with the size of the dynamometer. (*Automotive Industries*, vol. 39, no. 6, August 8, 1918, p. 243, 1 fig., *e*)

Engineering Materials (See also Hoisting and Conveying)

THE METALLOGRAPHY AND HEAT TREATMENT OF METALS USED IN AEROPLANE CONSTRUCTION, F. Grotts. The second installment of a very interesting article, a complete abstract of which will be given in an early issue. In the present issue special attention is called to the part dealing with the analysis of crankshaft material. Crankshafts made of chrome-nickel steel often contain hair lines or inclusions of manganese sulphide and silicate. They are objectionable due to the fact that they form surface cracks that will have a destroying effect on soft-metal bearings and also form slight lines of weakness. A number of such shafts were investigated with the following results.

Some shafts have stood up very well after a 100-hour run, while others show that cracks have begun to grow from the inclusions and still others have failed entirely, the failure being traced to the inclusions. As these inclusions can be avoided, and since they are unquestionably lines of weakness and do cause failures, why argue over their acceptance?

Hair lines are sometimes traced from quenching in cold water. Sometimes they are started by improper forging (forging strain). Heat treatment when not conducted properly will give a bad shaft. Variance of temperature in the furnace and crude quenching methods are the principal factors. Some pyrometers are found to be incorrect as much as 200 to 300 deg. fahr. Too much attention cannot be paid to the proper treatment of crankshafts. The gas pockets shown may be secondary pipes and the cracks connecting the pockets may be pipe cracks (expansion and contraction). A pipe generally can be removed by properly discarding the top section of the ingot, by bottom pouring, or by the use of molds having a greater top diameter than bottom. In the case of green steel there are local gas pockets.

Snowflakes occur in this steel because of poor mill practice. The manufacturer in trying to rush the heat sometimes pours while green. Furthermore, if a high-nickel bar of this steel be forged at too low a temperature there might be a condition such as this. The author prefers to think that the fault herein shown traces its origin to poor mill practice. (*Chemical and Metallurgical Engineering*, vol. 19, no. 4, August 15, 1918, pp. 191-197, illustrated, *eA*)

THE MANUFACTURE OF FERRO ALLOYS IN THE ELECTRIC FURNACES, Robt. M. Keeney. A very extensive paper not suitable for abstracting. It covers in considerable detail the methods of operation in several plants producing ferrochromium, ferromanganese, ferromolybdenum, ferrotungsten, ferrovanadium and ferrouranium. The most interesting part of the paper for mechanical engineers is that referring to ferrouranium, a material about which there is still a certain amount of uncertainty.

It is stated that ferrouranium was developed not because of any particular need for uranium in steel manufacture, but because of the large quantity of sodium uranate that was accumulating as a by-product of radium production. Considerable difficulties were encountered due to the tendency of uranium to form carbides, and also because of the strong affinity of uranium for oxygen, which makes uranium oxides quite stable.

A considerable amount of experimentation has shown that it is apparently impossible to produce a ferrouranium containing 30 per cent uranium with less than 3 per cent carbon. Therefore experiments were made on producing as high a uranium alloy as possible by using uranium metal. However, a new difficulty was encountered here, that of producing uranium metal. Among other things, these experiments showed the ease with which metallic uranium oxidizes.

A method to develop uranium metal was finally developed by using uranium oxide and petroleum coke. The uranium metal made in this way contained 93.0 per cent uranium, carbon 4.39, silica 1.43, iron 1.35, vanadium 1.31, phosphorus 0.051, sulphur 0.013.

Tests were also made on addition of uranium metal to steel in a tilting Siemens furnace lined with magnesite. It was found that uranium metal is not a satisfactory agent for the addition of uranium to steel for these reasons: First, it has such a high melting point that if it is added to the steel in the furnace just before pouring in the ladle all of the metal is not melted and only a comparatively small proportion enters the steel; in the second place, when it is left in the steel bath for a period long enough to melt it, it passes into the slag and oxidizes so easily that no uranium is recovered in the steel.

Experiments were also made on the production of uranium steel and by the addition of ferrouranium to molten steel. The results were not conclusive. (*Bulletin of the American Institute of Mining Engineers*, no. 140, August 1918, pp. 1321-1373, *eA*)

Foundry

Exceptional Gang Core Boxes, J. V. Hunter. A gang core box used to be one which produced a few identical cores at each operation. Recently a further advance has been made, and now instead of producing a single row or two of cores to lay out on the baking plate at one time, production has been increased to making a whole plateful of cores each time that the gang box is filled. This method makes the labor involved simply one of carrying to and moving from the ovens large numbers of plates of cores.

The article shows such core boxes and the manner of making them and describes in detail the operations.

It was a comparatively simple thing to develop the gang-type core box for simple cores, but the application of this method to the production of cylindrical and other shapes, such as are usually made in halves, proved to be a much more difficult proposition. To make a gang box for either half separately would be a simple matter, but to make them so that the edges would match exactly at all points when the plates were closed caused considerable trouble.

The writer describes in detail how this problem has been solved, with the result that now a few simple operations performed with great rapidity by an experienced workman produce at each cycle a full plate of cores, which by former methods would have been made up singly in halves, baked in two separate units, then laboriously pasted together and the edges dressed up. The article is of undoubted interest in furnishing considerable information on one of the recent developments in American foundry practice. (*American Machinist*, vol. 49, no. 9, August 29, 1918, pp. 377-380, 10 figs., *dA*)

The Fluidity of Molten Cast Iron, Matthew Riddell. The title chosen for this paper is claimed to be one which is meant to cover the expression of a view of the functions and operations of the cupola, which, in the author's opinion, has not been publicly discussed before.

The fluidity of cast iron is stated to depend on the amount of superheat or number of degrees of temperature over and above its freezing temperature that has been imparted to it in the cupola. The greater the superheat the greater will be the fluidity, and, other things being equal, the longer will it remain fluid to fill up the intricacies of the mold.

When the metal runs dull from the cupola various reasons are suggested, among them being lack of sufficient supply of coke. Up to a certain extent additions of coke will help, but repeated experience shows that after a certain limit of coke has been reached in the large, further additions appear to make the metal duller instead of more fluid. Another peculiarity of cupola operation is to which the writer calls attention is that better results are obtained in the way of hot metal when the bed coke is not well lighted above the tuyeres before the blast is put on and the first iron takes longer to come down than when opposite conditions prevail.

The writer bases his theory on the following:

First, that an iron which is very low in combined carbon, although high in total carbon, cannot be melted until a very high temperature is reached and consequently the liquid metal will be extremely hot. Further, in the course of melting the free graphite is rapidly dissolved and enters into solution of the iron with the result that the molten mass has a high percentage of combined carbon and, therefore, a low freezing point. Under such conditions an iron which will not melt until it has been heated to, say, 1400 deg. cent., does not freeze again until the temperature has fallen to about 1130 deg., so that such a metal may be said to have 270 deg. of life and will appear fluid.

The temperature which will be attained in the process of melting is determined by the amount of carbon in solution at the time the metal enters the melting zone and not that of the original iron charged into the cupola. Hence, in order to obtain the hottest melted metal it is essential to get the unmelted iron into the melting zone as quickly as possible. When the metal is held above the melting zone through excessive coke in the charges, the iron is afforded an opportunity to dissolve the graphite with the result that the material enters the zone with a lower melting temperature than it otherwise would have had. On the other hand, if the first charge is resting on coke which is not yet alight when the blast is turned on, its combined carbon is unchanged and the quick combustion of the coke by the blast raises the maximum temperature in the cupola before the absorption of graphite has been able to proceed very far.

In his conclusions the writer emphasizes the fact that the cupola is not suited to directly impart superheat or fluidity to any material which is being melted therein. He claims that while the freezing temperature of foundry iron may for all practical purposes be taken as constant, namely, at about 1130 deg. cent., the melting temperature varies and is regulated by the amount of carbon in combination or solution when the material enters the melting zone. (Paper before the British Foundrymen's Association meeting at Sheffield, June 1918, abstracted through *Foundry Trade Journal*, vol. 20, no. 199, July 1918, pp. 364-366, 1 fig., *g*)

Accuracy in Setting Cores, J. V. Hunter. In a great majority of cases cores in molds are supported entirely by the sand. Sometimes, however, they require greater accuracy in the setting than can be obtained by supporting the cores in sand.

Thus, in the present article is described the manufacture of cast-iron tanks used under about 30 lb. steam pressure on car-heating systems. Trouble was experienced from leakage about the chaplets required to hold the core in position. The chaplets were of the long-spike type, quite heavy and extending through the top of the core to a special blocking arrangement on top of the mold, and the metal would not burn into these chaplets.

To cope with this and other troubles it was decided to support the core directly from the walls of the flask by means of a pipe extending through the core, this pipe serving for the removal of gas. The article describes in detail how this was done.

A somewhat similar problem had to be solved by a concern manufacturing small steam engines used for driving winches

and cable hoists. The quantity of identical units was large, and the boring out of the piston head and getting the rod in place required a large amount of time. For this reason it was decided to cast the rod into the head, thereby not only saving time, but also insuring a head that would not work loose on the rod.

Further, to have the head in perfect balance without finishing all over, it was necessary to set the rod in such a manner that there should be no opportunity for it to shift.

A core had previously been used to inclose a portion of the casting which was provided with the hole *A*, Fig. 1, the exact

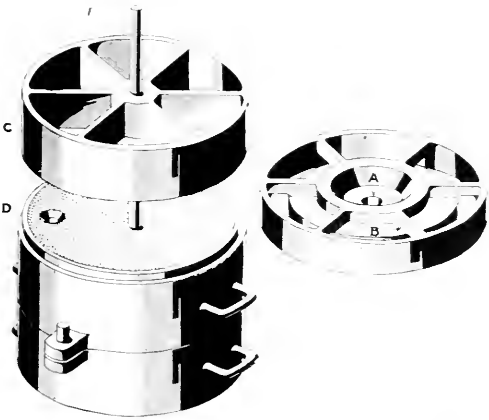


Fig. 1 Casting-in a Rod in Small Steam-Engine Piston

size of the rod, and the iron setting frame *B* made to guide the core into position in the mold.

The mold was made in a manner similar to that for the tank, being provided with a match board for the pattern that held the latter in a certain position in relation to a finished rim of the flask. The core is set by using the frame *B* to guide it into the same position relative to the finished edge of the flask as that occupied by the pattern.

The piston rod is inserted in the core, and the cope rammed about it and around the core which covers the pattern cavity below. During the ramming, and later, during the pouring of the casting, the piston rod is accurately held in a vertical position by the frame *C*, which is bored out on its lower rim to fit over the finished rim *D* on the upper edge of the cope flask. The center is bored to a close fit on the piston rod. The amount of preparation necessary to carry through this piston-head casting operation was inconsiderable and the results obtained were remarkably accurate. (*American Machinist*, vol. 49, no. 10, September 5, 1918, pp. 439-440, 3 figs., *dp*)

Fuel and Firing

Boiler Furnaces and Boiler Furnace Design, Dr. D. S. Jacobus, Mem.Am.Soc.M.E. A careful analysis of the factors affecting the efficiency of boiler furnaces, particularly with regard to those operated under steady load conditions.

The following fundamental elements in design were brought out: In the first place, enough draft must be provided to draw the products of combustion through the furnace and provide a draft suction under all conditions within the setting. Some suction should exist within all points of the setting irrespective of how hard the boiler must be driven. The next thing is to avoid a construction in which the brickwork is heated on both sides when under too great a stress (which particularly applies to the arch). Torchlike action of the flames on the walls should also be guarded against. This latter produces erosion and is apparently occurring more often with some classes of fuel than with others.

The above requirements, if satisfied, will give a furnace that will stand up. The next thing is to make it economical and this means one that will operate economically not on a short run, but under steady load conditions for long periods.

To make the furnace economical one must watch out first for excess air and then for carbon monoxide, and in this latter connection the author points out that the amount of carbon monoxide is frequently determined erroneously.

Under certain conditions it may be necessary to admit air above the fire. Hence the furnace should have such a volume and such a shape as to cause the combustible gases to mingle with the excess air.

In general, in a well-designed furnace there must be a way provided for unburned gases which come from one part of the fire to mingle with the excess air from another part of the fire.

Another feature in furnace economy is the burning out of the ash. Here care should be used since on one hand any loss of carbon in the ash counts against efficiency, but, on the other hand, one must guard against the endeavor to burn out the ash too clean at the expense of having too much excess air.

The questions of powdered-coal burning and oil fuel were also briefly touched upon by the author. (Paper before the American Boiler Manufacturers' Association, June 17, 1918, abstracted through *Power*, vol. 48, no. 9, August 27, 1918, pp. 318-320, *gp*)

Air Screens for Ovens and Furnaces, F. Wellman. Workers are greatly inconvenienced by the heat radiated from ovens and furnaces, which results in the necessity of changing the working shifts frequently and induces the workmen to refrain from examining the glowing material more than is absolutely necessary. The ill effects are somewhat mitigated by the use of hollow furnace doors cooled with cold water, but this means is only of any use when the furnaces are closed, and does not afford any protection when the doors are open for inserting or removing parts. Another method that gives partial relief consists in drawing off the hot air in front of the furnace opening by centrifugal exhausters. This method is open to the drawback that when a workman approaches the oven closely the transition of temperature is all the more sudden, and on this account more dangerous to his health. The best method to use consists in installing immediately behind the furnace door, and between the door and the furnace, a narrow slit through which cold air is blown upwards, so as to interpose a screen of air between the furnace and the door. This arrangement is found to give very good protection, and has the further advantage that flames are prevented from being forced out of the doors when they are opened, so that the workmen may operate without the use of very long tongs. The cool air has the further good effect of generally ventilating the shop in which the furnaces are placed.

Drawings and photographs of this arrangement are given, and it is explained that it is of importance that the air should emerge from all parts of the slit with the same velocity. An air-screening arrangement, manufactured by Wener Geub, Cologne, for a large steel foundry is described in some detail. The slit is only 6 mm. wide, and the air is forced out at a great velocity. Measurements showed that the velocity of the air was about 15 m. a second at 500 mm. distance from the open-

ings of the slit, and 7.9 m. a second at 1000 mm. distance. Further measurements showed that the velocity all along the slit was nearly constant. The air is driven by a high-pressure ventilator drawing from the open air. This ventilator is capable of drawing 64 cu. m. of air per minute, and is driven by a 12-hp. motor which delivers the air at a pressure of 465 mm. (water column). Further installations of a similar nature are described, and it is concluded that this type of protection should be extensively used. (*Zeitschrift des Vereines deutscher Ingenieure,* abstracted in *Page's Engineering Weekly,* vol. 33, no. 727, August 16, 1918, p. 79, *d*)

Tars Distilled from Bituminous Coal in Hand-Fired Furnaces, S. H. Katz. A paper recording results of tests made as a part of the comprehensive investigation of combustion in furnaces that is being conducted by the Bureau of Mines. It deals especially with the liquid or tar part, at ordinary temperatures, of the volatile matter evolved in a coal fire.

Three samples of such tar were examined and the results show that in the hottest fires the volatile matter evolved by the coal is the same as the so-called "primary volatile products of coal." This matter, after it is produced, yields oxides of carbon and water vapor by burning, and by cracking forms end products, i.e., carbon or soot and fixed gases. The two processes should be considered as acting at the same time and coördinately. The paper describes in detail the equipment used and the method of carrying out the tests. The results are presented in the form of tables.

It appears that the greatest proportion of tar vapors exists at the surface of the burning coal, while in the plane 1 ft. above the bed practically no tar remains, no matter what the excess of air mixed with the combustible gases above the bed.

On the basis of experimental evidence the investigator came to the conclusion that tars can exist in the fires of a hot furnace burning bituminous coal for a period that is less than 0.1 sec. The following conclusions are also of interest:

When bituminous coal in quantities to last for a period of hours is added to a slowly burning fire, tar may be found in the gases within the fuel bed through a considerable part of the time the coal is burning. When coal is added to fires in uniform quantities and at short, regular intervals, the greatest quantity of tar in the gases is at the surface of the bed.

Naphthalene and anthracene, which, at intermediate temperatures, are characteristic of the thermal decomposition of the primary volatile matter of coal, were absent from the tars collected.

It is probable that, at the high temperatures of flames, the tars that escape burning are decomposed directly to soot and fixed gases; that is, without formation of hydrocarbons such as naphthalene and anthracene, which are produced as intermediates, at least in part, at lower temperatures.

Decomposition of all the unburned tars in hot fires to soot and fixed gases occurs in less than 0.1 sec. (*U. S. Bureau of Mines Technical Paper* 195, March 1918, 17 pp. 3 figs., *e A*)

Furnaces

Graf Gas-Consuming Furnace, John Nelson. The aim in the design of this furnace was to secure the combustion of the gases which ordinarily are wasted in the operation of power boilers and pass off in the form of smoke. It has been in practical operation on a battery of Stewart boilers developing upward of 1700 hp. The plant records are said to indicate reduced fuel consumption of about 25 per cent, using bituminous coal.

The operation of the furnace is based on the introduction at the top of the bridge wall of the furnace of preheated air impelled at high velocity by a steam jet. This results in a complete intermixture of air and flue gases at a point of highest temperature, the result being a series of reactions in which escaping carbon monoxide and free carbon, together with the hydrocarbons are converted into carbon dioxide.

The ordinary bridge-wall form is discarded, and instead of a straight horizontal top, the wall is curved as an inverted arch, the arc corresponding to that of the boiler shell. It is claimed that a more uniform flow of gases from the firebox along the circumference is obtained. The air is introduced into the furnace through a 4-in. pipe which is brought down

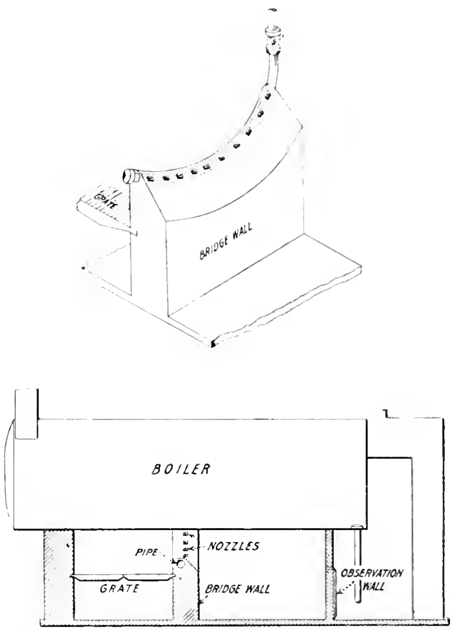


Fig. 2 Some Details of the Graf Furnace

through the masonry of the side wall and is curved to conform with the arch of the bridge wall in which it is imbedded. The actual entrance of the air into the chamber is through a series of nozzles (Fig. 2). As shown in the figure, the lower interior wall of the nozzle is given an even, gentle curve, which serves to facilitate and guide the flow of air. The nozzles are so spaced that their jets combine at a point about 6 in. above the bridge wall to form a solid stream of air covering the complete width of the furnace. The nozzles are set at an angle of 70 deg. in the direction in which the gases flow. The air is delivered by a steam jet. The steam is admitted through a nozzle $\frac{1}{16}$ in. in diameter. The vacuum is created by the steam sucking in an amount of air which is proportional to the volume of steam used. The steam serves a double purpose of preheating the air and of giving a velocity sufficient to produce a complete intermixture with the flue gases.

Tests made at the Worcester Polytechnic Institute demonstrated a complete absence of carbon monoxide in the flues, as well as a minimum of free carbon. The observation doors reveal a condition of apparently full incandescence in the

combustion chamber, even immediately after stoking. (*The Iron Age*, vol. 102, no. 6, August 8, 1918, p. 339, 1 fig., *d*)

Hoisting and Conveying

A Safe-Load Chart for Rope Slings, F. W. Salmon, Mem.Am.Soc.M.E. A chart intended to meet the requirements of practical men. A card, Fig. 3, about 3.5 by 6 in., is divided around the edge as a protractor, every 10 deg. being marked with a plain black triangle. In the center space appears a chart of the safe loads based upon the particular kinds and sizes of slings that are used in the shop. Upon the back of the card may be printed directions for its use.

When an unusual load is to be lifted, the foreman can hold the card in the manner shown in Fig. 4, and when the sling just becomes taut he can estimate the angle to about the nearest degree. Having the total weight to be lifted, he can instantly determine whether or not the sling is safe to handle the load. (*American Machinist*, vol. 49, no. 6, August 8, 1918, p. 242, 2 figs., *p*)

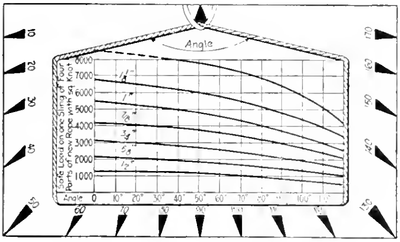


Fig. 3 Load Chart for Rope Slings

Bridge Motors for Overhead Traveling Cranes, R. H. McLain. Discussion of the factors affecting the selection of sizes of motor and gear ratio for bridge motion of overhead traveling cranes.

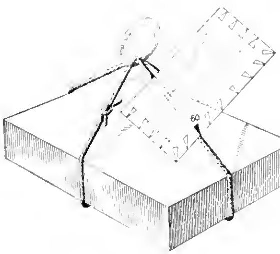


Fig. 4 Manner of Using the Chart in Fig. 3

The author analyzes the work done by the bridge motor and states that four things which tend to limit the rate of its acceleration. They are as follows:

Automatic magnetic control can absolutely limit it;
Slipping of wheels can partially limit it;
Swinging of load can limit it in some cases, and finally
It may be limited through considerations for the comfort of the operator.

An average acceleration of something like 1 to 1½ ft. per sec. per sec. will be fast enough for cranes which travel at less than 500 ft. per min. or make infrequent starts. Cranes which make regular frequent trips of 50 to 60 ft. every minute or so may need an average acceleration of 2 to 2½ ft. per sec. per sec. and special cranes handling heavy swinging loads may need still higher peak accelerations.

The motor is always out of danger when it is powerful enough to slip the wheels under full load without exceeding its working limits, and the practical way of protecting the motor is to have the crane do its work with only a quarter of the wheels driven, where it is possible to do so.

The swinging of the load will, in some cases, have a great deal to do with the rate of acceleration, and, for example, when the load is hung from the crane by a flexible rope, the motor is relieved somewhat, as it does not have to start the load as soon as the crane starts.

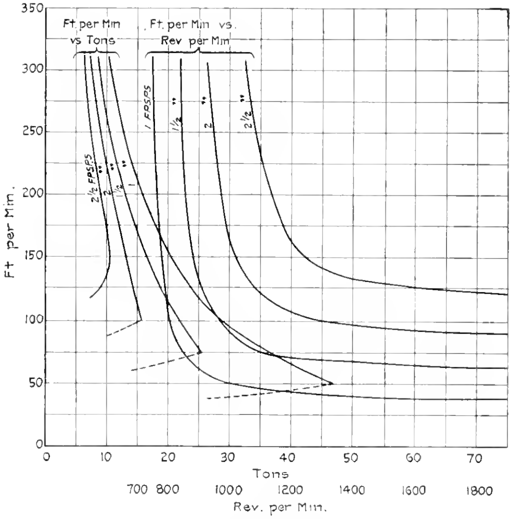


Fig. 5 Acceleration Chart for Overhead Traveling Crane Bridge Motors

The discomfort of the operator becomes an important factor where manual control is used, rough material is being handled and half of the wheels are driven. In order to get data on the subject, the author asked several manufacturers to send him test data on their cranes. These data show a variation in the peak rates of acceleration in feet per second per second from 0.54 to 3.09 for empty cranes and 0.348 to 1.85 for loaded cranes, the weights of the complete cranes in pounds being, respectively, 90,000 and 320,000.

The table covers the range of cranes with rated loads from 10 tons to 100 tons, and shows quite wide variation within the limits indicated above of the peak rates of acceleration. The author gives a formula for calculating the rate of acceleration with or without load used in compiling the table referred to above.

It is claimed that the rate of acceleration is absolutely as important as the final speed of the crane in determining the sizes of motor for a crane. In order to show what a given motor may do under various conditions of load, speed and rate of acceleration without exceeding its working limit, the author prepared Fig. 5. While calculated on several assumptions which may not be altogether correct, the curve gives a basis

for comparing conditions. These assumptions are that rolling friction of crane is 50 lb. per ton, and that there are no gear losses between the motor and the track. The maximum peak torque allowable at the motor shaft is taken at 78 lb-ft. The total flywheel effect of motor, armature, brake, wheel and gears is taken as 8.4 lb. at 1 ft. radius on armature shaft.

The way to use Fig. 5 is as follows: Suppose a 12.5 ton loaded crane is being considered and a rate of acceleration of 2 ft. per sec. per sec. is desired. Then read up from 12.5 tons to the curve marked "2 ft. per sec. per sec." The intersection is at 170 f.p.m. Then read across from 170 f.p.m. to f.p.m. vs. r.p.m. curve marked "2 ft. per sec. per sec." The intersection is at 995 r.p.m. This indicates that the motor should be geared so that 995 r.p.m. corresponds to 170 f.p.m., and that when so geared it can start 12.5 tons at 2 ft. per second per second peak acceleration without exceeding 78 lb-ft. torque on the motor shaft.

The writer recommends that if automatic magnetic control is going to be used on the crane, an acceleration should be adopted of 2 ft. per sec. per sec. for all cranes except those which have swinging loads or which make very short, rapid trips of something like 50 or 60 ft. per min. when a peak acceleration of 3 ft. per sec. per sec. should be used. If, however, only a quarter of the wheels are driven, the peak acceleration may, in all cases, remain not higher than 2 ft. per sec. per sec.

With manual control a peak acceleration of 1 to 3 ft. per sec. per sec. should be used, depending on the nature of the work. For power-house and stand-by cranes, 1 ft. per sec. per sec. is ample; for hot-metal ladle cranes 3 ft. per sec. per sec.; and for busy loading cranes 2 to 3 ft. per sec. per sec. (Paper before the Twelfth Annual Convention of the Association of Iron and Steel Electrical Engineers, Baltimore, September 1918, abstracted from an advance publication, 9 pp., 2 figs., *pg*)

Hydraulic Engineering

Hydraulic Accumulator Protective Valve. Description of a new type of valve designed to protect large accumulator systems.

The valve is installed directly at the pipe outlet of the accumulator with a pilot-line connection to some distant point of the piping system. The pressure of the liquid from the pump lifts the main check and charges the accumulator. At the same time the plunger in the cylinder is raised, thus holding the main check off its seat irrespective of whether the accumulator is being charged or discharged, as long as the pressure of the pilot line is maintained. If a break should occur in the piping system, the pressure is immediately lowered, and this loss of pressure in the pilot line and small cylinder is overcome by a spring permitting the plunger to drop.

Hence, as long as the pressure is maintained in the system the liquid flows freely, but if the pressure should be lowered for any reason the main check valve is seated, which prevents falling of the accumulator. (*The Iron Age*, vol. 102, no. 7, August 15, 1918, p. 389, 1 fig., *d*)

Internal-Combustion Engineering

The Diesel Motor Injection Valve, W. Stremme. (*Zeits. Vereines Deutsch. Ing.* 62, pp. 111-115, March 9, 1918.) The influence of the injection valve on the injection performance is considered, and it is shown that the nozzle opening is the basis of standardization. Standardization is quite feasible and is essential to the bulk production of Diesel motors. Charts are given showing standardized and unstandardized values of nozzle and needle diameters, etc., for Diesel engines ranging from 25 to 200 hp. per cylinder. One important advantage of standardization would be the easier obtaining of perfect combustion without repeated trials and adjustments on individual engines. (Taken from *Science Abstracts,* Section B—Electrical Engineering, vol. 21, pt. 7, no. 247, July 31, 1918, p. 250, *g*)

Independently Driven Circulating Pumps for Jacket Water. In the case of oil engines, particularly those of the Diesel type, the pressures in the cylinders are very great, necessitating the use of heavy cylinders and pistons. There is, therefore, a large amount of metal present and a considerable amount of heat stored therein.

When the engine is shut down after a period of full load and the water circulation simultaneously ceases, enough heat is still stored up in the metal to evaporate the hot water in the jacket and leave an excess. This excess is conducted through the walls into connected parts that were not designed to withstand temperature stresses and as a consequence they are strained or cracked.

The suggestion is made that an independently driven pump should be used instead of a direct-connected pump, so that the pump may be kept running after the engine has stopped until all the heat is removed and the metal is cooled to a normal temperature. (*Power,* vol. 48, no. 7, August 13, 1918, p. 238, *p*)

Gile Sub-Piston Engine. Description of a two-stroke engine having, in addition to its regular working piston, a sub-piston in each cylinder, operated from a special crank on the crankshaft.

During the power stroke the main and sub-piston both travel in the same direction and at substantially the same rate of speed. This continues until they have reached a point where the main crank is within 45 deg. of the bottom dead center, at which point the exhaust valve begins to open. As soon as the exhaust valve opens the sub-piston is gradually stopped by a rocker-arm movement and is then started on its return stroke, during which it scavenges the cylinder of the burned gases and at the same time draws in a fresh charge of gas from the carburetor through the intake ports in the cylinder walls near the lower end of the stroke.

In the cylinder walls at the upper end there is a series of flutes which afford a passage for the gas in the space between the main piston and the sub-piston. It is claimed that the fuel in passing through these flutes is so thoroughly broken up that the engine can burn kerosene as readily as gasoline, no preheating of the fuel or air being required. (*Automotive Industries,* vol. 39, no. 6, August 8, 1918, pp. 229 and 238, 2 figs., *d*)

Lubrication

Lubrication of Air-Compressor Cylinders, W. H. Callan, Mem.Am.Soc.M.E. A résumé of experience with air-compressor cylinder lubrication in which it is claimed that the temperature of the inside of the cylinder wall of a water-jacketed cylinder is not more than 30 deg. fahr. higher than the temperature of the jacket water as long as the water does not boil.

In view of this condition, the writer claims that a light mineral oil should be used rather than oils of heavy grade and high flashpoint; further, that a pure mineral oil should be used, preferably one having a gravity of from 31 to 33 Baumé, a

flashpoint of 375 to 390 deg. fahr. and a viscosity of 140 to 150 Saybolt at 100 deg. fahr. (*Power*, vol. 48, no. 7, August 13, 1918, pp. 229-230, *g*)

Machine Shop

Emulsion Lubrication of Cutting Tools, J. A. De Cew. Discussion of the lubrication of cutting tools with special reference to their lubrication by materials in a state of emulsion.

If oil is mixed with a substance which is soluble in a large amount of water, and subjected to mechanical action, the oil is broken up into fine particles which float in water and thus produce what is known as an emulsion.

As the emulsifying agent is usually more expensive than oil, only enough of it is used to cause the emulsion to form. It is believed that as the oil particles in suspension came in contact with the hot tool surfaces, some of them are interposed between the parts in contact and thereby produce lubricating action.

The coarser oil particles are said to be prevented by their size from penetrating between the surfaces as far as the aqueous medium, but the finer particles which are microscopic in size follow the solvent and perform lubricating service.

If the compound is slowly stirred into water very white emulsions are likely to be produced, from which a portion of the oil will gradually separate if allowed to stand for a time, but if the compound is diluted in water by means of pressure, using special apparatus and proper temperatures so that instantaneous solution can take place, then the emulsifying agent may be diluted with water without breaking up its combination with the oil, and a diluted solution is obtained which resembles the original compound in character.

When such a solution of oil dries on a metallic surface, it leaves a film which acts as a protective coating against rust. (*American Machinist*, vol. 49, no. 10, September 5, 1918, pp. 433-434, *p*)

Using a Punch Press in Lieu of Bending Rolls, J. V. Hunter. Brief description of the way in which awkward and annoying jobs involving the bending and forming of sheet metal may be rendered simple and easy by means of a few cheaply made dies of hard wood used in the ordinary form of punch press to be found in any structural shop. The article is of considerable interest in that it calls attention to the possibilities of the use of wooden dies. (*American Machinist*, vol. 49, no. 6, August 8, 1918, pp. 243-245, 6 figs., *g*)

Electric Furnace for Heat-Treating of Small Aeroplane Parts, Dwight D. Miller. The article refers to the handling of nickel-steel parts and presents the subject from the point of view favorable to the electric furnace. The method of carrying on the heat-treating operations with such furnaces is described in detail. (*American Machinist*, vol. 49, no. 9, August 29, 1918, pp. 373-376, 2 figs., *p*)

Gas-Engine Work on the Pacific Coast, Frank A. Stanley, Mem.Am.Soc.M.E. Description of machine operations used in the shops of the Atlas Imperial Engine Company, of Oakland, Cal., in building stationary, portable, marine, hoisting, etc., engines.

The company builds units of one, two, three and four cylinders, ranging in capacity up to several hundred horsepower, and has, therefore, to arrange for performing a number of operations.

Fig. 6 shows the arrangement of the crankshaft bearings and base compartments, the bearings through the automatic ring oilers receiving the lubricant from a chamber below the shaft. The main bearings are of unusually great length, about ten times the diameter of the shaft.

The lower case for the crankcase proper is formed by a finished surface along the top of the base casting. The crankcase consists of an integral rectangular frame for enclosing all the

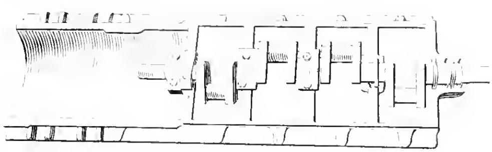


Fig. 6 Arrangement of Crankshaft Bearings and Base Compartments

working parts of the engine with the exception of the pistons and valves. The top of the crankcase is adapted to receive the cylinders, and each side of the case is fitted with doors to give easy access to the interior.

The cylinders are cast with heads as an integral part.

An interesting detail is shown in Fig. 7, namely, the reversing gear for use with marine engines. In this gear there are six pinions spaced about the central gear, all made from steel forgings and provided with bronze bushings. The entire set of gears is enclosed in an oiltight casing and runs in oil all the time. This gear arrangement is of interest, as it gives the propeller the same rate of speed astern as when running ahead.

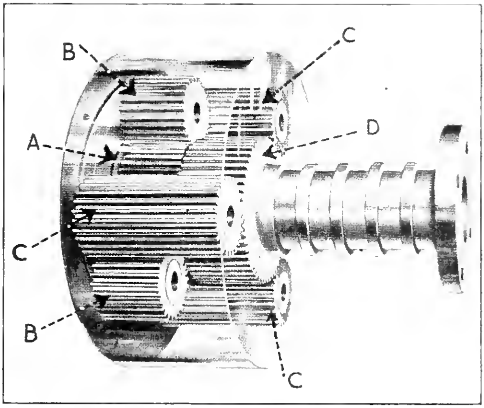


Fig. 7 Reversing Gear for the Atlas Imperial Engine Company Marine Engine

The go-ahead drive is by means of a friction clutch of the multiple-disk type, which admits of adjustment by loosening a single bolt and screwing around a clamp collar. The gear case is a plain cylindrical affair, which when the reverse lever is operated is prevented from rotating by a pair of clamp shoes, or brakes, which are actuated by a powerful screw-and-toggle motion; at the same time the friction is released.

The reverse drive is then through the gears and pinions as follows: The power from the engine is transmitted through the shaft to the spur gear *A*, which, when the case is prevented from turning by the clamps before mentioned, drives three short pinions *B* (two of which may be seen in the cut), and these drive the long pinions *C* which mesh with the gear *D* upon the propeller shaft. The reverse direction of rotation

therefore occurs between pinions B and C. (*American Machinist*, vol. 49, no. 8, August 22, 1918, pp. 343-347, 16 figs., *d*)

Reclaiming Oil from Metal Turnings, C. L. Smith. Description of a system for collecting steel turnings, recovering the cutting oil that usually clings to them, and loading them on cars, as used in the plant of the Cincinnati Milling Machine Company.

Receiving trucks are provided for conveying the turnings to the oil and scrap building, located about 100 ft. distant from the main plant. The design of the trucks is such as to eliminate the handling of the turnings as much as possible, and actually only two of these trucks operated by one man are needed for the entire plant.

The trucks are lined with sheet metal and the sheet covering the sloping bottom is perforated at the lower end to allow the oil drained from the turnings to pass into the tank located below. A 4-in. baffle plate is provided at the front to divert the oil into the receiving tank underneath, and at the top of the perforated section an oil splash guard is placed for the same purpose. Means are provided for easily draining and cleaning the oil tank and unloading the chips into the oil separator. The top of the separator is level with the floor which is preferable to one having the top located above the floor level.

For collecting the chips a specially shaped galvanized steel pan is used. This pan is placed on a small shop truck directly beneath the sliding door in the oil pan of the screw machines and the chips can be raked into it without spilling oil on the floor, which again is claimed to be preferable to the usual method of removing the turnings from the machine oil pan with a fork and putting them in a wheelbarrow.

After being filled the collecting pans on the shop trucks are carried to the rear of the shop where the receiving truck is stationed.

By the receiving truck and the elevators the turnings are delivered to a Tolhurst oil separator.

The dry chips are ultimately dumped into specially arranged concrete switch bins, therefrom to be loaded on cars. These bins have sloping bottoms and sheet-metal doors that are the full height of the bins. The bins are about 25 ft. apart so that a standard 40-ft. car can be loaded from both ends at the same time.

Records of the company show that the oil reclaimed from the turnings represent a really worth-while saving. In April 1918 3092 gal. were recovered, in May 2400 gal. and in June 1402 gal., the general average being about 100 gal. per working day. (*The Iron Age*, vol. 102, no. 10, September 5, 1918, pp. 558-559, 2 figs., *d*)

Sand-Blasting Machine, M. E. Hoag. In an article under the title Manufacturing the Comptometer, the writer, among other things, describes machines used for sand-blasting the comptometer parts.

One of such machines is shown in Fig. 8, built and designed for this special purpose. The body of the machine A carries a shaft and set of pulleys at each end, over which pass endless rubber belts for carrying the work under the blast nozzles. Under the machine is a hopper through which the spent sand runs by gravity to a switch bin, from which it is carried by elevators to a supply bin overhead. Sliding doors at B permit work to be held under the blast by hand and glass windows at C allow the workmen to watch the progress of the work without risk to eyes and lungs.

The sand runs from the overhead supply bin to the nozzles through the spout D to the gates E, which have screw adjustments and distribute the sand in a long, flat stream under the air nozzles F, and the opening in the machine body at G is closed by a canvas curtain and permits work being placed on the endless belts. The exhaust pipes H carry off the spent air and fine dust, leaving the returned sand always clean and ready for use. These machines use from 12 to 14 oz. air pressure. (*American Machinist*, vol. 49, no. 9, August 29, 1918, p. 391, 1 fig., *d*)

Machine Tools

Flush-Pin Versus Limit Gages, Albert H. Dowd. Description of several types of flush-pin gages, both for work and inspection, and a general discussion of the application of such gages.

Limit gages are not always reliable when the product is such that it must be kept within very close limits of accuracy. This is due to the fact that the ordinary go and no-go gages do not determine the fluctuations in the work sizes to any appreciable degree. The writer gives an example where with a

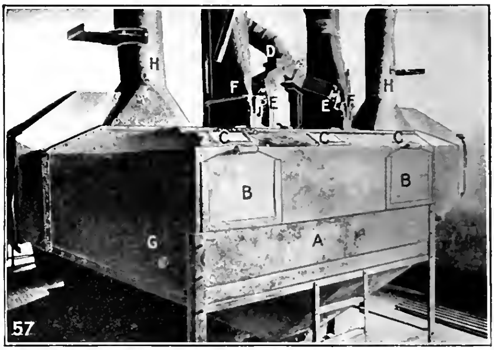


Fig. 8 Sand-Blasting Machine

go gage of 1.998 and no-go 2.001, a hole machined so that it actually measured 2.0005 would still pass inspection. Yet while the work would be verging close to the danger line, the operator would not be aware of it, except by the feel of the gage as he entered it in the hole. The very next piece of work might not pass the gage due to the wear of the tools, and if the operator were inclined to be careless, three or four pieces might need reboring before the error became apparent.

In boring and turning, plug and snap limit gages are used universally, but for gaging depth, shoulder distance and work of this kind, the writer believes that another type of gage should be considered, namely, one which will act as a limit gage and at the same time show the machine operator how closely he is approaching the danger line.

The flush-pin gage is of this type. It is used to considerable extent on gun work for close tolerances and can be made up at a reasonable price. In its simplest form it can be used for tolerances of about 0.005 in. or greater, and with additional refinements it can be made to indicate a fluctuation of 0.005 in. or even less.

The application of the flush-pin principle in gaging a piece of work during machining is shown in Fig. 9. In this case the work A must be machined so that depth B will be within a tolerance of 0.25 mm. This gage is on the same principle

as flush-pin gages generally, but as the work is recessed, provision is made in the shoulder G to roughly center the tool when placing it in the work. This facilitates the handling and roughly locates the flush pin against the face of the casting C. The registration of this gage is by means of the pin E,

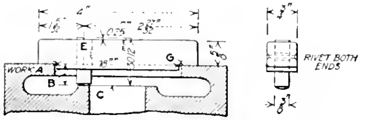


Fig. 9 Method of Using a Flush-Pin Gage

which is shouldered, as shown, to indicate the variations in the facing of the boss C.

The flush-pin principle can be applied to work requiring especially close tolerances by the addition of an indicator multiplying lever in connection with a suitably graduated scale. (*American Machinist*, vol. 49, no. 7, August 15, 1918, pp. 283-284, 5 figs., *dp*)

Metal-Concrete Planing Machine. In the June 1918 issue of The Journal (page 505) an abstract from the *American Machinist* was given describing a large planing machine with a concrete bed.

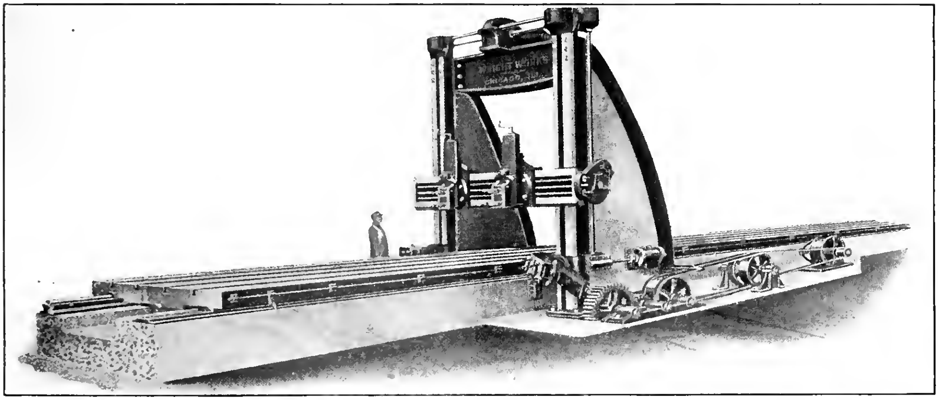


Fig. 10 Metal-Concrete Planing Machine

The present article briefly describes a similar machine developed by David A. Wright, of Chicago, and states that the machines are built in sizes ranging from 6 to 20 ft. with any length of bed. The platen of the machine is made of structural-steel sections, with inserted cast-iron T-slots (Fig. 10) in the upper surface and is filled with reinforced concrete. After the concrete filling has set and the platen is put in position on the machine, the upper surface is planed off. The ways on which the platen travels consist of a flat cast-iron one for the front and a piece of steel shafting for the rear one, both supported by concrete foundations. The frame of each side housing consists of three castings for the front, back and base, respectively. After these have been finished and assembled, concrete is poured in to provide rigidity. The feed is of the pneumatic type. (*The Iron Age*, vol. 102, no. 8, August 22, 1918, p. 449, 1 fig., *d*)

Sheet Corrugating and Curving Machines. Description of specially constructed machines for corrugating steel shelters for the United States Army.

These shelters are made of No. 11 gage sheet steel and are corrugated 4 in. deep by $12\frac{3}{4}$ in. center to center. The top and bottom of the corrugations are $5\frac{3}{4}$ in. wide each and the sides are on a 15 per cent angle. After being corrugated the sheets are curved to a 5-ft. radius on a machine, also specially designed for this purpose and described and illustrated in the original article.

The corrugating machine has semi-steel, hexagon-shaped, hollow-cored rolls, with cross-ribs running their entire length. The rolls are drilled and tapped for interchangeable dies, which are also of semi-steel, and the corrugations are machined out of the solid. The machine is 10 ft. high and weighs when assembled 85,000 lb.

The curving roll forms the sheets after they have passed through the corrugating machine. It occupies a oor space of $6\frac{1}{2}$ by 12 ft. and weighs 10,000 lb. (*The Iron Age*, vol. 102, no. 9, August 29, 1918, p. 501, 2 figs., *d*)

Measuring and Testing

A Comparison of Various Manometers, L. Holborn (*Ann. d. Physik*, 54.7., pp. 503-510, April 9, 1918. From the Physikal.-Techn. Reichsanstalt). For pressures higher than those suitable for the mercury manometer, there are several instruments on the market. These, in some instances, register pressures as high as 1000 kg./cm.². One form mentioned in detail is a differential manometer. The pressure is communicated by resin oil to the inside of a strong cylinder. Here it acts on a plunger, whose ends project from the cylinder, but whose center, in the cylinder, is slightly tapered.

The author points out the corrections necessary for change in dimensions of the metal due to the pressures. Two manometers compared over a range 100 kg./cm.² to 1000 kg./cm.² differed by 0.03 per cent at low pressures, but by only 0.01 per cent above 300 kg./cm.². Another manometer, less satisfactory, showed differences from each of the above of about 0.18 per cent. (Taken from *Science Abstracts*, Section A—Physics, vol. 21, pt. 7, no. 247, July 31, 1918, p. 281, *c*)

METHOD FOR TAKING MOVING PHOTOMICROGRAPHS. At the last annual meeting of the American Society of Testing Materials at Atlantic City (June 1918), considerable interest was aroused by the exhibition of moving photomicrographs by Prof. Herbert F. Moore of the University of Illinois, Urbana, Ill.

The moving photomicrographs shown represented the first successful attempt for recording the gradual changes in the structure of a metal when subjected to repeated bending stresses. The great possibilities of this method are, of course, obvious.

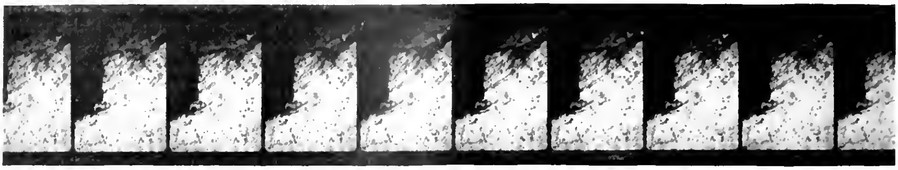


FIG. 11 STRIP OF PRINTS FROM FILM SHOWING DEVELOPMENT OF SMALL CRACKS OR SLIP LINES

The present article contains illustrations of the machine which was used to bring a wrought-iron test piece under repeated stress, as well as the apparatus used for taking the moving photomicrographs.

In Fig. 11 is shown a section of the original film early in the experiment. This is a strip of prints showing development of small cracks or slip lines with magnifications of about twenty times. These photographs were taken at the rate of sixteen per second, the exposure used being one-fiftieth of a second.

The original article also contains seven still photomicrographs showing the development of slip lines in a specimen of iron from the unstressed state to the finally developed crack. Fig. 12 is likewise of interest in reproducing a strip of prints from a film showing the various phases in the development of a large crack.

FIG. 12 STRIP OF PRINTS FROM FILM SHOWING DEVELOPMENT OF LARGE CRACKS

So far the moving-photomicrograph method has been applied only to wrought iron, because of the large crystals and distinct markings, and also because of its easy deformation under stress, but it is expected that ere long this method will be applied to steel and non-ferrous metals and alloys. It has been stated that this new device may determine just how steels begin to deteriorate under stress. In this way it may lead to new methods of heat treatment prolonging the life of certain steels and rendering them less liable to fatigue. In any event, it will give a much clearer insight than we have had hitherto into the actual growth of strain phenomena and ways they affect metal of various physical and chemical structures. (*The Iron Age*, vol. 102, no. 6, August 8, 1918, pp. 323-325, 10 figs., *d*)

Mechanics

CONCRETE BEAMS WITH FIXED ENDS. In many cases building ordinances make no provision for fixed ends of concrete beams. The design requirement for a single-span concrete beam supported on concrete columns at each end provides that the beam shall be designed for a moment of $WL/8$ at the center, which is approximately only for brick bearing walls, but is not true where the beam is supported by concrete columns more or less fixed to the beam, as little or no provision is made to allow for the bending to which the column must be subjected as a result of the rigid connection with the beam. This method of design provides a beam about 50 per cent too strong and may prove to be excessively weak in long-span construction columns. The present article gives the discussion of a fixed beam designed in reinforced concrete as applied in the construction of a factory building in Illinois.

The distribution of bending moments through the columns and beams was obtained by the method of slopes and deflections. In this method of analysis the bending moment is found in the beam at the intersection of the center lines of the column and mid-depth of the beam and in the column just above and below this intersection.

Fig. 13 shows the design used for one of the frames. In designing the columns for direct load and bending care must be taken in considering the column section just above the floor, as this is the critical point. This is due to the fact that this location is as high as anywhere in the columns, and, in addition, only the bare column section, without any bracket, is available to take up the stress.

The original article gives a complete calculation of the various moments. (*Engineering News-Record*, vol. 81, no. 8, August 22, 1918, pp. 359-361, 5 figs., *pA*)

Munitions

THE 75-MM. FIELD GUN, MODEL 1916, M. III. Special correspondence to the *American Machinist*, describing the latest

of the four types of 75-mm. field guns built by the United States Government. The article gives the length, weight and other data, and describes and illustrates the component parts of the breech-closing and firing mechanism.

The gun weighs 749 lb., has a total length of 90.9 in., and a right-hand twist constant from origin to muzzle. It can use either shrapnel or shell, the weight of the shrapnel being 15.96 lb. and the weight of the shell 12.36 lb.

A service pressure of 33,000 lb. per sq. in. is used. The mechanism is of the drop-block type and is semi-automatic, the block closing automatically when a round of ammunition is inserted.

A complete and interesting description is given of all features not involving elements of military secrecy. (*American Machinist*, vol. 49, no. 8, August 22, 1918, pp. 323-328, 4 figs. and table of nomenclature of the breech mechanism, *dA*)

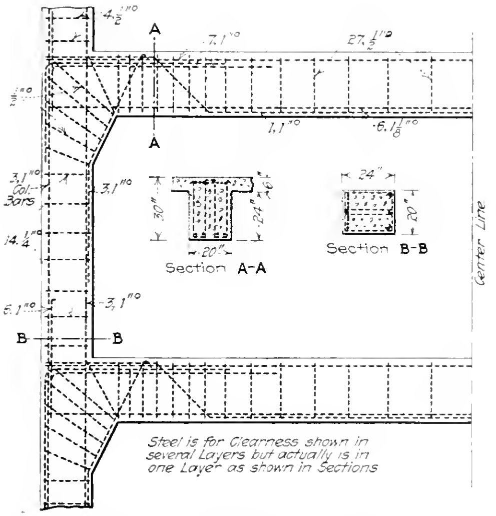


Fig. 13 Reinforcing Details at Rigid Connection of Beam to Column

Power Generation

Development of Power from the Standpoint of the Boiler Room, C. F. Hirshfeld, Mem.Am.Soc.M.E.. J. E. Aldred lecture on Engineering Practice at Johns Hopkins University.

The writer states that although only a small percentage of the latent heat contained in fuel is converted into electric energy there is comparatively little improvement to be hoped for in power plant economy, but there is a large and profitable field for betterment in the operating conditions of the *average* power plant. He emphasizes that in a boiler plant it is not the highest thermal efficiency but the highest possible commercial efficiency that is aimed at. He presents from this point of view an interesting study of the overall efficiency of a boiler showing how step by step the entire installation of a power plant is usually a compromise between various requirements. (Abstracted through *Power*, vol. 48, no. 8, August 20, 1918, pp. 284-286, 2 figs., *g*)

Power Plant

Boiler Equipment of the Auzberg Power Station, P. Koch. (*Zeits. f. Dampfkessel. u. Maschinenbetrieb*, No. 43, 1917. *Elektrot. u. Maschinenbau*, 36. p. 158, March 31, 1918. Abstract.) It was made a condition that the grates should burn Bohemian brown coal economically, and it was found by trial that the Piedboeuf chain grate was most suitable for this fuel. Four Burkhardt vertical-tube boilers are used, each of 400 m.^{2} heating surface and designed for 15 atmos. working pressure with superheater and wrought-iron economizer. Induced draft is provided, and the total grate surface of each boiler is 17.2 m.^{2} Flue ashes are caught in special spirals and removed below the boiler-house floor. The wrought-iron chimney is 29.5 m. high and 1500 mm. internal diameter. Butterfly plates below the grate cut off the air supply from part of the grate area at times of light load. The accompanying table gives the principal results of three steam trials:

Test No.	I	II	III
Kg. fuel per m.^{2} of grate surface	149.7	199	222
Kg-cal. per hr. per m.^{2} grate	565,000	706,000	800,000
Draft in combustion chamber, mm. of water	2.5	2.7	5.2
Draft behind economizer, mm. of water	5.2	5.7	10.6
Percentage of Heat:	%	%	%
Utilized in boiler.	62.9	59.6	59.8
Utilized in superheater.. ..	5.3	6.1	7.5
Utilized in economizer..	11.8	10.5	11.9
Lost in flue gases....	13.2	12.4	15.0
Lost in ash (unconsumed), radiation, and conduction..	6.8	11.4	5.8

A noticeable point is the low draft required. The loss of draft amounts to 2.7, 3, and 5.4 mm. water column at heating-surface loads of 28.3, 33.3, and 38.1 kg. per m.^{2} respectively. During these tests the guaranteed maximum power was obtained without artificial draft. (Taken from *Science Abstracts*, Section B—*Electrical Engineering*, vol. 21, pt. 7, no. 247, July 31, 1918, p. 249, *d*)

Refrigeration

The Practical Side of the Low-Temperature Compression System, H. Sloan. Description of three different installations put into operation during 1917. All are operated in connection with brine-cooling systems. In addition to the description of the installation itself are given data of tests and some of the temperature readings especially analyzed.

The average suction pressure for the low-pressure cylinder was 0.935 lb. while the average temperature was — 11.85 deg. fahr.

This temperature agreed very closely with the outgoing brine temperature and did not follow temperature changes due to differences in the suction pressure, which means that the degree of superheat depends upon the temperature of the brine circulated.

The discharge temperature for the low-pressure cylinder averaged 123.3 deg. fahr. The gas entering the intermediate pressure drum (a long header into which the gas from the low-pressure ammonia cylinders is discharged and where it is cooled to the saturation point of the pressure corresponding to the intermediate pressure) was cooled to the average temperature of 15.19 deg. fahr., at which temperature it entered the high-pressure cylinder. The average pressure on the intermediate drum was 28.4 lb. and the temperature of saturated gas cor-

responding to this pressure is 15.5 deg. fahr., which indicates that the gas entered the high-pressure cylinder in a saturated condition and is important as an indication of the efficiency of the method employed for removing the superheat due to compression in the low-pressure cylinder.

If the low-temperature compression system secures the desired results, it will have the advantages of smaller dimensions in the cylinders on account of higher volumetric efficiency, and a reduction in ammonia losses due to combustion and cooling of the liquid ammonia at low-suction pressure with the intermediate pressure. (*A. S. R. E. Journal*, vol. 4, no. 6, May 1918, pp. 549-556, and discussion, pp. 556-560, 4 figs., *dt*)

Rolling Mills

THE SLICK WHEEL MILL. Description of a new process of making car wheels in which they are formed directly from large rolled bars by a rolling-forging process as now applied at the Cambria Steel Works.

The process begins with a cylindrical bar from 18 to 20 in. in diameter, rolled from a standard-size ingot. This bar is introduced into the rotary shear which cuts off short cylindrical blanks of the necessary size. The blanks are then transported to a heating furnace and heated gradually as necessary for the high-carbon steel used in making the wheels. From the furnace they go to a piercing machine which projects a short steel punch way into the center of the blank, making a cylindrical opening in the center thereof, and as this blank is introduced into the wheel mill a loose pin or mandrel which is previously placed in position is projected into the opening. As the wheel is pressed and rolled in the wheel mill this mandrel holds the blank centrally in position and at the same time forms a major portion of the length of the bore of the wheel or blank. The mandrel remains in the wheel or blank as it is rolled and is withdrawn from the mill.

The mill itself includes a pair of dies so arranged that the axis of one of the dies is at an angle to that of the other die. A hydraulic plunger of enormous size projects one die towards its companion die and an electric motor which can develop from 1000 to 2000 hp. is provided for rotating one of the annularly disposed dies, which by friction also rotates the companion die and the blank which is clamped between them and pressed by hydraulic pressure. The blank is shortened and assumes the reverse form of the dies as the pressure and rotation continue.

The time required to roll the blank into a wheel or other annular shape varies from 20 sec. for the smaller sizes with least work to about one minute for the large sizes with more work. A thrust of 3,000,000 lb. or more is taken up by large thrust bearings which are believed to be the largest in the world. These thrust bearings are shown in Fig. 15.

The rotary shear, Fig. 14, employs a pair of large disks arranged with their axes parallel, each disk composed of two pieces mounted on a large shaft and holding clamped between them by means of suitable bolts the shear blades proper. The round bar to be cut is carried on a longitudinal roller of large diameter which supports throughout its length and is adjustable to hold blank bars of different diameters in proper relative position to the shear knives. After one end (forming a blank) has been cut from the bar by the shear rotary knives, the bar is pushed lengthwise of the supporting roller between the side guides by means of a rotary pusher.

The shearing mechanism proper consists of two pairs of rotatable disks to which the eccentric shear knives are clamped.

In order to give a general idea of the large size of this machine, the following dimensions may be noted: The length of the shear proper is about 36 ft.; the length of the feed apparatus is about 60 ft.; and the length of the engine shaft or width of the engine is about 17 ft.; so that the whole apparatus is about 113 ft. long. The width of the shearing is about 18 ft. overall; the height is 13 ft. 8 in. above foundation and its weight approximately 850,000 lb.

The original article is illustrated by numerous line drawings and halftones showing the various details of the machinery

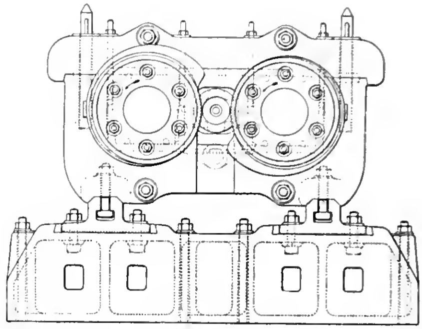


FIG. 14 SLICK ROTARY SHEAR

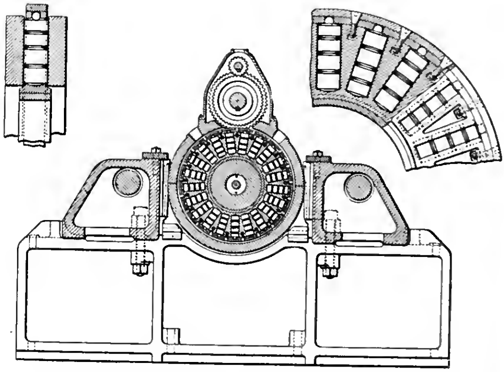


FIG. 15 ANNULAR THRUST BEARINGS USED IN THE SLICK WHEEL MILL

of the wheel mill and of its installation. (*The Iron Age*, vol. 102, no. 9, August 29, 1918, pp. 491-498. 17 figs., *dA*)

Steam Engineering

WRECK OF A 25,000-KW. TURBINE IN NEW WEST END STATION, CINCINNATI, OHIO. The accident to one of the two 25,000-kw. single-cylinder impulse turbines in Cincinnati occurred on September 4, 1918.

The turbine had been installed about two months previous and had satisfactorily passed the trial load tests. On the morning of September 3, i. e., the day before the accident, the machine was started at 8 o'clock and carried 12,000 kw. all day. At a little before 9.00 a.m. on the day of the accident the erecting crew had about 20,000 kw. on the turbine, which, at first, carried the load well. Then there was a loud bang inside the casing, followed by others accompanied by violent

vibration which shook the station. The throttle was immediately tripped, but the noise and vibration continued, much modified, until the machine slowed down to about 700 r.p.m.

From an inspection it appears that the seventeenth diaphragm was distorted at top and bottom. There are approximately 350 buckets in this diaphragm and all but eleven are burned or crushed.

The blades on this wheel are 28 in. long and made of steel; they have a shrouding over their tips, but use no rosary fastening. It is peculiar that about every tenth blade broke off immediately above where it was fastened on to the wheel, making a clean and sharp break. The blades which remained in the wheel were burned away at their top edges, the projections on the tips of the blades merely showing the effect of having the shrouding pulled away from them.

It is believed that the distortion of the diaphragm was the primary cause of the trouble, this being confirmed by the fact that the projections on the sixteenth diaphragm top and bottom show signs of rubbing on both halves.

It is interesting to note that the turbine was in operation five days after the accident, and, as a matter of fact, could have been put back in service even sooner, had it not been deliberately kept open for the inspection of the engineers of the builders. (*Power,* vol. 48, no. 12, September 17, 1918, pp. 425-426, 3 figs, *d*)

Wreck of the 35,000-Kw. Turbine in Northwest Station, Chicago. On Wednesday, August 1, the 35,000-kw. turbine in the Northwest Station of the Commonwealth Edison Company of Chicago was completely wrecked.

The present article gives the first published seemingly authentic information as to this accident and its probable cause.

The machine carried no load at the time of the accident, but had been in service all day. It was taken off the line shortly after midnight July 31, and the crew arranged to give the machine its regular monthly overspeed run to test the automatic-stop governor, and it was when this test was given that the accident occurred.

The article in *Power* correctly points out that if the stage had been set for observation of the machine, it could not have been better set. The accident actually happened during the test, under conditions ideal for observation of the machine and the taking and recording of the necessary measurements.

According to a statement of the switchboard operator, the speed at which the turbine began to be demolished was that which gave but 26½ cycles (the generator is of 25 cycles), which would mean a speed of 1590 r.p.m., or 6 per cent above the normal speed of 1500 r.p.m.

The steam pressure was 240 lb. and the throttle was wide open for the overspeed test, with the watch engineer standing at the throttle. Then came the thump, severe vibration and a crash as the low-pressure casing burst and pieces of metal flew about the room.

As regards the damage to the turbine the following facts, among others, are recorded as significant: The cast-iron low-pressure casing is blown away from the 18th wheel on. The diaphragms in the last low-pressure stages are broken up and the semi-steel cone supporting these diaphragms is demolished.

The next to the last (19th) low-pressure wheel has a large piece broken out, while the top of the periphery of the last or 20th low-pressure wheel is bent so that it presents a wavy line. The bedplate beneath the outboard-bearing pedestal is cracked.

The conclusion to which the writer comes is that it was the 19th wheel at the low-pressure end that was the first to let go. On the other hand, he does not believe it was the blades on the last two wheels that were torn off by centrifugal force alone.

In this connection, attention is called to an editorial in the same issue of *Power*, on page 355, devoted to the Chicago accident here described and a similar accident in Boston last February.

It is stated that experts who checked the design of the wrecked turbines gave it a factor of safety of four, so far as centrifugal stresses were concerned, but referred to the possibility of stresses being set up by unequal expansion through sudden changes of temperature.

It is significant that both of these accidents occurred immediately after changes in operating conditions, which involved a considerable temperature change in the low-pressure end—the first due to sudden imposition of an excessive load; the second to the taking off of the load. (*Power*, vol. 48, no. 10, September 3, 1918, pp. 345-348, 4 figs., *d*)

A New Theory of the Steam Turbine, Harold Medway Martin. This is a continuation of an abstract of a serial, the first installment of which appeared in The Journal, September 1918, p. 784.

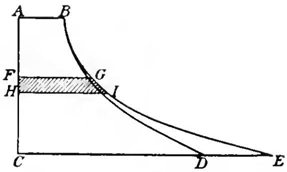


Fig. 16 Ideal Indicator Diagram for Steam Turbine

In the present installment the writer calls attention to the well-known fact that in steam-turbine practice the gain made by the use of superheated instead of saturated steam is substantially more than is thermodynamically due. This was shown quite conclusively by Baumann in a paper read before the Institution of Electrical Engineers (British) in 1912. Last year an extended set of correction tables drawn up by C. H. Naylor were issued under the auspices of the British Electrical and Allied Manufacturers' Association. From these figures, combined with the heat-drop tables issued by the same association, the present author secured the following figures of relative consumptions under certain standard conditions:

TABLE 1

Superheat, deg fahr....	0	50	100	150	200	250	300
Relative consumption.. ..	1.160	1.101	1.046	1.000	0.9592	0.9235	0.8909

From these figures and other data it would seem that the saving due to a superheat of 150 deg. fahr. is reckoned at 16 per cent instead of at 15 per cent as in Baumann's paper in 1912. This may be due to the improvement effected during recent years in average turbine efficiency, since, as the writer claims, with any given type of turbine the relative gain from using superheat should increase somewhat with the efficiency of the turbine. This is the reverse of the opinion generally held.

From this the writer proceeds to the consideration of the discrepancies between the gains and losses. To do this he takes for purposes of comparison the condition of the steam, not as supplied to the stop valve but after passing through the

governor valve. In addition, the discrepancies are made larger by the fact that the ratio of blade speed to steam speed is, on the average, less the greater the amount of available heat. Furthermore, the heat which becomes available in a steam turbine differs from the adiabatic heat drop and is, in general, considerably larger. The ratio of the two, known as the reheat factor, forms the subject of an important discussion by the writer, who claims that it is substantially greater for superheated than for saturated steam when the latter is assumed to be in thermal equilibrium throughout the whole of its expansion.

Suppose a turbine to consist of an infinite number of stages. At each stage a certain portion of the total energy of the steam is converted into kinetic energy, of which a part is expended in doing useful work on the shaft, and the remainder, which is wasted in friction, is restored to the expanding steam in the form of heat; the consequence is that at each stage the pressure corresponding to a given volume of the steam is somewhat greater than it would be did the turbine work friction-free. Whether steam be used to actuate a turbine or a reciprocating engine the amount of work done down to any stage of the expansion can be represented by an ideal indicator diagram such as is shown in Fig. 16. In this the expansion line BD is that corresponding to frictionless working or to unit efficiency, while BE represents the expansion line for a turbine working with an hydraulic efficiency η. The total area of the diagram is in this case larger than before, because the energy wasted in friction, being returned to the steam as heat, makes the volume at every point of the stroke more than if unit efficiency were attained. On this larger diagram, however, only the fraction η is recovered as useful work on the shaft, whereas in the ideal case of unit efficiency the useful work done is represented by the whole of the area $ABDC$. In all cases $\eta \times ABEC$ is less than $ABDC$.

The efficiency ratio ε of the turbine is equal to the actual work done divided by that theoretically due from a perfect turbine, or

$$\varepsilon = \eta\frac{ABEC}{ABDC}$$

and the reheat factor R is defined by the relation

$$R = \frac{ABEC}{ABDC}$$

so that $\varepsilon = \eta R$, where η is known as the hydraulic efficiency of the turbine.

The actual thermodynamic head under which any turbine works is therefore not represented by the adiabatic heat drop u, but by a larger quantity U, where $U = Ru$.

From this the writer proceeds to show how to determine the value of the reheat factor corresponding to different values of the hydraulic efficiency of the turbine and comes to the expression

$$R = \frac{1}{\eta} \cdot \frac{1-\left(\frac{1}{x}\right)^{\eta[1-(1/\gamma)]}}{1-\left(\frac{1}{x}\right)^{[1-(1/\gamma)]}}$$

where η is the hydraulic efficiency of the turbine and x the ratio of the initial to the final pressure. From this he derives the values of the reheat factor for superheated steam throughout the whole range of its expansion for the various hydraulic efficiencies given in Table 2.

In other words, the efficiency ratio of a turbine is defined as the product of its hydraulic efficiency and the reheat factor.

In view of its use elsewhere in this discussion attention is called to the following expression for λ:

$$\lambda = \frac{1+\frac{1}{\gamma-1}}{\frac{1}{\gamma-1}+k}$$

where γ is the index when the expansion is adiabatic.

Among other things the writer calls attention to the paradox following from the above expression for the reheat factor R. If the expansion be carried far enough, the efficiency ratio is independent of the hydraulic efficiency which can be shown by making $x = \infty$. Since then the efficiency ratio is equal to $R\eta$, its value is always unity if the expansion be carried to zero pressure. The following physical explanation is given: To reduce the final pressure to zero we must go down to the absolute zero of temperature. In deducing the value of R it was assumed that all the heat energy not expended in doing useful work was restored to the fluid in the form of heat. At the absolute zero of temperature the working fluid retains no heat energy and the latter has accordingly all been turned into useful work and the efficiency ratio is unity, however great the frictional losses may have been at each stage of the turbine.

The writer points out that the error in reheat factors for wet or saturated steam is considerable, because for the adiabatic expansion of such steam in thermal equilibrium the expression of the form pV^n = constant (where $n = \gamma$), is only moderately

TABLE 2 REHEAT FACTOR FOR STEAM SUPERHEATED THROUGHOUT THE WHOLE RANGE OF ITS EXPANSION

Values of $x = \frac{p_0}{p_1}$	Hydraulic Efficiency η			
	0.5	0.6	0.7	0.8
1	1.0000	1.0000	1.0000	1.0000
2	1.0393	1.0312	1.0235	1.0160
4	1.0753	1.0629	1.046 .	1.0310
6	1.1033	1.0809	1.0602	1.0397
8	1.1195	1.0934	1.0695	1.0454
10	1.1310	1.1024	1.0762	1.0494
15	1.1554	1.1209	1.0891	1.0585
20	1.1691	1.1313	1.0964	1.0617
25	1.1841	1.1445	1.1057	1.0692
50	1.2219	1.1718	1.1253	1.0810
100	1.2586	1.1998	1.1450	1 0932
200	1.2962	1.2279	1.1643	1.1053

TABLE 3 REHEAT FACTORS R FOR STEAM INITIALLY IN THE DRY BUT SATURATED CONDITION, AND EXPANDED FROM DIFFERENT INITIAL PRESSURES DOWN TO 1 LB. ABSOLUTE, THERMAL EQUILIBRIUM BEING MAINTAINED THROUGHOUT THE EXPANSION

Abs. Initial Pressure, lb. per sq. in.	Abs Final Pressure, lb. per sq. in.	Hydraulic Efficiency				
		0.5	0 6	0.7	0.8	0.9
2	1	1.0085	1.0078	1 0065	1.0046	1.0022
4	1	1.0191	1.0163	1.0129	1.0089	1.0043
6	1	1.0284	1.0217	1.0169	1.0114	1.0056
8	1	1.0316	1.0256	1.0195	1.0130	1.0062
10	1	1.0355	1.0290	1 0221	1.0148	1.0071
15	1	1.0435	1.0348	1.0264	1.0181	1.0078
20	1	1.0496	1.0394	1.0294	1.0191	1.0088
25	1	1.0537	1.0427	1.0318	1.0210	1.0104
50	1	1 0669	1.0531	1.0394	1.0261	1.0129
100	1	1.0809	1.0640	1.0475	1 0313	1.0155
200	1	1.0956	1.0755	1.0559	1.0368	1.0162

accurate. In such a case the reheat factor may be determined in another way, published in *Engineering* several years ago. The writer repeats the argument presented there and gives a table showing the value of reheat factor for steam unusually dry and expanding in thermal equilibrium throughout, that is to say, with no undercooling, a condition which is, however, not realized either in a steam turbine or in a reciprocating engine. These values are given in Table 3.

The writer makes the following comparison of Tables 2 and 3. Suppose a steam turbine designed to give an hydraulic efficiency of 0.7 for the range of expansion of from 200 lb. absolute down to 1 lb. absolute. Then if the steam supply is saturated and the expansion takes place in thermal equilibrium throughout, its thermodynamic efficiency ratio will, from Table 3, be $0.7 \times 1.0559 = 0.739$ nearly. If, on the other hand, the turbine is designed to give the same hydraulic efficiency with steam supplied at 200 lb., and superheated to such an extent that the superheat is not lost when the exhaust port is reached, the efficiency ratio will be $0.7 \times 1.1643 = 0.815$ nearly. Hence, with the same hydraulic efficiency the thermodynamic efficiency ratio will be fully 10 per cent more with superheated than with saturated steam expanding in thermal equilibrium.

It will be obvious, therefore, that the adiabatic heat drop forms a somewhat fallacious foundation for estimating the saving to be effected by superheating the steam. (*Engineering*, vol. 106, no. 2742, July 19, 1918, pp. 53-55, 3 figs. The article is to be continued, *tA*)

The 45,000-Kw. Compound Turbine at Providence, R. I., J. P. Rigsby. Description of a turbo-generator unit recently put in operation at a local power plant in Providence, R. I. It is of the Westinghouse cross-compound, double-unit type, the high- and low-pressure sides each driving a generator of 22,500 kw. capacity. These generators are mounted on separate bedplates supported on foundations parallel to each other.

The energy given up by the steam at full load is equally divided between the high- and the low-pressure turbines, though at lower loads a greater proportion is carried by the high-pressure element. The steam pressure at the throttle is set at 200 lb. with 100 deg. fahr. superheat and a vacuum of 29 in. in the exhaust. At the high-pressure element the speed is 1800 r.p.m. and at the low-pressure element 1200 r.p.m.

Several features of construction of the turbine are of particular interest. Thus, the high-pressure spindle consists of a hollow steel drum about 3 ft. in diameter carrying most of the blading. There are two blade rings of larger diameter at the one end and corresponding dummy rings or balance pistons on the other. The spindle ends are pressed into the drum and are secured with T-headed shrink links, which are themselves held in place by the blade and dummy rings.

The low-pressure spindle consists of a central hollow drum rigidly secured to the spindle ends with two disks mounted upon each of these ends. These disks carry the low-pressure blades, the maximum mean velocity of which is so low that ordinary good cast steel can be used in the blade rings.

The condenser equipment is claimed to be the largest in the world. The condenser unit is composed of two separate and distinct low-level jet condensers, which can be operated together or separately, if necessary. The same water level is maintained in each condenser by the use of a water-equalizing connection between the two pump bodies. This water-equalizing connection is so constructed that no surges occur between the condensers. For this purpose a connection is made in the form of a tee, the bottom of which forms a reservoir, and a baffle running almost to the bottom prevents surging; also an air-equalizing connection is provided to maintain the same vacuum in each condenser. (*Power*, vol. 48, no. 9, August 27, 1918, pp. 292-298, 9 figs., *dA*)

Varia

Einstein's Gravitation Theory, I, II, III and IV, H. A. Lorentz (*K. Akad. Amsterdam*, Prov. 19, pp. 1341-1369, and 20, pp. 2-34, 1917). The author considers that through the Einstein equations the general theory of relativity may now be regarded as having assumed a definite form. He attempts, in the present communication, to prepare the way for its future development and application to special problems: (1) by presenting the fundamental ideas in as simple a form as possible, (2) by showing how Einstein's differential equations for the gravitation field can be derived from Hamilton's principle, and, in connection therewith, dealing with the energy, stresses, momenta, and energy currents in that field. By means of a four-dimensional geometric representation it is shown that any system consisting of material points and an electromagnetic field is expressible in terms of a single quantity H occurring in the variation theorem, and which is called the *principal* function. It consists of three parts, referring respectively to the material system, the electromagnetic field and the gravitation field, the material points being assumed to have no connection other than that resulting from their gravitational attraction. Space and time are combined in the four-dimensional extension R_4, a point P in which indicates a definite place at a definite instant. The curve traced out by P when the time coördinate only varies is called, after Minkowski, a *world line*, so that an intersection of two world lines represents the coincidence, at a certain moment, of the two objects to which they belong. It should be noted that a propagated light wave will have its world line. And Einstein observes that our observations can determine only these coincidences, so that if astronomical data could be extended arbitrarily and without limit, a gravitation field, e.g., that of the sun, with its material points and light waves, would be completely defined by a field figure consisting of the world lines in R_4, drawn so that each observed coincidence is represented by an intersection of two lines, and so that the points of intersection succeed each other in the right order. It should therefore be possible to express the fundamental laws of physical phenomena by geometric considerations referring to the field figure in such manner that this mode of expression shall be the same for all possible field figures. The introduction of coördinates is of secondary importance in a geometrical treatment of this kind, and employed by the author only to obtain the equation representing the connection between the electric and magnetic forces, on the one hand, and the charge and convection current, on the other; and to establish the general equations, which are required for the solution of special problems. Since coördinates play no essential part in the general discussion of principles, the latter must necessarily be independent of the actual coördinates chosen, so that the general covariancy of the equations postulated by Einstein is assured beforehand. (Taken from *Science Abstracts*, Section A—Physics, vol. 21, pt. 7, no. 247, July 31, 1918, pp. 282-283, *g*)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society.

SOCIETY AFFAIRS

A Record of the Current Activities of the Society, Its Members, Council, Committees, Sections and Student Branches; and an Account of Professional Affairs of Interest to the Membership

THREE MILLION men at the front by July 1, 1919, is more easily attainable than the industrial readjustment by that time to maintain three million men. The most important task before the country is that of industrial readjustment, the work peculiarly that of the engineer.

On the occasion of a recent visit to Washington with regard to the essential curtailment of the paper used in the Society's publications, the Secretary had an opportunity to take up with Mr. C. A. Otis, Chairman of the Resources and Conversion Division of the War Industries Board, the work of the Society's Committee on War Industries Readjustment, and was pleased to learn that this was eminently satisfactory. In fact, Mr. Otis warmly complimented the Society for its enterprise. The task is stupendous, however. It is more than the Administration in Washington, no matter how powerful or well organized, can complete alone. It must be done by individuals throughout the United States. Hence this appeal through our members and to all they can influence, to undertake only such activities as have a direct effect on winning the war.

Through our Local Sections, corresponding to the Regional Committees of the War Industries Board, any member may secure information, either as to what are the prospective requirements of our Government on the one hand, or to place before the proper authorities the information respecting the abilities of any plant to undertake work. In other words, our Society, through its several committees, is able to act as one of the clearing houses of the Government in this essential work of readjustment.

Another essential work of the people of the United States is that of invention, and here again the Society is prepared to act as a clearing house to ascertain on the one hand the problems to be solved and on the other hand to offer the special abilities of individuals who are prepared to give all or a portion of their time either at places designated by the Government or at their offices or homes.

In connection with these very essential activities of the Society, you will note in the program of the coming Conference at Indianapolis that we are to have the subject of research treated authoritatively by the head of the Mechanical Engineering Division of the National Research Council, Prof. W. J. Lester. Professor Lester is a very forceful and fluent speaker.

The above are the immediately obvious requirements of the hour which every member will naturally wish to undertake. The more far-reaching and fundamental activities of the Society, however, are those of setting and maintaining the ideals of the engineering profession. In connection with the Indianapolis Conference on October 25-26, an opportunity is to be afforded representatives from each of the Sections in the United States to bring together the point of view of the membership on the great questions of engineering ideals; and we are to have a "self-examination," as some friend has called it. It is hoped that in the following month the Local Sections all over the United States will further discuss this matter by calling on their respective representatives to report the results of the Indianapolis Conference. Then at the Annual Meeting in December there will be a still more representative gathering of engineers from all over the United States for a further discussion and statement of the objects and aims of a professional engineering society. All those members who cannot attend the Indianapolis meeting are urged to write their views, and failing also to attend and speak at the Annual Meeting in New York, they should write to the Secretary.

During the war, views of the world and the members of the engineering profession have undergone a change and it behooves the Society, as expressing the thoughts and ideals of the profession, to lead in that expression.

CALVIN W. RICE,
Secretary.

The Coming Annual Meeting

Plans for the Annual Meeting, to be held December 3-6, have so far developed that tentative announcement of several of the sessions can now be made. The practice in previous years of having a leading subject for the meeting of broad, general interest, will be adhered to, with a discussion throughout the day on Wednesday, December 4, of the general topic on Human Engineering, particularly in reference to questions of administration which have arisen in the war industries. The titles of the papers now in preparation for this session are as follows: Organization; Standardization and Administration of Wages; Non-Financial Incentives; Incentive of Control in Industry; Employment of Labor; Dilution of Labor; Intensive Training; Human Relations in Industry.

There will be at least two sessions for general papers of technical interest for which an ample variety of strong contributions have been received.

One session will be under the auspices of the Gas Power Sub-Committee with papers on oil engines and cooling losses in combustion engines. Another session will be in charge of the Sub-Committee on Textiles, with papers on industrial power problems and aeroplane fabrics. A session arranged by the Sub-Committee on Machine Shop Practice will be devoted to the subject of gages, methods of manufacture and testing. The apparatus in the Department of the Bureau of Standards, located in the Engineering Societies Building, New York, will be added to with a view to placing the equipment on exhibition during the meeting.

Another session will be a joint session with the American Society of Refrigerating Engineers, which holds its annual convention simultaneously with that of our own Society. Papers will be contributed by both societies.

Everything points to a most successful meeting, equal if not exceeding those of the last two years which have been the largest in the history of the Society. On Wednesday and Thursday evening of the meeting there are to be addresses or moving pictures relating to the war, and the trend of many of the papers at the special sessions will be in the direction of the work which the members of the Society and other engineers are accomplishing in the one all-absorbing undertaking of the present time. It is expected that complete details will be given in THE JOURNAL for November, together with abstracts of the papers.

Women's Auxiliary of the A. S. M. E.

The organization meeting of the Women's Auxiliary of the A.S.M.E. was held at Society headquarters on September 20, at the call of Mrs. Charles E. Davis, whom President Main had appointed as representing this Society at the invitation of the Council of Organizations for War Service. The families of all local members were invited, and formed an enthusiastic gathering. The meeting was addressed by Miss Esther Lape, Secretary to the Section on Aliens of the Council of Organizations for War Service, who told the ladies of the work to be done in the War Information Centers of the city.

It was voted to organize under the following officers: Mrs. Charles E. Davis, Chairman; Mrs. E. J. Prindle, Vice Chairman, and Mrs. Jesse M. Smith, Secretary.

The Committee plans to circularize the ladies shortly for volunteer service along these lines.

Commission to Standardize Screw Threads

The Act recently passed by Congress for the appointment of the Commission to Standardize Screw Threads is now a law and is being carried out, and it is expected that within a few days Secretary Redfield will have officially announced the names of the members of the Commission.

An informal organization meeting was held recently in Washington in which extensive preparations were made for carrying out this important standardization work. Manufacturers of every kind of screw thread, no matter for what purpose, whether they be screws for use on battleships, in rolling mills, machine tools, looms or surgical instruments, typewriters, etc., will be requested to furnish the Commission, whose headquarters will be at the Bureau of Standards, Washington, with complete information as to the type of thread they are using. It is particularly desired that they list each size manufactured, stating the pitches, system and form of thread, the tolerances, nomenclature, the gages in use and the methods of testing and gaging.

This information will be carefully collated by the Secretary to the Commission, and all manufacturers and others interested will be invited to appear before the Commission in order that their particular form of product may have proper consideration.

The Commission is arranging a series of meetings in Washington, D. C., and in other parts of the country, at which all manufacturers will have an opportunity for a hearing.

A questionnaire is to be sent out at once, and manufacturers who for any reason fail to receive a copy should apply immediately, addressing the Secretary of the Screw Thread Commission, Bureau of Standards, Washington, D. C

New Volume of Transactions

Volume 39 of Transactions is now being issued to the membership. It contains an account of the activities of the Society for 1917, the year in which the United States entered the great war. The volume includes the papers and addresses given at the Spring and Annual Meetings and a selection of papers presented at meetings of the Local Sections. Inevitably many of these relate to problems with which engineers are concerned in the prosecution of the war and to which, with patriotic devotion, they are giving their undivided thought and attention.

At the beginning of the war this Society, in common with many others, tendered its services to the President of the United States. The offer was promptly accepted to the great satisfaction of the membership, and as the needs of the Government have grown the Society has responded to the many requests which have come to it.

Individually, also, the members have heeded the call and are serving in almost every department of the Government, abroad at the front, at the Nation's Capital, in arsenals, navy yards, shipyards, aviation fields, etc., and in the industries of the country engaged in munitions manufacture. The earnest and helpful spirit resulting from these many points of contact is reflected in the pages of this volume.

Eighth Volume of Condensed Catalogues

The eighth annual volume of the A. S. M. E. Condensed Catalogues is now coming from the press and it is with much pleasure that the Society records a further considerable gain in size and comprehensiveness of this useful volume.

Four hundred and fifteen firms, including a majority of the leading manufacturers in their respective lines, are represented by publication of catalogue data. The General Mechanical Equipment Directory, in which all eligible manufacturers are entitled to listing of their products free of charge within reasonable limits and irrespective of the use of space, has also been extended and improved and it is believed that this reference feature will prove of even greater value than heretofore. The Engineering Data Section contains, in addition to the usual material, a complete list of Transactions papers beginning with the first volume issued in 1880.

U. S. Navy Needs Steam Engineers

The urgent demand for engineers to man the supply and cargo ships of the U. S. Navy has forced the Navy Department to redouble its efforts for obtaining men adapted for this service. It is fully realized that there are many men at the present time who are anxious to join the service, but do not know where they fit in. The U. S. Navy Steam Engineering School at Hoboken, N. J., is giving a five-months' course in steam engineering to those men who are able to qualify. It has been found that those men who have either a mechanical or electrical engineering degree or have pursued these courses, and have not graduated, but have had sufficient practical training, constitute excellent material. Many men who are not technical graduates, but have had practical experience covering a number of years have also qualified.

Through arrangement with the War Department the Navy will be permitted to induct, individually, through its local board, a given quota of men, who have special qualifications. Application for this school should be sent to Ensign C. L. McIntyre, 225 West 42nd St., New York City.

Committee on Aims and Development

The Council, at its meeting on September 20, authorized a Committee on Aims and Organization to discuss and formulate aims of the Society in the light of modern development and present-day thought, and to assist toward finding a method of coöperation with the rest of the engineering profession suitable to carry out these aims. The Committee is being appointed by the President, and consists of one delegate from each of the Local Sections, and a number of members-at-large selected by the President. It is planned to hold a general meeting of the Committee in Indianapolis, October 24-26, coincidentally with the meeting of the Council and of the Mid-Western Sections in that city, and the President will appoint an Executive Committee from the general committee to lay out the program of work.

CHAIRMEN OF STANDING COMMITTEES OF ADMINISTRATION NOW MEMBERS OF THE COUNCIL

In accordance with the amendment to C 15 of the Constitution, which became effective at the last Spring Meeting, the Standing Committees of Administration now consist of the following: Finance, Meetings and Program, Publications and Papers, Membership, Local Sections and Constitution and By-Laws. The appointment, organization, duties and terms of service of these committees are to be designated by the By-Laws.

An important feature of the amendment is that the chairman of each of the Standing Committees of Administration shall have a seat in the Council of the Society, although they have no vote. At the Council meeting held last month, these chairmen were, for the first time, privileged to take part in the proceedings in their new capacity as committee representatives.

This is an important step in the Society's development. It assures that those who are directing its fundamental activities will meet together once a month with the other members of the Council and there present for consideration the important interests which they represent. It will undoubtedly facilitate the prompt transaction of business and enhance the coördination of effort which is so essential in a large organization.

In view of the initiation of this forward step at the present time, we are pleased to publish in this number of The Journal the portraits of the several chairmen. Four of these chairmen become new members of the Council, one of these, however, Mr. Jesse M. Smith, Past-President of the Society, having previously had long service as a Council member. The other two committee chairmen, Mr. R. M. Dixon of the Finance Committee, and Mr. D. Robert Yarnall of the Sections Committee, were already Council members.

Robert M. Dixon
Finance

L. P. Alford
Meetings and Program

George A. Orrok
Publications and Papers

Hosea Webster
Membership

D. Robert Yarnall
Sections

Jesse M. Smith
Constitution and By-Laws

Coöperation Between the A.S.M.E. and the War Industries Board

One of the important recent activities of the Society has been the work of its War Industries Readjustment Committee and its Regional Representatives in aiding manufacturers throughout the country in the adaptation of their plants to the production of war material, as outlined in The Journal for August 1918, page 695.

This matter originally came up at a meeting of the New York Local Section on non-essential industries held last February, after which a committee was appointed to investigate and report. This led to the appointment of a permanent committee in June, consisting of G. K. Parsons, *Chairman*, Erik V. Oberg and Fred A. Scheffler.

Later, this work was taken up on a broad scale by the War Industries Board of the U. S. Government, through its Resources and Conversion Section, of which Mr. Charles A. Otis is chief. A War Resources Committee and a Regional Advisor were appointed by the Government in each of 20 sections, or regions, of the United States for the purpose of organizing the various lines of trade in the different regions.

As soon as this plan was announced, our President, Mr. Charles T. Main, immediately appointed a Regional Representative of the Society in each of these 20 regions to coöperate with the War Resources Committees and the Regional Advisors of the Government.

In this connection it will be of interest to describe what has been done by our War Industries Readjustment Committee, the chairman of which, Mr. G. K. Parsons, is Regional Representative in Region No. 3 (New York), in coöperation with the local Regional Advisor of the Government in this region, Mr. William F. Morgan. This committee of the Society has been called upon to make a number of industrial surveys for Mr. Morgan for a number of different purposes, such as:

1 To determine the wisdom of the Government's letting contracts for certain munitions to particular manufacturers.

2 To determine whether the essentiality of the products of a certain corporation, together with its probable future requirements, were sufficient reason to warrant permitting it to increase its capital stock.

3 To determine the fitness of certain plants for the manufacture of products which had never been manufactured there before, and the ability of the prospective management to establish the essential industry in question.

4 A study of various industries to determine what sort of essential work they can best be adapted to.

The foregoing illustrates, not only to our regional representatives, but to others, how our members can best render assistance in this work. A plant which can take on war work, as well as those plants which are overburdened with war work and would like the assistance of some other plant on part of its work, should notify either the Regional Advisor of the Government, or the Regional Representative of the Society, whose headquarters are nearest at hand.

When a manufacturer notifies the Regional Advisor of the War Industries Board that he is in a position to accept orders for war work he should be prepared to state specifically just what class of articles he can manufacture and the rate of production. Also in certain instances it will be advisable for the manufacturer to state the number and class of help employed, the number, size and type of machines which the plant contains.

Following is a list of the Regional Advisors of the War Industries Board and of our Regional Representatives:

Regional Representatives

War Industries Readjustment Committee

Boston, A. C. Ashton, 33 Columbus Ave., Somerville, Mass.
Bridgeport, Harry E. Harris, Post Office Box 852.
New York City, G. K. Parsons, 29 Pine St.
Philadelphia, C. N. Lauer, Day & Zimmermann.
Pittsburgh, J. M. Graves, 435 Sixth Ave.
Rochester, Ivar Lundgaard, 208 Culver Rd.
Cleveland, F. H. Vose, 3203 Whitehorne Rd., Euclid Heights.
Detroit, E. J. Burdick, 511 Seminole Ave.
Chicago, A. D. Bailey, 21 Elmwood Ave., LaGrange, Ill.
Cincinnati, Fred A. Geier, 2301 Grandview Ave., E. W. H.
Baltimore, Wm. W. Varney, 710 North Carey St.
Atlanta, Robert Gregg, 960 Ponce de Leon.
Birmingham, W. P. Caine, Tenn. Coal, Iron & R. R. Co., Ensley, Ala.
Kansas City, J. L. Harrington, Rockhill Manor.
St. Louis, R. L. Radcliffe, 701 Laclede Gas Bldg.
Milwaukee, W. M. White, 747 Summit Ave.
San Francisco, B. F. Raber, 2027 Delaware St., Berkeley, Cal.
Dallas, A. C. Scott, Scott Engineering Co.
Seattle, R. M. Dyer, Puget Sound Bridge & Dredging Co.
St. Paul, Oliver Crosby, 63 S. Robert St.

Regional Advisors

War Industries Board

Boston, Stuart W. Webb, Chamber of Commerce.
Bridgeport, B. D. Pierce, Jr., 1st Bridgeport Nat'l. Bank Bldg.
New York, Wm. F. Morgan, Merchants Assn. of New York.
Philadelphia, Ernest T. Trigg, 1228 Widener Bldg.
Pittsburgh, Geo. S. Oliver, Chamber of Commerce.
Rochester, E. A. Fletcher, Chamber of Commerce.
Cleveland, W. B. McAllister, Chamber of Commerce.
Detroit, Allan A. Templeton, Detroit Board of Commerce.
Chicago, D. E. Felt, 29 S. LaSalle St.
Cincinnati, Edwin C. Gibbs, 31 E. 4th St.
Baltimore, S. F. Shavannes, Merchants & Mfrs. Assn.
Atlanta, Edw. H. Inman, Chamber of Commerce.
Birmingham, T. H. Aldrich, 322 Brown-Marx Bldg.
Kansas City, Franklin D. Crabbs, 10th & Central Sts.
St. Louis, Jackson Johnson, 510 Locust St.
St. Paul, D. R. Cotton, 1414 Pioneer Bldg.
Milwaukee, August H. Vogel, 4th Floor, City Hall.
Dallas, Louis Lipsitz, 407-9 Southland Life Bldg.
San Francisco, Frederick J. Koster, Chamber of Commerce.
Seattle, Herbert Witherspoon, Chamber of Commerce.

Resolutions by Committee on Public Relations

The following resolutions of the Public Relations Committee of the Society, Dr. F. H. Newell, *Chairman*, constitute a progress report of the committee and offer a constructive statement regarding the status of the engineer in public affairs—his obligations to the public and his opportunity for leadership:

1 The object of this Committee is to give special attention to those matters not specifically covered by the work of other Committees and which have to do with the larger relations of the Society and of its members to the public.

2 Because these relations have not been kept continuously prominent nor widely emphasized, there has been more or less misapprehension on the part of the public as to the work of the Society and of its members, especially in larger affairs of general concern. It is obviously the duty of this Committee to do what it can to improve this understanding.

3 In the rapid evolution of affairs, the engineer as a man and citizen, in order to hold his proper position relative to other professions and callings and to do his part, must be continually alert in keeping the public aware of the fact that the great work of war and of peace is that of the engineer and that in this he should be a leader. In order to fully employ his ability he must enjoy a proper appreciation and be free from the limitations which may be imposed by others who do not possess a wide view of engineering achievements and possibilities.

4 While it is realized that there must be radical changes in the education of the engineer to enable him in the future to fill the requirements of larger leadership, yet at the present time much can be accomplished by the present organizations devoting time and energy to progress in other than purely technical lines. The engineering society to meet present conditions should seek advance in those matters which aid the engineer in being more effective, outside as well as inside his purely technical occupations.

5 In seeking such advance it is practical to learn from other associations of educated men holding similar high ideals and which

have worked out practical methods for achieving result such for example as the Architects, the Commercial Clubs, the Doctors and Lawyers.

6 There is need of a well-considered scientific study of the ways which have been found advantageous by such organizations and a comparison of their methods and conditions with those of the mechanical engineer.

7 Growing out of such study should be the development of a carefully considered plan designed to put the engineer in the best possible relation with the public, not directly for private gain or gratification, but in order that each man may perform his largest functions for the benefit of society and that he may fulfill more completely the duties which come to him because of the fact that he has been educated partly at public expense and as an educated man has superior obligations to the world about him.

8 Following such study should be an awakening of the membership to the fact that the engineer as a man can and should occupy a position of wider initiative and leadership in public affairs. This can best be done by a carefully-thought-out series of papers on the subject.

9 At the same time the public should be educated to an appreciation of the fact that the engineer can and should perform still larger functions with corresponding benefit in increased comfort, health and prosperity of the community.

10 Organized effort should be made to anticipate action by officials in appointments to places of responsibility which because of the nature of the work should be filled by engineers. It should be made difficult, if not impossible, for the position of director or superintendent of public works and construction to be filled by other than men having an engineering education and experience.

11 There should be facilities provided for exchange of ideals and experience among engineers in the public employ, giving them the information and moral support in their efforts for higher public service.

12 While any betterment in the status of the engineer in the long run will redound to the benefit of the public, the profession should constantly be reminded that its position in the community will be conditioned largely by what it does for the public. In striving toward any widening of influence in American life our dependence must be on actual service rather than on any demand for recognition, no matter how logical.

ALL SHOULD COME TO INDIANAPOLIS

October 25 and 26

By the time this issue of The Journal is in the hands of the members the final program of the big joint meeting of the Mid-Western Sections, to be held in Indianapolis on October 25 and 26, in connection with the Council meeting there, will have been completed. As now determined, the event at Indianapolis comprises the Council meeting on Friday morning, the joint meeting of the Indianapolis, Cincinnati, St. Louis, Chicago, Milwaukee, Detroit, and, it is hoped, Cleveland Sections, together with a meeting of the new Committee on Development of the Society, and a meeting of the Fuel Conservation Committee of the Engineering Council. The Indiana Engineering Society, the Indianapolis-Lafayette section of the American Institute of Electrical Engineers and the Indianapolis section of the Society of Automotive Engineers have also been invited to participate.

The Indianapolis Committee is in charge of the arrangements. This committee comprises:

Lawrence W. Wallace, Chairman, Asst. General Manager, Diamond Chain & Mfg. Co.

W. A. Hanley, Vice-Chairman, Chief Engineer, Eli Lilly & Co.

B. G. Mering, Treasurer, Industrial Engineer, American National Bank Bldg.

Charles Brossman, *Secretary*, Consulting Engineer, 1616 Masons' Bank Building.

Gilbert A. Young, head of M. E. Department, Purdue University, Lafayette, Ind.

F. C. Wagner, Professor Mechanical and Electrical Engineering, Rose Polytechnic Institute, Terre Haute, Ind.

The Local Committee will be glad to furnish any one information on transportation to Indianapolis, and will secure hotel accommodations, arrange to meet visitors at the trains upon notification, etc.

Headquarters

The headquarters of the meeting will be the Claypool Hotel, where also the two professional sessions scheduled and the committee meetings will be held. While the hotel has ample accommodations for a large number of guests, and while no overcrowding is anticipated at this season of the year, members intending to go to Indianapolis should get in touch with the Local Committee and ask them to secure reservations for them in advance. The Local Committee intends to immediately issue to all members information on the cost of accommodations, on transportation, and also a copy of the final program.

Program

As determined at the time of going to press with The Journal, the program is as follows:

Friday, October 25

9:30 a. m. Registration at Claypool Hotel.

9:30 a. m. Meeting of the Council.

11:30 a. m. Meeting of the Committee on Local Sections and members of the Executive Committees of the Mid-Western sections.

12:30 p. m. Informal luncheon at the Claypool. The Mayor of Indianapolis is confidently expected to welcome the visitors and President Main to respond.

2:00 p. m. Symposium on Fuel Conservation:

An Explanation of the Regulations of the Fuel Administration, by Dr. P. B. Noyes, Director of Coal Conservation, U. S. Fuel Administration.

What the Fuel Administration Expects of the Engineers, by David Moffat Myers, Advisory Engineer, U. S. Fuel Administration.

Discussion, in which the Administrative Engineers of the Fuel Administration and members of the Society will participate.

6:30 p. m. Informal dinner, at which nominee for President M. E. Cooley, is expected to speak, followed by war pictures.

Saturday, October 26

9:00 a. m. Symposium on Research.

Opening address by Professor Walter Rautenstrauch, member of the Society's Committee on Research.

Address by Dr. W. J. Lester, Vice-Chairman of the Mechanical Engineering Division of the National Research Council.

Discussion by members of the Society.

11:30 a. m. Exhibition of the Liberty Motor.

12:30 a. m. Informal luncheon at place arranged by the Local Committee. Members and guests will be conducted in automobiles.

The afternoon will be free for excursions, and the local committee is making arrangements to be announced.

The Local Committee hopes to arrange for members to visit both the Columbia Club, the features and functions of which are so unique as to call attention to it all over the country, and the Canoe Club, which has a large membership of professional and business men, and a splendidly equipped building.

Committee Meetings

Committee meetings other than the ones listed on this program include a meeting of the new Committee on Development, which is a committee appointed by the President and confirmed by the Council to inquire into the aims and activities of the Society in a similar manner to the committees of the Civil Engineers and the Mining Engineers. This committee consists of delegates from each of the Local Sections and members at large appointed by the President, and it is expected that the entire committee will be present at the Indianapolis meeting. The meeting of this Committee will, it is hoped, commence on Thursday afternoon and continue throughout the whole time at Indianapolis.

The Fuel Conservation Committee of the Engineering Council, which is connected with the Bureau of Mines and with the Fuel Administrator and is studying and devising problems of fuel utilization, especially coal, will meet at a time and place to be determined.

Let Every Nearby Member Attend

The Committee on Local Sections and the Local Committee of the Indianapolis Section assure all members who go to this meeting and who bring their friends, a profitable and enjoyable time. Special arrangements will be made to take care of visiting ladies and no pains will be spared to make this meeting, which is the first of a series of joint meetings planned by the Sections Committee, an occasion of benefit. The period of the meeting is planned so that members who attend will be inconvenienced in their work as little as possible. They will be able to get in four days' work in the week and spend the week-end in Indianapolis.

Indianapolis is the largest inland city on the American continent and one of the most important railroad centers in the country. It is also one of the handsomest cities and one of the most prosperous and progressive. Its growth has been practically that of two decades. It is the commercial, social, educational, political and governmental center of Indiana and is more typically the capital of a state than any other like city in the country. It is situated 60 miles from the center of population of the United States, and is within the geographical center of manufacturing. The city has more than 1200 factories; in the output of automobiles it is the second city in the country.

AMONG THE SECTIONS

Cleveland Section

At the September meeting of the Council the petition of the members of the Society residing in Cleveland for a Local Section in that vicinity, duly passed by the Committee on Local Sections, was approved. This new Section comprises the towns or cities of Akron, Barberton, Bedford, Chardon, Cleveland, Cuyahoga Falls, East Cleveland, Elyria, Hudson, Kent, Lakewood, Lorain, Massillon, Quarryville, Ravenna, Sandusky, South Euclid, Wickliffe, Willoughby, and Wooster, totaling a Society membership of approximately two hundred and sixty at the present time, the sixth largest in the country.

The new Section comes into being as the mechanical-engineering section of the Cleveland Engineering Society, organized in 1891 and now comprising a membership of approximately a thousand, and known throughout the country as one of the most active and influential local organizations of engineers. The national societies of Civil Engineers, Electrical Engineers and Automotive Engineers all have organized groups in Cleveland, so that opportunities for coöperation and coördination of activities are manifold.

Many of the officers and prominent members of the Cleveland Engineering Society are also included in our own membership, notably R. I. Clegg, Prof. F. H. Vose, Col. E. H. Whitlock, F. L. Sessions, F. W. Ballard, A. H. Bates, H. C. Hale, A. G. McKee, and J. H. Stratton. In addition to the liaison members, there are C. E. Drayer, George S. Black and W. O. Henderer of the C. E. S.; and Ambrose Swasey, Worcester R. Warner, S. T. Wellman (past officers of the Society), G. E. Merryweather and R. H. Danforth. Upon the abilities of these gentlemen we may count to realize to the fullest extent the enthusiasm in coöperative service for the greatest good.

It is hoped that papers presented at the proposed joint meetings in Cleveland may be published simultaneously in the *Journal* of the Cleveland Engineering Society and our own Journal, with mutual benefit. This *Journal* is a noteworthy feature of the local organization, having achieved wide repute in the field of technical periodicals.

The Cleveland spirit portends a growing enthusiasm in other localities, as the Society is intensely interested in spreading the movement to establish Sections which shall take an active part in the work of the local organizations in their districts.

New Officers of Sections

The following members of Executive Committees for the fiscal year 1918-1919 have been recorded by the Committee on Local Sections:

Atlanta: Robert Gregg, Chairman; William J. Neville, Secretary; H. J. Hinchey, C. P. Poole, Earl F. Scott.

Baltimore: A. E. Walden, Chairman; William L. De Baufre, Vice-Chairman; A. G. Christie, Secretary-Treasurer; W. W. Varney, J. C. Smallwood.

Birmingham: W. P. Caine, Chairman; Paul Wright, Vice-Chairman, James W. Moore, Secretary; H. M. Gassman, W. Lee Roueche.

Boston: W. G. Starkweather, Chairman; Elmer Smith, Secretary; A. C. Ashton, Treasurer; W. W. Crosby, George P. Aborn, Edward M. Jennings.

Buffalo: H. B. Alverson, Chairman; H. P. Parrock, Vice-Chairman; W. W. Boyd, Secretary; F. W. Bailey, Kester Barr.

Chicago: C. E. Lord, Chairman; P. A. Poppenhusen, Vice-Chairman; A. L. Rice, Secretary; Robert Quayle, J. J. Merrill.

Cincinnati: George W. Galbraith, Chairman; E. A. Muller, Vice-Chairman; J. T. Faig, Secretary-Treasurer; A. L. Jenkins, H. M. Norris.

Connecticut: To be announced.

Bridgeport Branch: E. L. Fletcher, Chairman; Arthur Brewer, Vice-Chairman; J. C. Kingsbury, Treasurer; C. F. MacGill, Secretary; J. Coulter, H. E. Wells.

Hartford Branch: Charles S. Blake, Chairman; Frank E. Howard, Vice-Chairman; M. D. Church, Secretary-Treasurer; C. L. Grohmann, B. M. V. Hanson, W. H. Honiss, S. F. Jeter, H. P. Maxim, C. H. Veeder.

Meriden Branch: C. K. Decherd, Chairman; C. N. [illegible], Jr., Secretary-Treasurer; F. L. Rowntree, J. A. Hutchinson, F. L. Wood.

New Haven Branch: J. A. Norcross, Chairman; E. H. Lockwood, Secretary; S. H. Barnum 2d, A. C. Jewett, F. L. Mackintosh, E. Pugsley.

Waterbury Branch: To be announced.

Detroit: E. C. Fisher, Chairman; E. J. Burdick, Vice-Chairman; F. H. Mason, Secretary-Treasurer; J. C. McCabe, E. J. Frost.

Erie: M. W. Sherwood, Chairman; C. M. Spalding, Vice-Chairman; R. Conrader, Treasurer; J. St. Lawrence, Secretary.

Indianapolis: L. W. Wallace, Chairman; W. A. Hanley, Vice-Chairman; B. G. Mering, Treasurer; Charles Brossman, Secretary; Gilbert A. Young, F. C. Wagner.

Los Angeles: Charles H. McGwire, Chairman; T. J. Royer, Secretary; Charles Burnham, Fred J. Fischer, J. A. Wintroath.

Milwaukee: W. M. White, Chairman; F. H. Dorner, Secretary; L. H. Strothman, W. Hutchens, M. A. Beck.

Minnesota: J. A. Teach, Chairman; R. B. Whitacre, Vice-Chairman; Ray Mayhew, Secretary-Treasurer; H. LeRoy Brink, J. V. Martenis.

New Orleans: H. L. Hutson, Chairman; E. W. Carr, Jr., Secretary-Treasurer; R. T. Burwell, W. E. Moses, J. S. Barelli.

New York: W. W. Macon, Chairman; H. D. Egbert, Secretary; S. M. Marshall, A. J. Baldwin, G. K. Parsons, W. C. Brinton.

Ontario: R. W. Angus, Chairman; C. B. Hamilton, Secretary; James Milne, J. H. Billings, G. V. Ahara.

Philadelphia: C. N. Lauer, Chairman; J. P. Mudd, Secretary; H. B. Taylor, L. F. Moody, W. B. Murphy, L. H. Kenney.

St. Louis: Lewis Gustafson, Chairman; J. P. Morrison, Secretary; George B. Evans, H. R. Setz, R. L. Radcliffe.

San Francisco: E. C. Jones, Chairman; Elgin Stoddard, Vice-Chairman; George L. Hurst, Secretary; H. S. Markey, J. H. Hopps.

Worcester: E. C. Mayo, Chairman; George N. Jeppson, Albert W. Darling, H. P. Fairfield, George E. Williamson, Frederick Fosdick.

BIRMINGHAM

September 9. An organization and business meeting was held in the Tutwiler Hotel. An open meeting for the latter part of October was decided upon.

James W. Moore,
Corresponding Secretary.

CHICAGO

A joint meeting of the Chicago Section of the A.I.E.E. and the War Committee of Technical Societies of Chicago was held on September 23. Col. P. Junkersfeld, Mem. Am. Soc. M. E., addressed the meeting on the subject of Emergency Conservation for the War Department in the U. S. The lecture was fully illustrated.

Joseph Harrington, Mem. Am. Soc. M. E., Fuel Administrative Engineer for the State of Illinois, and Dr. H. M. Nichols, Mem. Am. Soc. M. E., secretary of the Chicago Section of the A.S.M.E., spoke at the dinner given to Mr. C. E. Drayer, the new secretary of the American Association of Engineers, at the City Club on September 4.

Arthur L. Rice,
Corresponding Secretary.

DETROIT

The opening meeting of the season of the Detroit Engineering Society was held on September 6. H. H. Esselstyn, Mem. Am. Soc. M. E., addressed the meeting on the Hog Island Shipyard.

September 20. The Detroit Engineering Society held a meeting in the Detroit Board of Commerce, which was addressed by Professor Henry S. Jacoby, on the subject of Recent Progress in Bridge Construction.

F. H. Mason,
Corresponding Secretary.

CONNECTICUT

Bridgeport Branch

September 9. Through the courtesy of the Bridgeport Chamber of Commerce all members of the Bridgeport Branch were invited to a luncheon at the Stratfield Hotel, where a talk was given by Charles A. Otis, Chief of the Section on Resources and Conversion, War Industries Board, the subject being Industry and the War.

E. L. Fletcher,
Chairman.

MILWAUKEE

September 11. The Engineers' Society of Milwaukee held a meeting in the City Club, at which E. R. Shepard, Associate Electrical Engineer of the United States Bureau of Standards, gave an illustrated talk on The Work of the Bureau of Standards, With Special Reference to Local Electrolysis Surveys. The meeting was preceded by a subscription dinner at the Club.

Fred H. Dorner,
Secretary, Engineers' Society of Milwaukee.

MINNESOTA

September 3. An organization meeting was held at the Midway Branch of the St. Paul Association of Commerce. Arrangements have been made to hold regular meetings in the clubrooms the first Monday of each month.

Ray Mayhew,
Corresponding Secretary.

NEW YORK

September 17. Marcel Knecht, member of the French High Commission in the United States, addressed a meeting at the Engineering Societies' Building, to which members of the other national societies were specially invited. The subject of the address was The Supreme Effort of the French War Industries—Franco-American Industrial Coöperation During and After the War. Brigadier-General L. B. Kenyon, of the British War Mission, recently returned from a trip to the front, told of his experiences, including his observations of salvaging work and machine and repair shops. He discussed particularly the necessity, even yet not thoroughly appreciated, for precision work in manufacturing ordnance.

H. D. Egbert,
Corresponding Secretary.

PHILADELPHIA

August 14. An organization meeting was held in the Engineers' Club, at which meetings were planned for each month, through May. The Section has also appointed several sub-committees on research, membership, public relations, organization, papers, meetings and boundary of the territory to comprise the Section.

John P. Mudd,
Corresponding Secretary.

SAN FRANCISCO

A joint council of the engineering societies of San Francisco, including the A.S.C.E., the A.I.E.E., the A.S.M.E., the A.I.M.E. and A.C.S., has been organized with C. D. Marx as chairman, E. C. Jones and E. C. Hutchinson, vice-chairmen, N. A. Bowers, secretary, and E. O. Shrave, assistant secretary.

The organization is the outcome of several meetings at which plans for more effective coöperation between societies have been worked out. Some of the expected changes are a closer touch among the members of the several associations, putting the several employment bureaus together in one central office, holding joint meetings to discuss subjects of common interest, coöperating in mailing notices for the sake of economy and consolidating headquarters at the Engineers' Club.

The first act of the joint council was the decision to urge upon the Governor of California the appointment of an engineer as member of the State Railroad Commission, which would "be regarded by the state as indicating a wish to place the public service on the highest plane of efficiency and would be creditable both to the appointing power and to the engineering profession."

George L. Hurst,
Corresponding Secretary.

NECROLOGY

GEORGE WILLIAM DICKIE.

A Tribute by C. E. Grunsky[1]

Those who knew Mr. George W. Dickie mourn with his family. His death has removed from the engineering profession a man of rare attainments and attractive personality whose achievements in his life work of shipbuilding and whose writings on related subjects have given him an international reputation.

When in the Spanish-American war the *Oregon* of the United States Navy made that famous dash around South America from Pacific Coast waters to the Caribbean Sea, he became known in every household of this country as the "Builder of the *Oregon*."

He was called to his final rest on August 17, without warning and while still remarkably vigorous in mind and body and actively engaged in the service of the United States as Chief Inspector at the Moore and Scott Shipbuilding Yards, Oakland, California.

George W. Dickie

Having known Mr. Dickie for over thirty years and being deeply appreciative of his human qualities, I may be permitted a few words relating to his character and his professional standing without attempting a complete review of his achievements. No one ever came into close contact with Mr. Dickie whether socially, professionally, or in business without profiting by such contact. His personality was an inspiration. Always kindly and helpful and absolutely fair in his dealings with his fellow-men, he could claim the confidence, respect and esteem alike of those whose industrial affairs he directed and those who worked under him. This varied and long experience and his contact with affairs and with men of prominence from all parts of the world and a habit of close observation coupled with a retentive mind and a happy faculty of expression made Mr. Dickie a most charming companion and an entertaining writer. As related by him with a flavor of Scotch humor, the simple story of how as a boy upon the suggestion of his schoolmaster, who spent much time on scientific work, he acquired the necessary lenses and built himself a telescope to view a comet then in the sky, and how at a penny a look he turned its construction to financial profit, is not alone a delightful reminiscence but a forecast of his later connection with the installation of the great Lick telescope on Mt. Hamilton, for which he designed and built the dome in which it is housed.

Mr. Dickie was born in Arbroath, Scotland, on July 17, 1844. He came to the United States with his parents in 1869 and in the same year reached San Francisco. Very soon after his arrival here he had an opportunity of showing his confidence in his ability to do well any problem of mechanical construction that was presented. Answering an advertisement for some one skilled in the construction of a gas plant, he was employed to erect one at North Beach. By following the usual practice of benefiting by the experience of others as related in professional papers and particularly by reference to the details of a gas plant recently completed in an English city and well described in a Scotch journal, the work was carried to successful completion.

Soon thereafter a mechanical engineer to design marine engines was wanted—possibly at the Risdon Iron Works, San Francisco, but the place does not matter—and Mr. Dickie presented himself. "You will not do," he was told, "we need a mechanical engineer and you are a gas engineer." Thereupon he confessed that his attainments were all along the lines of mechanical engineering, he having served his apprenticeship in a railroad engineering shop in Scotland with special attention to locomotive construction. He was thereupon or soon after employed at the Risdon Iron Works where his work took a wide range. [He designed the first successful triple-expansion engine ever built in the United States, and within a few years had made himself famous by designing the first Scotch marine boiler on the Pacific Coast and also the first successful compound steam engine. Several of the latter are still in operation, notably those on the old steamers *Santa Cruz* and *Gypsy*.] On one occasion he secured for his firm a large contract for mining machinery, making a proposition which was accepted as against another proposal by Mr. Irving M. Scott, of the Union Iron Works. This kind of successful competition was not to Mr. Scott's liking and resulted in his making an offer to Mr. Dickie, which was accepted. He thus became a member of the staff of a concern in which he had ample opportunity to apply his constructive genius. He was manager of the Union Iron Works from 1883 to 1905 [and during that period designed many privately owned ships, in addition to the following vessels for the Government: Battleships *Oregon*, *Wisconsin* and *Ohio*; the cruiser *Olympia*, later the flagship of Admiral Dewey; the cruisers *South Dakota*, *San Diego*, *Charleston* and *Milwaukee*, the gunboat *Wheeling* and destroyers *Paul Jones*, *Preble* and *Perry*.]

As a narrator of his personal experiences he was unique. He knew how to present them in a humorous vein and with a lesson nicely turned. And he was always ready, when opportunity was presented, to let others have the benefit of this fund of experiences which seemed inexhaustible. How effectively he could make his point appears from the following which happens to be before me. After returning from the Columbian Exposition at Chicago in 1893, he told the Technical Society of the Pacific Coast of his impressions and in the course of his remarks, to drive home the fact that local conditions must be duly weighed, he related the following occurrence:

"One day at the engineering congress in discussing a paper on river-steamboat construction I was endeavoring to point out the advantage of compounding stern-wheel engines, recommending tandem compounds on each side, either condensing or non-condensing, when the author of the paper remarked that first cost was the most important consideration in the construction of a western river steamboat, efficiency or durability being of secondary importance. 'But,' said I, 'the everyday expense of running must

[1] Mem.Am.Soc.C.E.; President, American Engineering Corporatiton, San Francisco, Cal. [Certain slight additions, in brackets, have been made to Mr. Grunsky's sixth paragraph.—Editor.]

be an important matter especially where transportation is effected so cheaply. 'Why,' said the author of the paper, 'I am afraid that the gentleman from the Pacific Coast has had but a small experience with western river practice. As an example of economy let me give you an instance of a freight stern wheeler in my district that made her daily runs for the last season of eight months on a total expense of \$2.25 for fuel, and this expense was caused by the carelessness of the crew one night in not securing wood enough for the next day's run, necessitating the captain's buying enough to last until dark, as his method of taking on fuel would not work in daylight. In this case what would be the advantage of compounding?'"

That Mr. Dickie had an eye to the esthetic even in the design of the engine or other machinery, can hardly be better expressed than in his own words:

"I am often told that the useful only should be retained in any design. That is true, but who can say what is useful? Your best poet says:

'Nothing useless is or low,
Each thing in its place is best;
And what seems but idle show
Strengthens and supports the rest.'"

And then, after referring to several illustrations, he asks the question: "In regard to our other surroundings, we are not satisfied with the bare necessities of existence, and why should we be so in mechanics?"

And so we find, too, that Mr. Dickie was a great lover of books and took much pleasure in collecting rare volumes. It was quite pathetic to hear him tell how his valued collection was destroyed in the San Francisco earthquake and fire of 1906. At that time Mr. Dickie was in the East supervising the construction of ships that were being built from his designs. The collection of rare books had been boxed and deposited for safe keeping at Mr. Dickie's office in San Francisco, where they were reached by the fire and destroyed. Had they been left at the Dickie home in San Mateo, they would have been preserved. A year later there came from England an agent of a dealer in rare books commissioned to purchase from Mr. Dickie certain rare volumes which it was known were in his collection. He was prepared to pay some thousands of dollars, and, like Mr. Dickie, was distressed when he learned that the trade could not be made because the books no longer existed.

Mr. Dickie wrote many papers bearing upon marine architecture and engineering, and also on matters relating to the American merchant marine. He was recognized as an authority on such matters and was widely quoted. He was thoroughly imbued with American ideals and was ever ready to serve this country to the limit of his ability. Immediately on the outbreak of the war he offered his services to the U. S. Government. His fertile brain was active and he sent on a number of propositions dealing with the protection of allied shipping against attacks by submarines. He was appointed chief inspector for the Government at the Moore and Scott Shipbuilding Works as already stated, and despite his 71 years was rendering most efficient service when the last call came.

He possessed in a high degree the best character traits of the Scotchman. An idea of his probity and fairness to his fellowmen will appear from the following circumstance related to the writer some months ago. Mr. Dickie had some time in the seventies loaned a few hundred dollars to a stranded Canadian who gave his note for the loan and left as a pledge certain shares of stock of no market value in mines located on the Comstock Lode. Neither interest nor capital were repaid. The note outlawed. Meanwhile the Comstock properties came into prominence, the value of stock was soaring, and one day it occurred to Mr. Dickie to take the stock which he held to the Nevada Bank to ascertain whether it had any value. When he was told that it was worth \$75,000 he was so taken by surprise that his knees came near giving away and he with difficulty withdrew from the bank. The stock was at once sent to the former owner, from whom, despite a fair offer, Mr. Dickie would accept nothing but a repayment of the loan and interest.

Mr. Dickie has been a useful man in the community. He had the esteem and love of those who knew him. He has left a place which none other can fill.

Mr. Dickie became a member of our Society in 1892. From 1895 to 1898 he held the office of Manager of the Society. He was also a life member of the Technical Society of the Pacific Coast, and a member of the California Academy of Sciences and the American Society of Naval Engineers.

ADOLPH FABER DU FAUR

Adolph Faber du Faur was born on March 27, 1826, in Wasseralfingen, Württemberg. After his preparatory education he entered the University of Tübingen, and upon graduation was employed for a year in Belgium at the Cockerill works. He was then appointed as assistant to his father, Wilhelm von Faber du Faur, who was permanent director of the government iron works in Wasseralfingen, and under whose management they became world-known.

In January 1851 Mr. Faber du Faur resigned from his position in Wasseralfingen and came to the United States, where he was first employed in Trenton, N. J. His next position was with the Balbach Smelting & Refining Co., Newark, and a little later he was connected with the New Jersey Zinc Co.

In 1857 he went to Washington and was there engaged until 1861 on the United States Capitol extension, the Post Office extension and the Washington Aqueduct, under Captains M. C. Meigs and V. B. Franklin. In 1861 he was called upon to undertake engineering work for the Government and had charge of the construction of Fort Stanton. During the Civil War he was under General Meigs in the Quartermaster Department and was appointed special agent of the Quartermaster Department for steam transportation. In 1867 he resigned from the service and went to Richmond, Va., there to take charge of the Westham Furnace. In 1868 he returned to New York and opened an office as mining and consulting engineer and expert in patent causes. He was actively engaged in this work up to within a few years ago, when age compelled his retirement. He died on August 17, 1918. He became a life member of the Society in 1880.

ALBERT BLAUVELT

Albert Blauvelt was born in Philadelphia, Pa., on June 7, 1862. After graduation from the Kingston Academy, Kingston, N. Y., he served an apprenticeship in the drafting room of F. L. Roberts, New York. From 1879 to 1883 he was connected with the McEntee Locomotive Works, Rondout, N. Y., and with the West Point Foundry. The following year he was in the employ of the Lidgerwood Co., Brooklyn, N. Y. He was next associated as designer and expert draftsman with the Fall Steam Pump Co., the Cold Springs, N. Y., Rifle Works, and the Baldwin Locomotive Works, respectively. From 1890 to 1894 he was with the Edison Electric Co., Orange, N. J., and then with the American Oil Co., as engineer in the insurance department. In 1894 he entered the employ of the Western Factory Insurance Association, Chicago, Ill., and at the time of his death, January 4, 1918, held the position of associate manager.

Mr. Blauvelt was among the pioneers to bring into prominence the profession of fire-protection engineering and in that profession he was recognized as an authority. He became a member of our Society in 1896.

JOHN J. MULLANEY

John J. Mullaney was born in Ireland in 1864. He was brought to this country when a child and was educated in the schools of New York City, later attending Cooper Union. His apprenticeship was spent with the Delamater Iron Works, New York, from 1880 to 1884. The next three years he was employed as a machinist and in 1888 he became superintendent of the tool and manufacturing departments of the Columbia Typewriter Co. and the following year was associated with the Smith Premier Typewriter Co. About 1890 he became associated with the Brosius Sewing Machine Co. as superintendent, resigning in 1893 to take a similar position with the Garvin Machine Co. Later he was president of the Ideal Opening Die Co., New York. At the time of his death Mr. Mullaney had consulting offices in New York.

He became a member of the Society in 1901. He died suddenly in the early part of June in Redbank, Cal.

HOWARD L. COBURN

Howard L. Coburn was born in Patten, Me., in 1867. He was graduated in 1887 from the Massachusetts Institute of Technology

and up to the time of his death had been associated in its development.

Mr. Coburn designed some of the largest cotton mills and power plants in New England and until 1904 devoted himself to that phase of his profession. About that time he became associated with the Ambursen Construction Co., New York, as chief engineer and director, and in that capacity began the building of dams.

One of the most important of his works was the construction of the Guayabal Dam for the United States Irrigation Service in Porto Rico. He also put the Bassan Dam across the Bow River in Alberta for the Canadian Pacific Railway, and the Jordan River Dam on Vancouver Island, B. C. In this country he built the Shoshone and Laprelle Dams in Wyoming, the dam at Akron, Ohio, and the Pittsfield Dam, located at Pittsfield, Mass.

In addition to this work he was associated as consulting engineer with Henry L. Doherty & Co., E. W. Clarke & Co. and H. M. Byllesby & Co.

Mr. Coburn was a member of the American Society of Civil Engineers, the Engineers' clubs of New York and Boston and of the Technology Club. He became a member of the Society in 1901. He died on June 19, 1918.

WILLIAM KENT

William Kent, eminent consulting engineer, author, educator, editor, and former manager and vice-president of the Society, died at his summer home in Gananoque, Ont., on September 18.

Professor Kent was born in Philadelphia in 1851 and was educated at the Central High School of that city, and at Stevens Institute of Technology, from which latter he was graduated in 1876. From 1877 to 1879 he was editor of the *American Manufacturer and Iron World*, of Pittsburgh, and from 1879 to 1890 he served as mechanical engineer with several manufacturing concerns. From 1895 to 1903 he was associate editor of *Engineering News* and for the following five years was dean of the L. C. Smith College of Applied Science, of Syracuse University. From 1910 to 1914 he was editor of *Industrial Engineering*. While practicing from an early day as consulting engineer, he was nevertheless most widely known in the engineering world as the author of The Mechanical Engineers' Pocket-Book, of which nine editions, aggregating more than 100,000 copies, have been printed.

A more extended account of Professor Kent's professional career will appear in the next issue of The Journal.

ROLL OF HONOR

Bergstrom, Harry E., First Lieutenant, Co. B, 69th Regiment Engineers, Fort Myers, Va.

Beyer, O. S., Captain, Chemical Warfare Service, U. S. Army, assigned to the American University Experiment Station, Washington, D. C.

Bissell, Albert W., Artillery Training School for Officers, Camp Zachary Taylor, Ky.

Bohnstengel, Walter, 109th Mobile Ordnance Repair Shop, Camp Cody, N. M.

Boynton, John E., Captain, Engineers, U. S. Army, assigned to Camp Humphreys, Va.

Brewer, Allen F., Chief Machinist's Mate, Engineer Officers' Material School, U. S. Naval Reserve Force.

Buck, Irwin, Captain, Ordnance Department, U. S. Army, assigned to Willys-Overland Co., Toledo, O.

Carroll, E. J., Lieutenant, Bureau of Steam Engineering, Navy Department.

Cary, James W., Private, 48th Co., Coast Artillery Corps, U. S. Army, San Francisco, Cal.

Case, George S., Major, Chemical Warfare Section, U. S. Army.

Cathcart, William L., Lieutenant Commander, U. S. Navy, assigned to special duty in Bureau of Steam Engineering, Washington, D. C.

Conrad, H. V., Captain, Inspection Division, Ordnance Department, U. S. Army.

Dorrance, George W., Second Lieutenant, Air Service, U. S. Army.

Evans, Melvin J., Second Lieutenant, Ordnance Department, U. S. Army, assigned to Savanna Proving Ground, Savanna, Ill.

Everitt, I. D., Lieutenant, Ordnance Department, U. S. Army, assigned to Aberdeen Proving Grounds, Md.

Geddis, Robert H., Corporal, 16th Co., 152d Depot Brigade, Camp Upton, N. Y.

Hanson, John J., First Lieutenant, Ordnance Department, U. S. Army.

Haselton, Philip H., Second Lieutenant, Ordnance Department, U. S. Army, assigned to Aberdeen Proving Grounds, Md.

Hill, George F., Captain, Chemical Warfare Section, Ordnance Department, U. S. Army.

Holden, Edward A., Chief Machinist's Mate, U. S. Steam Engineering School, Pelham Bay Naval Training Station, 2nd Co., 6th Regiment.

Houston, H. A., Captain, Engineers, U. S. Army.

Keller, John O., Second Lieutenant, Ordnance Department, U. S. Army; assigned as Materiel Instructor, Ordnance Supply School, Camp Hancock, Ga.

Kerr, Charles P., First Lieutenant, Air Service, U. S. Army, Technical Section, American Expeditionary Forces, France.

Kniese, First-class private, Engineering Section, Ordnance Department, U. S. Army.

Lynd, Roy E., Captain, Ordnance Department, U. S. Army, assigned to the Tredegar Co., Richmond, Va.

Malcome, George H., Captain, Chemical Warfare Service, Gas Defense Division, U. S. Army.

Marshall, K. L., First Lieutenant, Chemical Warfare Service, U. S. Army, American Expeditionary Forces, France.

Marshall, W. A., Private, Machine Gun Company Detached Service; American Wing, British G. H. Q., Machine Gun School, B. E. F., France.

May, J. T. L., First Lieutenant, Chemical Warfare Service, U. S. Army, assigned to Fourth Battalion Headquarters, Edgewood Arsenal, Edgewood, Md.

Miles, Dale S., Private, First class, Quartermaster Mechanical Repair Shop, Fort Sam Houston, Tex.

Penney, R. L., Major, Ordnance Department, U. S. Army; assigned to Rock Island Arsenal, Rock Island, Ill.

Prozan, Moses, Private, Mechanical Resources and Development Division, Chemical Warfare Section, U. S. Army, American University, Washington, D. C.

Reckerdres, Henry, Ensign, U. S. Navy, Submarine Service.

Reed, Melbourne O., Ensign, U. S. Navy, assigned to U. S. Naval Training Camp, 10th Regiment, Pelham Bay Park, N. Y.

Richmond, Julian, Lieutenant, U. S. Naval Reserve Corps, Paris, France.

Royer, Earl B., Private, Medical Detachment, 6th U. S. Cavalry, American Expeditionary Forces, France.

Ruddy, William, First Lieutenant, Inspection Division, Ordnance Department, U. S. Army.

Skinner, James D., Captain, Ordnance Department, U. S. Army.

Smith, Harry R., Candidate, Field Artillery Officers' Training Camp, Camp Zachary Taylor, Ky.

Stanton, Robert B., Jr., First Lieutenant, Engineers, U. S. Army.

Stockmann, E. B., Ensign, U. S. Naval Reserve Submarine Unit, 10th Regiment, U. S. Naval Reserve Force, Pelham Bay Naval Camp, New York.

Tait, Godfrey M. S., Captain, Chemical Warfare Service, U. S. Army.

Turley, Charles L., Lieutenant, 21st Engineers, U. S. Army.

Vincent, J. G., Lieutenant-Colonel, Air Service, U. S. Army; Airplane Engineering Department, Bureau of Aircraft Production.

Wadsworth, G. R., Major, Signal Corps, U. S. Army, Chief Engineer, Naval Aircraft Factory, Navy Yard, Philadelphia, Pa.

Watkins, Roy A., Ensign, U. S. Naval Reserve Force, Aviation Department, assigned to Bureau of Steam Engineering, Division of Aeronautics, Washington, D. C.

Yates, Sheldon S., Candidate, Field Artillery Officers' Training Camp, Camp Zachary Taylor, Ky.

Young, Charles M., Ordnance Training School, Fort Slocum, New York.

Fourth Liberty Loan

THE people of the United States are asked to subscribe for $6,000,000,000 of bonds at 4¼ per cent interest, which will mature on October 15, 1938, unless the Government exercises its right to redeem the issue on or after October 15, 1933. Bonds will be dated October 24, 1918, and the first interest coupon for 173 days will be payable April 15, 1919. Interest dates thereafter will be October 15 and April 15.

Denominations of bonds: Coupon and registered bonds will be issued in amounts of $50, $100, $500, $1,000, $5,000, $10,000; and registered bonds in amounts of $50,000 and $100,000.

The interest on $30,000 of bonds of the Fourth Liberty Loan is exempt, until two years after the termination of the war, from surtaxes and excess profits and war-profits taxes. The bonds are also permanently exempt from all other federal, state, and municipal taxation, except estate and inheritance taxes.

Initial payment will be 10 per cent payable with the subscription and subsequent payments will be as follows: 20 per cent on November 21, 1918; 20 per cent on December 19, 1918; 20 per cent on January 16, 1919; 30 per cent on January 30, 1919. Payment may be made in full at time of subscription or on any subsequent installment date. *The campaign started on September 28 and ends on October 19.*

Comparative Data of Three Previous War Loans

First Liberty Loan, May 5 to June 15, 1917: subscription invited, $2,000,000,000; amount subscribed, $3,716,322,450; allotment, $2,000,000,000. Interest, 3½ per cent.

Second Liberty Loan, October 1 to October 27, 1917: subscription invited, $3,000,000,000; amount subscribed, $4,617,532,300; allotment, $3,808,766,150. Interest, 4 per cent.

Third Liberty Loan, April 6 to May 4, 1918: subscription invited, $3,000,000,000; amount subscribed, $4,176,517,550; allotment, full amount subscribed. Interest, 4¼ per cent.

LIBRARY NOTES AND BOOK REVIEWS

REVIEWS of books of special importance to mechanical engineers by members of the Society and those particularly qualified, brief descriptive notes of accessions to the Library of the United Engineering Society, items of interest relating to the Library's activities, etc.

Bookkeeping and Cost Accounting for Factories. By William Kent, M.E., Sc.D., Mem.Am.Soc.M.E. John Wiley & Sons, Inc., New York, 1918. Cloth, $8\frac{1}{4}$ x 10 in., 261 pp., profusely illustrated with forms. $4 net.

This recently written work differs materially from any other on the subject that has been called to my attention.

The aim of the author has been to present his subject to engineers, manufacturers and students in a manner that would appeal to practical men and at the same time combine the theoretical principles of accounting in a way to be easily understood and readily followed by those far enough advanced in a knowledge of factory management.

The book is peculiarly well fitted to serve as a textbook for the management and accounting departments of large manufacturing companies, especially those engaged in metal industries, as the problems of bookkeeping and cost finding have been analytically handled, due consideration being given to modern methods and the developments of systems that have stood the acid test and have become practically standard methods in general use wherever their special merit has proved them especially applicable to certain classes of business.

Mr. Kent has succeeded in working out many clearly detailed examples descriptive as to the accounting and cost methods that should be followed, all of which represent practical methods that have been successfully used and can be easily modified and applied to varying manufacturing conditions and requirements.

The chapters on Cost Finding Methods; Distribution of Burden; Depreciation, Inventory Valuation and Appraisals; Charting of Statistics; Problems and Difficulties *re* Standard Costs, are very well written, and the mass of information culled from many reliable sources, combined with Mr. Kent's well-known analytical method of treating subjects of this kind, makes the work one which places before the reader the most concise and up-to-date treatment of the subject that has yet been published in a single volume.

It is this feature of the new work that will appeal to the constructive reader, as it enables him to grasp clearly in a minimum time the various phases of any problem in bookkeeping and cost accounting in which he may be interested. It is essentially a work of reference and will be consulted more often than the usual work of this character that has been published to develop one theory and leaves the reader to wander through many other publications before he can secure a comprehensive grasp of the subject.

To the factory accountant anxious to improve his methods of accounting, the chapters on Factory Accounting, Cost Accounting, Modern Accounting Systems for Steel Works, etc., furnish a fund of knowledge that is readily understood and capable of easy modifications to meet varying conditions.

On the whole, I feel that Mr. Kent has succeeded admirably in gathering together the best ideas and methods in use today, supplementing these by his own views, clearly expressed and easily followed, and has produced a book that more nearly represents a standard textbook on factory bookkeeping and cost accounting than any other published to date.

Albert Walton.

Aeroplane Construction and Operation. Including Notes on Aeroplane Design and Aerodynamic Calculation, Materials, Etc. A Comprehensive Illustrated Manual of Instruction for Aeroplane Constructors, Aviators, Aero-Mechanics, Flight Officers and Students. Adapted Either for Schools or Home Study. By John B. Rathbun. Stanton and Van Vliet Co., Chicago, 1918. Cloth, 5 x 8 in., 426 pp., illus., pl., charts, diag., tables. $2.

The author has attempted to produce a book standing between the popular descriptive work and the mathematical engineering treatise, which will meet the needs of aviators and airplane builders. The volume covers the subject concisely and simply with the use of only elementary mathematics.

Allen's Commercial Organic Analysis. A Treatise on The Properties, Modes of Assaying, and Proximate Analytical Examination of the Various Organic Chemicals and Products Employed in the Arts, Manufactures, Medicines, etc., with Concise Methods for the Detection and Estimation of Their Impurities, Adulterations, and Products of Decomposition. Vol. IV. By the Editors and the following Contributors: M. Bennett Blackler, E. W. Lewis, T. Martin Lowry, Ernst J. Parry, Henry Leffmann, Charles H. Lawall. Fourth edition, entirely rewritten. Edited by W. A. Davis and Samuel S. Sadtler. P. Blakiston's Son & Co., Philadelphia (copyright 1911, reprinted 1917). Cloth, 6 x 9 in., 466 pp., tables. $5.

The subject has been divided between a number of authorities and much new matter has been included, so that the volume forms a convenient compendium of present knowledge on the subject.

Chemical Control of Gas Manufacture. Practical Instruction in Gas Works Chemistry for Superintendents, Foremen and Chemists. Part I. Practical Application. By W. M. Russell. Part II. Elementary Chemical Theory. By F. Wills. The Gas Age, New York, 1916. Cloth, 5 x 8 in., 152 pp., 47 illus., 1 pl., 18 tables. $1.50.

Devoted to a discussion of the methods for controlling gas-works processes by the use of chemistry, giving the most recent and reliable tests and analyses and explaining the methods used. Adapted to the requirements of the men in the smaller plants.

The Design of Aeroplanes. By Arthur W. Judge. Whittaker & Co., New York, 1917. Cloth, 6 x 9 in., 242 pp., 90 illus., 67 tables. $4

This volume endeavors to fulfill the need for a compendium in which the principles underlying aeroplane design, from the standpoint of the mechanical engineer, are concisely presented and accompanied by the necessary data. A small amount of new matter has been inserted in this edition, typographical errors have been corrected and a chapter on fuselage design and construction added. Contains a bibliography.

Electrical Phenomena in Parallel Conductors. Vol. I. Elements of Transmission. By Frederick Eugene Pernot. First edition. John Wiley & Sons, Inc., New York, 1918. Cloth, 6 x 9 in., 332 pp., 82 illus., 35 tables. $4.

Gives the mathematical developments leading to solutions for a number of problems arising in connection with the transmission of electrical energy over metallic circuits. Deals with continuously alternating-current phenomena only and is intended to serve as an introduction to subsequent volumes deal-

ing with specialized forms of electrical transmission. There is an appendix containing formulae and tables.

Electrical Locking. By James Anderson. Simmons-Boardman Publishing Co., New York (copyright, 1918). 6 x 9 in., 219 pp., 210 illus. $2.

Describes in detail the various methods for the supplementary protection of a system of interlocking switches, the apparatus used, methods of wiring, etc. Portions of the book appeared in the *Railway Signal Engineer*.

A Handbook of Briquetting. By G. Franke, translated by Fred C. A. H. Lantsberry. Vol. II. Briquetting of Ores, Metallurgical Products, Metal Swarf and Similar Materials, Including Agglomeration. J. B. Lippincott Co., Philadelphia, 1918. Cloth, 6 x 9 in., 214 pp., 79 illus., 4 folded pl., 14 tables.

Describes the various materials briquetted, methods of briquetting and agglomeration, preparation of material, compression and subsequent treatment of briquets. A number of complete briquetting and agglomeration plants in Germany and Austria are shown in detail. Appendices to vols. 1 and 2 are included.

Handbook of Mathematics for Engineers. By Edward V. Huntington, with Tables of Weights and Measures by Louis A. Fischer. Reprint of Sections 1 and 2 of L. S. Marks's Mechanical Engineers' Handbook. First edition. McGraw-Hill Book Co., Inc., New York, 1918. Flexible cloth, 5 x 7 in., 191 pp., illustrated, tables.

Designed to supply in compact form, accurate statements of those facts and formulæ of pure mathematics which are most likely to be of use to the worker in applied mathematics.

How Wooden Ships Are Built. A Practical Treatise on Modern American Wooden Ship Construction with a Supplement on Laying Off Wooden Vessels. By H. Cole Estep. The Penton Publishing Co., Cleveland, 1918. Cloth, 9 x 12 in., 101 pp., 201 illus., 6 tables.

This book is a revised publication of a series of articles that appeared in *The Marine Review*. It deals with methods of construction rather than with ship design and is intended for shipbuilders rather than for naval architects. A supplement on methods of laying down wooden ships is included.

Hydraulic and Placer Mining. By Eugene B. Wilson. Third edition, thoroughly revised. John Wiley & Sons., Inc., New York, 1918. Cloth, 5 x 8 in., 425 pp., 95 illus., 1 pl., 20 tables. $3.

The third edition contains much additional information intended to bring the work up abreast of the latest improvements in this industry. The book is designed to appeal not only to those actually engaged in placer mining, but also to those who wish to get the latest ideas on the subject.

Municipal Housecleaning. The Methods and Experiences of American Cities in Collecting and Disposing of their Municipal Wastes—Ashes, Rubbish, Garbage, Manure, Sewage, and Street Refuse. By William Parr Capes and Jeanne Daniels Carpenter, with an introduction by Cornelius F. Buns. E. P. Dutton & Co., New York, 1918. Cloth, 6 x 10 in., 232 pp., 16 tables (2 folded). $6.

Designed to furnish the information needed by those who are interested in the problems of the collection, care and disposal of municipal wastes. Also takes up the need for more efficient management and for the development of revenue-producing by-products. Intended to help public officials in selecting and operating the system best adapted to local conditions, and also to serve as a guide to the layman who wishes to inform himself about the methods of municipal housecleaning.

Ports and Terminal Facilities. By Roy S. MacElwee. First edition. McGraw-Hill Book Co., Inc., New York, 1918. Cloth, 6 x 9 in., 315 pp., 118 illus., 1 folded map, 17 tables. $3.

Contents: The Nature of the Problem, The Relative Importance and Physical Characteristics of the World's Leading Ports, General Characteristics of a Well-Coordinated Seaport, Port Competition for Rail and Maritime Freight, The Harbor, Belt Railway and Competition at the Terminals, Lighterage, Cartage, Drays and Motor Trucks, Piers, Wharves and Quays, Wharf Equipment, Cargo Transfer and Handling, Shed Equipment, The Warehouse, Standard Package or Specialized Freight, Bulk Freight, Inland Waterways and the Seaport, The Industrial Harbor and Upland Development, The Free Port as an Institution, The Processes By Which the Free Ports of Hamburg and Bremen Were Created, Bigliography.

A revision of the material used in a course of lectures at the School of Business, Columbia University. Discusses some of the engineering and economic factors which determine the success or failure of a port.

Standard Cotton Mill Practice and Equipment. With Classified Buyer's Index. Published Annually by The National Association of Cotton Manufacturers, Boston, 1918. Cloth, 6 x 9 in., 203 pp., illus., tables. $1.50.

An annual encyclopedia, containing economic trade and engineering data of interest to mill executives. Contains also a classified directory of manufacturers of cotton-mill supplies and equipment.

Steam Engines. A Thorough and Practical Presentation of Modern Steam Engine Practice. By Llewellyn V. Ludy. American Technical Society, Chicago, 1917. 6 x 8 in., 192 pp., 103 illus., 1 pl., 8 tables. $1.

Treats of the theory and construction of various types of steam engines, and of their purchase, operation and testing. A non-mathematical treatise intended for stationary engineers and particularly adapted for home study.

Storrs. A Handbook for the Use of Those Interested in the Construction of Short-Span Bridges. By John W. and Edward D. Storrs. Published by the authors, Concord, N. H., 1918. Flexible cloth, 4 x 7 in., 40 illus., 20 tables. $1.

A small pocketbook containing designs and methods of construction of small highway bridges, culverts, etc. Intended to assist men without engineering training in the construction of such structures.

Uniform Cost Accounting for Steel Furniture Industry. Compiled by Erich W. Kath. The National Association of Steel Furniture Manufacturers, Cleveland (copyright, 1918). Cloth, 5 x 8 in., 106 pp., 5 forms.

The methods of ascertaining costs presented are the result of careful investigation of the conditions in different organizations. The systems recommended are in accord with the best practices of accounting and can, with minor changes, be adapted to the needs of the various concerns.

Water Rights Determination. From an Engineering Standpoint. By Jay M. Whitham. First edition. John Wiley & Sons, Inc., New York, 1918. Cloth, 6 x 9 in., 204 pp., tables. $2.50.

Intended to assist an owner of an indefinite water right in determining the meaning of his right as expressed in horsepowers, and the number of cubic feet of water per second to which he is entitled. Gives citations from representative writings and presents many tests and power determinations used by the author. A bibliography is included.

PERSONALS

In these columns are inserted items concerning members of the Society and their professional activities. Members are always interested in the doings of their fellow-members, and the Society welcomes notes from members and concerning members for insertion in this section. All communications of personal notes should be addressed to the Secretary, and items should be received by October 15 in order to appear in the November issue.

CHANGES OF POSITION

Philip D. Wagoner, president of the General Vehicle Company, Long Island City, N. Y., has assumed similar duties with the Elliott-Fisher Company, Harrisburg, Pa.

Henrik Gaeger has accepted a position as assistant engineer in the engineering section of the Division of Steel Ship Construction of the Emergency Fleet Corporation, Philadelphia, Pa. He was formerly affiliated with the Prescott Company, Menominee, Mich.

George S. Wheatley has assumed the duties of efficiency engineer, Midvale Steel and Ordnance Company, Coatesville, Pa. He was until recently secretary to the vice-president of the Midvale Steel Company, Philadelphia, Pa.

Frank G. Frost, formerly general superintendent of the Houston Lighting and Power Company, Houston, Tex., has accepted the position of superintendent of power for the New Orleans Railway and Light Company, New Orleans, La. Both of these companies are subsidiaries of the American Cities Companies.

Ralph Earl, formerly associated with Morris Knowles, Inc., Pittsburgh, Pa., in the capacity of assistant engineer, has become connected with the Water Purification Board, Sewerage and Water Board, New Orleans, La.

Leland G. Knapp, until recently affiliated with the Harsh and Chapline Shoe Company, Milwaukee, Wis., as efficiency engineer, has entered the employ of the Wisconsin Motor and Manufacturing Company, of the same city.

John B. Wilkinson has become identified with the Federal Dyestuff and Chemical Corporation, Kingsport, Tenn., in the capacity of superintendent of heat, light and power. He was formerly draftsman with the Nordberg Manufacturing Company, East Milwaukee, Wis.

E. T. Spidy, formerly production engineer, Canadian Ingersoll-Rand Company, Sherbrooke, Canada, has accepted a similar position with the Canadian Pacific Railway Company, Angus Shops, Montreal, Canada.

Douglas K. Warner, efficiency engineer, New Departure Manufacturing Company, Burdett, N. Y., has become connected with the Sheffield Scientific School, Yale University, New Haven, Conn.

Jiles W. Haney has accepted the position of assistant professor of mechanical engineering, University of Nebraska, Lincoln, Neb. He was formerly affiliated with the experimental engineering department of Pennsylvania State College, State College, Pa.

Grant E. Furbush has resigned his position as instructor in industrial engineering at Pennsylvania State College, State College, Pa., and has accepted the position of mechanical engineer with the Fafnir Bearing Company, New Britain, Conn.

E. J. Heinen, formerly with the Strong and Scott Company, Minneapolis, Minn., is now efficiency engineer with the Minneapolis General Electric Company.

Charles J. Simeon, formerly with the Curtiss Aeroplane Company, Buffalo, N. Y., has accepted the position of employment manager with the Morgan Construction Company, Worcester, Mass.

F. W. Shumard, equipment and production engineer at the Utica, N. Y., plant of the Savage Arms Corporation, has accepted a similar position in Washington, D. C., in the maintenance division of the Motor Transport Corps.

Norman G. Hardy has become affiliated with the old Hickory Powder Plant, Jacksonville, Tenn. He was formerly connected with the Arizona Copper Company, Clifton, Ariz., as superintendent of power.

Hugo R. Pausin has resigned his position as superintendent, E. W. Bliss Company, Brooklyn, N. Y., to take a position as production manager, Metropolitan Engineering Company, Brooklyn, N. Y., on a trench-warfare contract for the United States Government.

Francis J. McGrail, formerly foundry superintendent, Struthers-Wells Company, Tonawanda, N. Y., is now in the employ of the Walker Foundry Company, Erie, Pa., in the capacity of general superintendent.

George D. Reynolds has resigned his position as machine designer at Edgewood Arsenal, Baltimore, Md., to accept the position of works manager of the Quickwork Company, St. Marys, Ohio, manufacturers of rotary shears, sheet and plate metal working machinery, etc.

Conrad H. Rapp, formerly associated with Hoggson Brothers, New York, as assistant manager, designing and engineering department, has assumed the duties of project manager, Bureau of Industrial Housing, officially the U. S. Housing Corporation.

Herbert D. Mozeen has severed his connection with the Syracuse Supply Company, Syracuse, N. Y., and has become identified with the Bureau of Aircraft Production, Dayton, Ohio.

Frank L. Glynn, formerly associated with the Curtiss Aeroplane and Motor Corporation, Buffalo, N. Y., has accepted the position of superintendent of the Training Department, Ordnance Department, Production Division, Philadelphia, Pa.

Frank Sawford, until recently chief engineer, electrical and mechanical operations, Canadian Collieries, Union Bay, B. C., Canada, has become affiliated with the Taylor Engineering Company, Ltd., Vancouver, B. C., Canada.

Arthur B. Coates has resigned the position of instructor in mechanical engineering at the University of Idaho, Moscow, Idaho, and has become connected with the experimental engineering department of the Ford Motor Company, Detroit, Mich.

Walter F. Jay has resigned his position as works manager of the Power Specialty Company, Dansville, N. Y., after an association of 13 years, to accept the position of production engineer, Production Division, War Department, Rochester District Ordnance office.

Walter E. Wollheim has severed his connection with the engineering department of the Nathan Manufacturing Company, Flushing, L. I., to assume the duties of president and mechanical engineer of the Alloy Foundry and Machine Corporation of New Rochelle, N. Y.

William W. Conner, formerly with the engineering department of the Eastman Kodak Company, Rochester, N. Y., has accepted a position as power superintendent at the Chrome, N. J., plant of the U. S. Metals Refining Company.

Arthur J. Coldwell, formerly superintendent of the Coldwell Lawn Mower Company, Newburgh, N. Y., has assumed the position of production engineer, Ordnance Department, U. S. A., New York.

R. H. Robinson, until recently superintendent of the metal division of the Standard Aircraft Corporation, Elizabeth, N. J., has become associated with the Land Products Company, Whitestone, L. I., N. Y., manufacturers of aircraft propellers, in the capacity of production manager.

Alexander Vallance has become connected with the shell department of the American Machine and Manufacturing Company, of Atlanta, Ga. He was formerly assistant professor of experimental engineering, Georgia School of Technology, Atlanta, Ga.

Albert P. Leonard, assistant chief engineer, Honolulu Iron Works Company, New York, has become affiliated with the engineering division of the Bureau of Aircraft Production, Dayton, Ohio.

Gilbert R. Haigh has taken up work in the U. S. Ordnance Department, as supervisor of production in the Saginaw, Mich. district. He was formerly connected with the Wilt Engineering Company, Detroit, Mich., in the capacity of production engineer.

ANNOUNCEMENTS

W. J. Schlacks, formerly general manager of McCord and Company, Chicago, Ill., announces that he has purchased the McCord locomotive lubricator and has incorporated the Locomotive Lubricator Company for the manufacture and sale of the Schlacks system of locomotive force-feed lubrication.

William P. Bixby has become affiliated with the Blaw-Knox Company, Pittsburgh, Pa.

Elmo J. Miller, consulting engineer, of Santiago, Cuba, has assumed the position of general manager, Compañie Azucarera Oriente, Xavier, Oriente, Cuba.

David F. Atkins has become associated with the Lord Electric and Lord Construction Companies, New York, in the capacity of mechanical engineer.

F. H. Rosencrants has accepted the position of mechanical equipment inspector, American International Shipbuilding Corporation, Hog Island, Pa.

John G. Schabert has been promoted to the position of assistant chief engineer of the Colt's Patent Fire Arms Manufacturing Company, Hartford, Conn.

E. L. Consoliver has been engaged in army training work since April 8, as chief instructor in the starting, lighting and ignition division in the University of Wisconsin Army School for Automobile Mechanics, organizing the work of this department. Since May, 1916, Professor Consoliver has been acting head of the mechanical engineering department, in the absence of B. G. Elliott, retaining, however, his connection with the University Extension Division. On July 1 his title was officially changed to assistant professor of mechanical engineering, University Extension Division, University of Wisconsin.

R. S. Wilbur has assumed the duties of assistant professor of mechanical engineering, Lafayette College, Easton, Pa.

Daniel W. Miller, of the Vacuum Oil Co., Minneapolis, Minn., has recently been made a special representative of the company, with offices at Chicago.

A. O. Gustafson is employed as checker in the engineering department of the Liberty Ordnance Plant, American Can Company, Bridgeport, Conn.

George H. Berge, formerly manager of Murphy Iron Works, Boston office, has succeeded the late M. C. Huyette, of the Buffalo office, and is now district manager for that territory.

EMPLOYMENT BULLETIN

THE SECRETARY considers it a special obligation and pleasant duty to make the office of the Society the medium for assisting members to secure positions, by putting them in touch with special opportunities for which their training and experience qualify them, and for helping any one desiring engineering services. The Society acts only as a clearing house in these matters.

GOVERNMENT POSITIONS

Stamps should be inclosed for transmittal of applications to advertisers; non-members should accompany applications with a letter of reference or introduction from a member; such reference letter will be filed with the Society records.

MECHANICAL ENGINEERS for Inspection Division of Ordnance Department; both younger and older men desired. 0603.

MARINE ARCHITECTS, MARINE ENGINEERS, HULL AND ENGINE DRAFTSMEN and other technically trained men for leading shipyards. Several yards are using civil, electrical, and mechanical engineers for construction of hulls or mechinery equipment, and this field of construction offers excellent opportunity for technically trained men. 0597.

FUEL ADMINISTRATION desires volunteers for engineering committees in the following counties in New York State: Wyoming and Orleans, near Buffalo; Livingston, Allegany, Ontario and Wayne, near Rochester; Franklin and Lewis, near Watertown; Herkimer, Otsego and Delaware, near Utica; Hamilton, Greene, Ulster, Sullivan and Orange, near Schenectady; Saratoga, Warren, Essex, Clinton, Washington, Columbia, Dutchess and Putnam, near Albany.

Also a real power-plant engineer to assist in checking up the questionnaires now being sent out. 0659.

FUEL ADMINISTRATION desires volunteers among the older men for office duties, meeting men, handling correspondence, etc. Location, New York office. 0598.

PRODUCTION EXPERTS. Mechanical engineers qualified as production experts for employment in district which extends from the southern portions of Ohio and Indiana to the Gulf of Mexico. Duties are to supervise the production of ordnance work at various plants engaged on Government contracts, and especially to speed up production wherever possible. Applicants should be mechanical engineers of thorough training and broad experience, who have an earning capacity of from $5000 a year upward. Positions require thorough business ability as well as technical knowledge. No one who is engaged directly on Government contracts can be employed. Maximum salary, $3600 per annum. 0658.

TECHNICAL GRADUATE, about 28 years of age, who has had some experience in installing office and shop systems; man who is physically unfit for military service or who has been placed in the limited service; one with initiative and the ability to get results preferred, even if with no previous experience in the work above named. Location Massachusetts. 0586.

ENGINEERS for special investigation work, familiar with general shop practice. Some technical education. Location Government plant on Long Island. 0602.

COST AND TIME-STUDY ENGINEERS, conversant with up-to-date shop methods. Location Government plant on Long Island. 0634.

THE U. S. NAVY GAS ENGINE SCHOOL, Columbia University, is desirous of obtaining names and addresses of men willing to enroll for training for the positions of chief engineer, warrant machinists and chief machinist mates on board the new submarines of the U. S. navy. Applicants must be men who have had extended experience in the operation of Diesel or other heavy-oil engines, and are fully capable of taking charge of Diesel engines, making ordinary repairs, foreseeing trouble, and maintaining the engines in efficient operation. Applicants should be between the ages of 21 and 35, but applications of men up to 40, if exceptionally well qualified, will be considered. The pay is attractive and the several months' training is most advantageous for future work. 0664.

CIVILIAN POSITIONS

FIELD SECRETARY for engineering organization work. Must be able to meet engineers and business men and secure their coöperation. Engineering and executive experience, tact and judgment are essential. Salary $200 to $250 per month, with exceptional opportunity. State draft classification. K. 0604.

HIGH-GRADE FOUNDRYMAN, capable of taking full charge of foundry department with a melting capacity of approximately 150 tons a day; not only a practical foundryman, but one who understands the theoretical side of foundry work, has wide experience in the production of both small and heavy castings, and possesses the necessary executive qualifications to enable him to efficiently supervise actual production work in his department. Location Ohio. J-0604.

INSTRUCTOR IN MECHANICAL ENGINEERING. Position pays a salary of $1600 a year and allows three months' vacation with pay. Work to begin September 15, 1918. Location Louisiana. J-0605.

GRADUATE MECHANICAL ENGINEER for a position leading up to chief engineer. Should have had five to ten years' experience in engineering department of a steel plant. Send résumé of education, experience and salary. Interview will be necessary. Location Pennsylvania. J-0606.

ASSOCIATE PROFESSOR OF MECHANICAL ENGINEERING in an eastern university, to have charge of classes in machine design and allied subjects; teaching and practical experience necessary. Engagement to begin October 1. J-0607.

PRODUCTION ENGINEER to take charge of cost-reduction work in Canadian shop manufacturing air compressors, rock drills and other lines. Gantt system preferred. State age, experience and salary expected. J-0608.

ASSISTANT TO CONSULTING ENGINEER for a large, nationally known manufacturing concern. Young man wanted with college training in mechanical engineering and who is in deferred classification under Selective Service Act. Experience in heating and power-plant engineering desirable. Work directly connected with the war, as company is over 75 per cent. engaged on Government work. Position permanent, with excellent opportunities for advancement. Location New York City. Apply by letter, outlining experience and stating salary expected. J-0609.

YOUNG MEN OF COLLEGE EDUCATION and some ability and training in research work. Experience in particular line not required, but a good measure of common sense and originality will be at a premium. Pay $150 to $200 per month or more for a man of undoubted ability. Headquarters Eastern New Jersey. Apply by letter. J-0610.

SALES ENGINEER of experience for position of sales manager. Must be good executive, thoroughly familiar with modern sales methods and experienced in power-plant and combustion engineering. Location Middle West. J-0611.

TECHNICAL GRADUATES specializing in power-plant and combustion engineering wanted as sales engineers. Must have good address and be either experienced salesmen or prepared to take course of training. Splendid opportunities to men possessing necessary qualifications. Location Middle West. J-0612.

YOUNG MAN to teach the elementary portion of mathematics and physics for the coming year, beginning September 17. Salary $800 to $1,000. College in New York State. J-0613.

STEAM-ENGINE DESIGNER. Man with broad experience in the design of tow-boat and marine engines. Give full details of experience, age and salary. Good opportunity for high-grade man. Apply by letter. Location Pennsylvania. J-0614.

INSTRUCTORS. Salary $1500 or $1600. Location Philadelphia. J-0615.

CHIEF DRAFTSMAN with executive ability, capable designer, competent to supervise ordering of materials and with capacity for details. Experience in general machine design, structural steel and electrical machinery. Salary $300. Location New York City. J-0618.

YOUNG MECHANICAL ENGINEER to do drafting; one with some experience in factory construction work. $35 to $40 a week. Location Newark, N. J. J-0622.

MECHANICAL ENGINEERS. Corporation doing a large percentage of Government work needs services of two engineers, preferably college graduates. In addition to mechanical engineering experience should have experience in scientific-management methods to direct and superintend a department for manufacturing, estimating and general investigation matters. Opportunity for the future is assured. In reply state age, nationality, references and present salary. J-0623.

TECHNICAL CORRESPONDENT. Man if possible not subject to draft, owing to physical reasons or on account of age, capable of taking charge of technical correspondence. Boston concern. J-0624.

INSTRUCTOR IN MECHANICAL ENGINEERING for University of Cincinnati. J-0625.

HIGH-GRADE EMPLOYMENT MANAGER. Man with college education, some employment experience, initiative and aggressive, capable of taking hold of an employment organization and developing it to meet the exacting requirements of the present day; capable of influencing men and women workers by pleasant personality, fairness and ability to get things done on time and in the right way. Salary $200 to $250 per month. State age, education, experience and names of last three employers, with the length of service in each case, as well as responsibility assumed. Appreciate photograph. Address L. W. Wallace, Assistant General Manager, Personal. J-0626.

RATE-SETTING AND TIME-STUDY WORK. Salary $35 to $40 a week, depending entirely on the man. J-0627.

DRAFTSMAN in contractor's office. Must be thoroughly experienced in conveying systems for boiler houses, ground storage plants, locomotive coaling stations, etc., and familiar with structural steel. Permanent position, good salary and opportunity for advancement to right man. State salary desired and complete experience. Apply by letter. Location Philadelphia, Pa. J-0628.

DRAFTSMAN. Competent designer and detailer. Man experienced in stationary boiler and power-plant work. Steady position and good salary. Location New York. Give age, experience, references and military status. J-0629.

INSTRUCTOR IN MECHANICAL ENGINEERING in well-known university in Maryland. College graduate with some experience in machine design and experimental engineering preferred. Salary $1700 or more, depending upon man engaged and the number of courses arranged for him to teach. J-0635.

ESTIMATING AND SALES ENGINEER. Large manufacturing company producing a complete line of mining machinery has opening for graduate mechanical engineer to assist in estimating, ultimately becoming sales engineer. Must be draft-exempt. Reply by letter. J-0636.

DRAFTSMAN—DESIGNER. Man experienced on automatic machinery for large manufacturing plant doing Government work. Permanent position. State age, education, previous experience, salary desired, etc. Location Cleveland, Ohio. J-0637.

MECHANICAL DRAFTSMAN, preferably one with experience in the design of high- or low-pressure air compressors, marine or high-speed engines. Permanent position. Location Connecticut, within 50 miles of New York City. Salary depends on past experience. J-0639.

DRAFTSMEN. Plant-layout men for general lines with knowledge of building construction and equipment. Position in Georgia. J-0640.

ESTIMATING ENGINEER, experienced in the purchasing line. Applicant should have technical training and be competent to estimate cost on construction work and mechanical equipment such as would be involved in the construction of water-filtration plants, both gravity and pressure types. Location New Jersey. J-0642.

CHIEF DRAFTSMAN to take charge of drafting room of about 120 men with company engaged in design and construction of by-product coke ovens, benzol and toluol plants. Prefer man with by-product coke-oven experience, but will consider man from other line of work, provided he has had general mechanical engineering experience and possesses good executive ability. Must be an American. Give full particulars with application; age, previous positions occupied, etc. J-0643.

SUPERINTENDENT OF TOOL ROOM. Will pay $5000 to $6000 a year to the right man, who must be capable of taking charge of toolmakers, getting out jigs and fixtures accurately and in a reasonably quick time. Should be fairly experienced not only in the making of tools and fixtures, but in the design of same. Location Buffalo, N. Y. J-0644.

ENGINEER fully capable and familiar with the design and manufacture of small motors not exceeding 2 hp. J-0645.

DRAFTSMEN on power-plant and industrial-plant design—not electrical men. Work is indirectly Government work, along the lines of fuel conservation in the New England States. Also some Government construction work. Headquarters Connecticut. J-0646.

BOILER-ROOM FOREMAN to take care of 10,000 boiler hp., operate Taylor stokers and take care of compound engines. Salary about $2000. Location Staten Island, N. Y. J-0647.

TECHNICAL GRADUATE with practical experience, preferably including marine experience, to take charge of a night class in steam-engine practice. Write, stating experience. J-0648.

TECHNICAL GRADUATE, with practical experience, to take charge of a night class in gas-engine practice. Write, stating experience. J-0649.

MACHINERY DRAFTSMAN AND ENGINEER capable of figuring stresses in all parts of punching, shearing, plate-planing, bending and rolling machinery. J-0650.

INSTRUCTORS of professional rank in electrical engineering and mechanical engineering, both positions connected with training of men for Army. Prefer men with practical experience and will consider men with no previous experience. Salary $2500 or more for first-class men. Term begins about October 1. J-0651.

MAN to take charge of employment and welfare departments. Ninety per cent. Government work and manufacture of automatic screw tools. $200 to $250 for good man. J-0652.

MEN AVAILABLE

Only members of the Society are listed in the published notices in this section. Copy for notices should be on hand by the 12th of the month, and the form of notice should be such that the initial words indicate the classification. Notices are not repeated in consecutive issues.

GENERAL OR WORKS MANAGER of a manufacturing concern. Position desired by a successful executive having extensive and exceptional experience with high-grade manufacturing concerns. Any firm needing a man to manage, who has learned how by hard knocks, will be supplied complete record on request. J-238.

STEAM-TURBINE SPECIALIST. Mechanical engineer, American, with 15 years' experience in U. S. and abroad in the designing, calculation, manufacture, testing and operation of small and large steam turbines, desires permanent position. J-239.

FUEL ENGINEER. Graduate mechanical engineer, age 35, with nine years' experience in the scientific testing of coal in all kinds of industrial plants, for one of the largest coal companies in the Middle West, desires position as combustion engineer for a large user of coal doing essential war work. At present employed. J-240.

MANAGER OF MACHINE WORKS OR SHIPBUILDING PLANT. Member, graduate mechanical engineer, wants responsible executive position with right concern. Experienced in progressive management, modern production, and handling and developing men; familiar with ship work and broad class of engineering. All-American, accurate and thorough, with first-class record in both design and construction of special machinery, machine-shop work, structural steel, power plants, piping, transmission and conveying machinery, and air compressors. Salary $7500 to $9000; only best propositions considered. J-241.

MECHANICAL ENGINEER, 1917 technical graduate, exempt from draft, with one year's experience in steam-power plant in construction, operation and maintenance. Some shop and electric railway equipment experience. Location around New York City. J-242.

TECHNICAL GRADUATE. Age 44; fifteen years' practical experience, covering machine shop, drafting room, estimating, cost accounting, rate setting, and modern shop management along production lines. J-243.

EXECUTIVE. Mechanical and production engineer with 25 years' wide, practical experience in developing, maintaining, systemizing and experimenting, and in all kinds of mechanical problems with light, interchangeable, high grade machinery and tool production. J-244.

MANAGER, EXECUTIVE ENGINEER. Mechanical engineer, technical graduate with broad business and engineering experience. Has developed power plant for unit steam railway car and designed vital parts that are now being used on steam automobiles. Splendid in designing and construction. Ample references. J-245.

FOUNDRY SUPERINTENDENT. Member, at present employed as general superintendent of large manufacturing plant, invites correspondence from employers who may need the services of a high-grade foundry executive about December 1. Practical molder, technically trained—steel, gray iron, brass, bronzes, etc. Desires position where mechanical and technical training combined with a broad, practical experience in modern shop methods will afford opportunity to broaden experience gained in several large corporations to better advantage. Excellent references from past and present employers. Married; dependents (3); age 43. Salary not less than $5000. J-246.

ENGINEER open for engagement in manufacturing or executive sales work. Would make excellent assistant to general manager; long experience in manufacture of alternating and direct-current motors, including fractional hp. sizes, and having executive and sales experience. J-247.

EXECUTIVE, SUPERINTENDENT, OR MECHANICAL ENGINEER. American, 38 years of age, married, with a wide experience in chemical plants and general engineering work, covering maintenance and operation of industrial works. Can furnish highest references. Now superintendent of chemical plant on Pacific Coast with salary $4000 per year; will consider making a change if suitable connections can be made. J-248.

ENGINEER, highly trained, with executive experience, desires position as technical adviser or assistant to president or general manager. Engineering degrees from two technical schools and Ph. D. from one of the great American universities. Specially skilled in mathematical physics and its application to the solution of engineering problems. Twenty-five years' experience, covering chemical and testing laboratory work, metallurgical operation, design and execution of heavy construction, water power and industrial investigations, valuation and some electrical operation. Familiar with properties and uses of most engineering materials. Unmarried, physically sound and accustomed to work in emergencies without regard to hours. Reads French and Spanish readily and speaks some Spanish. Last 15 years in consulting practice. Prefers connection with interests developing large enterprise. American-born and of American parentage. Will go anywhere in United States, allied or friendly countries. Salary about $7500. J-249.

MECHANICAL ENGINEER, associate member, desires executive position requiring thorough technical training and experience with ability to handle men and situations. Class 4 of draft. J-250.

MECHANICAL ENGINEER with 15 years' experience as machinist, foreman and tool designer for interchangeable work and steel stampings; high-grade technical and practical executive. Associate member, age 36, married, technical graduate; can develop automatic labor-saving machinery and equip factory for economical quantity production. Desires position as mechanical superintendent with progressive concern. J-251.

MECHANICAL ENGINEER understanding machine and press work desires responsible position with a progressive firm. Experience in office and shop. Successful record as foreman, but desires to advance. M. I. T man, age 28, Class I of draft. Prefer location in Connecticut. J 252.

CHIEF ENGINEER of medium machine building plant wishes to connect with larger concern as assistant works manager or assistant chief engineer, chief draftsman, or any important executive position. Resourceful, rapid designer, with inventive ability; graduate M E.; experience in factory organization and systematizing; not afraid of long hours. $3000 to start. J-253.

MECHANICAL ENGINEER. American, with 12 years' experience covering shop, time study, erection, design, sales and general office. Age 35, married, technical graduate. Employed at present. Desires position in engineering executive line with responsibility. Relations with co-workers invariably pleasant and successful. Exemplary habits and good health. Can report promptly. J 254.

MECHANICAL ELECTRICAL ENGINEER with wide experience in internal combustion engine foundry and machine-shop practice and exceptional executive ability. Now at the head of a very large concern. Speaks English, French and Italian fluently. Available within a reasonable time. Minimum salary $1800. J 255.

SUPERINTENDENT OR WORKS MANAGER. American, age 43, with 22 years' practical experience with large organizations and modern methods of operation in the production of automatic, semi-automatic and single purpose machines, also the economical manufacture of interchangeable parts from small ball bearings to large machine tools. By the proper use of a good technical education, ability to handle all classes of help, combined with tact and common sense, have been able to successfully fill positions of machinist apprentice, toolmaker, general foreman, chief draftsman, superintendent and works manager. Two years in charge of 600 men on munitions and screw-machine products. Eastern location preferred. J-256.

MECHANICAL-ELECTRICAL ENGINEER. Designer and inventor of heavy motor control devices in general use, who is employed, but inactive on account of war conditions, desires active employment in development work in which experience and ingenuity are essential. Special consideration will be given to openings likely to prove permanent. Graduate of leading technical college, fully conversant with manufacturing; member A. S. M. E., associate member A. I. E. E. J-257.

WORKS MANAGER OR SUPERINTENDENT Position desired by member successful in general manufacturing lines and with broad experience as executive in plants with foundry, pattern, polishing, plating and machine-tool departments. Thoroughly familiar with cost accounting, estimating, stock control and general office routine. Will be available early in October. J-258.

DIESEL ENGINEER with experience on stationary and marine engines desires position in this capacity, preferably with a concern engaged in Government work. Draft class 4. J-259.

ENGINEER with broad designing and production experience and six years in charge of design work desires position as engineer or chief draftsman. J-260.

CANDIDATES FOR MEMBERSHIP

TO BE VOTED ON AFTER OCTOBER 21

BELOW is a list of candidates who have filed applications since the date of the last issue of The Journal. These are classified according to the grades for which their ages qualify them, and not with regard to professional qualifications, i.e., the ages of those under the first heading place them under either Member, Associate or Associate-Member, those in the next class under Associate or Associate-Member, those in the third class under Associate-Member or Junior, and those in the fourth under Junior grade only. Applications for change of grading are also posted. Total number of applications 161.

The Membership Committee, and in turn the Council, urge the members to scrutinize this list with care and advise the Secretary promptly of any objections to the candidates posted. All correspondence in this regard is strictly confidential. Unless objection is made to any of the candidates by October 21, and provided satisfactory replies have been received from the required number of references, they will be balloted upon by the Council.

NOTE. The Council desires to impress upon applicants for membership that under the present national conditions the procedure of election of members may be slower than under normal conditions.

NEW APPLICATIONS

FOR CONSIDERATION AS MEMBER, ASSOCIATE OR ASSOCIATE-MEMBER

Alabama

CUMMINGS, E. P., Operating Superintendent, Alabama Power Co., Birmingham
MUELLER, Grover R., Manufacturers' Agent and Sales Engineer, Birmingham

California

BOWEN, Samuel R., Manager, Oil Tool Dept., S. A. Guiberson, Los Angeles
DRAKE, Frank B., President and Manager, Johnson Gear Co., San Francisco
GRUNDEL, Irving G., Draftsman, Union Oil Co., Oelum
IRELAND, Thomas W., Engineer, Steam Heat Dept., Great Western Power Co., San Francisco

Colorado

PERSON, Howard A., Chief Engineer, United Oil Co., Florence
WILLIAMSON, Edward L., President and Manager, West Riverside Canal Co., Riverside

Connecticut

MORELAND, Albert S., General Foreman, Remington Arms Co., Bridgeport
RHEAUME, Herman C., Plant Engineer, Stamford Rolling Mills Co., Stamford
SMITH, Charles F., Engineer, Remington Arms Manufacturing Co., Bridgeport
TAPPAN, Dewitt, Assistant Superintendent, Veeder Manufacturing Co., Hartford

District of Columbia

BYRNE, Henry H., Aeronautical and Ordnance Patent Expert, War Department, Washington
ETTENGER, Robert L., Consulting Mechanical Engineer, Southern Railway System, Washington
LOWE, James R., Mechanical Engineer, Ordnance Department, Engineering Division, Washington
SNELLING, Henry H., Engineer and Expert, Church and Church, Washington

Illinois

CHRISTOPHERSEN, C. Birger, Engineering Draftsman, Illinois Steel Co., So. Chicago
McFARLAND, Owen D., Mechanical Engineer, Gayton & Cumfer Mfg. Co., Chicago
MERRICK, Wendell S., Captain, 309th Engrs., 84th Div., U. S. A., Chicago
REECE, Wade W., Chief Engineer, Schulze Baking Company, Chicago

Indiana

HUTCHCRAFT, D. K., Vice President Indiana Air Pump Co., Indianapolis

Iowa

SAENGER, Louis P., General Superintendent, Mechanical Engineer, Clinton Sugar Refining Co., Clinton

Maryland

RACH, J. Louis W., Superintendent and Mechanical Engineer, E. J. Codd Co., Baltimore

Massachusetts

MAHON, Thomas, Foreman Machinist, Becker Milling Co., Hyde Park
RANGER, James A., General Contractor, Holyoke
SHEAK, Edwin R., charge of all mechanical operations, Thomas G. Plant Co., Roxbury

Michigan

EATON, Homer M., General Manager of Gas Companies operated by W. E. Moss & Co., Detroit
GARLAND, Harrison W., President The M. Garland Co., Bay City
KETTLE, Edgar U., Consulting and Research Engineer, Grand Rapids Veneer Works, Grand Rapids
KIEFER, Edgar W., First Vice President, Port Huron Sulphite & Paper Co., Port Huron
STANBROUGH, Duncan G., General Superintendent, Packard Motor Car Co., Detroit
WILSON, Charles B., President and General Manager, Wilson Foundry & Machine Co., Pontiac

Minnesota

MORRIS, John E., Secretary and Treasurer, Stacy-Bates Co., Minneapolis

Nebraska

ANDERSON, Augustus C., Consulting Engineer, Anderson and Bennett, Omaha

Nevada

LITTLE, Robert E., Chief Draftsman and Assistant to Master Mechanic, Los Angeles & Salt Lake R. R., Las Vegas

New Jersey

HORNING, Maurice O., Engineer, American Gas Furnace Co., Elizabeth
RUSSEN, Frank A., Chief Patternmaker, Safety Car Heating & Lighting Co., Jersey City

TALMAGE, Walter H., Mechanical Engineer, The Heller & Merz Co., Newark
TOLFAIR, William D., Product Engineer, Laboratories of T. A. Edison, West Orange
VAN AKEN, Lionel D., Lt. Colonel, Ordnance Department, Production Officer, E. I. du Pont de Nemours & Co., Pompton Lakes

New York

BURMISTROFF, Ivan, Assistant to Engineer, Russian Mission of Ways of Communication, New York
COHEN, Frederick W., Assistant General Manager, Metal & Thermit Corporation, New York
CRANK, Albert F., Secretary, Acting Treasurer, Chief Engineer, Conveying Weigher Co., New York
GRIFFIN, W. A., Captain, Ordnance Department, U. S. A., Assistant Production Manager, Rochester Ordnance Office, Frontier Iron Works, Rochester
HAMMOND, Edward K., Associate Editor of "Machinery," New York
JAMIESON, Charles M., Operating Planner, Wright-Martin Aircraft Corp., Long Island City
KINNEY, Price W., Employment Manager, Gleason Works, Rochester
LECHLER, Bruno C., General Manager, S. S. Hepworth Co., New York
LEVIN, Vladimir Z., Chief Inspector, Russian Mission of Ways of Communication, New York
LOOMIS, Crawford Charles, Engineer, Remington Arms U. M. C. Co., Inc., Ilion
LOWE, Aubrey L., Assistant Superintendent, Remington Arms U. M. C. Co., Inc., Ilion
REDIER, Roger P., General Sales Manager, Allied Machinery Co. of Am. New York
UPTEGRAFF, Thos M., Secretary and Manager, Defiance Paper Co., Niagara Falls
VAN GELDER, George S., 1st Lieut., Ordnance Department, U. S. A., New York
WEBB, Daniel J. H., Superintendent and Mechanical Engineer, Franklin Contracting Co., New York
WIKANDER, Oscar R., Consulting Engineer, S. K. F. Administration Co., New York
WILSON, James A., Engineer, Corning Glass Works, Corning

Ohio

BLITZ, Edgar G., Time Study and Efficiency Engineer, Toledo Scale Co., Toledo
FAUZON, Arturo, Mechanical Engineer, The World's Products Research Co., Cleveland
GREEN, Carl R., Manager and Owner, Green Engineering Co., Dayton
McCORMACK, Daniel J., Hydraulic Engineer, The Wellman Seaver Morgan Co., Cleveland
NONNEMAN, I. W., Chief Engineer, the Borden Co., Warren
SAUZEDDE, Claude, Manufacturing Engineer, Steel Products Co., Cleveland
SCHOENBERGER, John H., Draftsman and Designer, The Lunkenheimer Co., Cincinnati
STOLBERG, Charles A., Major, Ordnance Department, U. S. A., Maxwell Motor Co., Dayton
WALTZ, Burt A., Department Planning Engineer, The B. F. Goodrich Co., Akron
WEAVER, Thomas D., Chief Engineer, Humphryes Mfg. Co., Mansfield

Oklahoma

CRAIG, Clyde B., Manager, Mid-West Branch, Bessemer Gas Engine Co., Tulsa

Oregon

KINCAID, Morden F., Mechanical Valuation Engineer, Spokane, Portland & Seattle Ry., Portland

Pennsylvania

AYARS, Allan M., Efficiency Engineer, Landis Tool Co., Waynesboro
BURDICK, Frederick H., Member of Firm, Standard Engineering Co., Pittsburgh
BUSH, Paul H., Assistant and Chief Draftsman, Frankford Arsenal Tool Division, Frankford Arsenal
COLEMAN, Harry S., Assistant Director, Mellon Institute of Industrial Research, Pittsburgh
ELLIS, Roy M., Manager, A. H. Fox Gun Co., Philadelphia
HEARSEY, Winthrop O., Superintendent of Machine Shop No. 5, Bethlehem Steel Co., Bethlehem
HILTEBEITEL, M. M., Power Apparatus Engineer, Westinghouse Elec. & Mfg. Co., Philadelphia
McDOWELL, Elmer K., Chief Works Engineer, Donora Steel Works, Donora
MEISENHELTER, Lewis R., Proprietor and Owner, L. R. Meisenhelter Machinery Co., Philadelphia
MENISH, John R., Chief Mechanical Engineer, Pennsylvania Lubricatng Co., Pittsburgh
NEWHALL, Ezra A., Designer and Draftsman, Rolling Mill Machinery, R. S. Newbold & Son Co., Norristown
RYAN, John Thomas, Vice President and General Manager, Mine Safety Appliances Co., Pittsburgh
SHARP, Robert E. B., Assistant Hydraulic Engineer, I. P. Morris Department, William Cramp & Sons Ship Engine Bldg. Co., Philadelphia
SHEARER, Harry T., President, General Manager, H. T. Shearer Machine Co., Waynesboro
SLEICHER, Charles A., President, Queen's Run Fire Brick Co., Lock Haven
TERHUNE, Howard, Designer and Assistant Sales Manager, Chambersburg Engrg. Co., Chambersburg
WEGMAN, Leroy A., Aeronautical Mechanical Engineer, Naval Aircraft Factory, Navy Yard, Philadelphia

Rhode Island

JENCKES, Robert A., Department Manager, General Fire Extinguisher Co., Providence

South Carolina

MAYO, James B., Engineer and Inspector, Factory Insurance Association, Greenville

Tennessee

HOLT, Herbert F., Consulting and Contracting Engineer Practice. Knoxville

Virginia

MOSS, William D., Manager, Capitol Motor Corp., Richmond

Wisconsin

HUEYLER, William, Mechanical Appraiser, The American Appraisal Co., Milwaukee

Canal Zone

MORRIS, Thomas C., Assistant Engineer, Panama Canal, Balboa Heights

France

INGLIS, Henry B., Aviator in United States Service. American Expeditionary Forces

Java

KNEPPERS, Jos. M., Engineer, Harrisons & Crosfield, Ltd., Batavia

Mexico

ARIZPE, Emilio, Manager, Aurora Cotton Spinning & Weaving Mill, Saltillo, Coah.

South America

WHEELER, Burr, Resident Engineer, Chile Exploration Co., Tocopilla, Chile

FOR CONSIDERATION AS ASSOCIATE OR ASSOCIATE MEMBER

District of Columbia

ADAMS, Ralph L., First Lieutenant Engineering Division, Motor Transport Corps, Washington

Illinois

CROWDER, Carl G., Production Engineer, Western Electric Co., Inc., Chicago

Maryland

BIMESTEFER, John, Jr., Designing Draftsman, Bethlehem Steel Co., Sparrows' Point

Massachusetts

SMITH, Robert L., Mechanical Engineer, Baxter D. Whitney & Son Winchendon

New Jersey

DAVIS, Frederick H., Mechanical Engineer, Balbach Smelting & Refining Company, Newark

New York

ARNTZEN, Asbjorn, Assistant Mechanical Engineer, F. L. Smith & Co., New York

Ohio

DAVIS, Howaad E., Mechanical Superintendent, The Austin Co., Cleveland
WALTERS, Carl F., Chief Engineer, Safe Cabinet Co., Marietta

Pennsylvania

BUDD, Alfred N., First Lieutenant, Ordnance R. C., Army Ins. of Ord., Hero Mfg. Company, Philadelphia

FOR CONSIDERATION AS ASSOCIATE-MEMBER OR JUNIOR

Delaware

ARMOR, Robert B., Chief Engineer, Benjamin F. Shaw Company, Wilmington

District of Columbia

VAN KEUREN, Harold L., Chief of Gage Section, Bureau of Standards, Washington

Illinois

BRAUNBERGER, Ray A., Sales and Industrial Engineerng, R. E. Ellis Engrg. Co., Chicago
TIKALSKY, Francis P., Section Head in machine and analysis Department of Planning Division, Western Electric Co., Inc., Hawthorne

Iowa

OGDEN, Frank F., 2nd, Consulting, Designing and Supervising Engineer and Architect, Expert Draftsman, Eddyville

Massachusetts

JOHNSON, Robert A., President and Manager, Franklin Machine and Tool Co., Springfield

Michigan

FISK, Louis C., Assistant Engineer, Motor Division, Hyatt Roller Bearing Co., Detroit
KERSHAW, Adolphus L., First Lieutenant, Ordnance Department, U. S. A., Eng. Div., Motor Equipment Section, Maxwell Motor Co., Detroit
TURNER, Edwin N., General Manager, Manistee Iron Works Co., Manistee

Minnesota

ROMERO, Cirilo, Instructor in Marine Steam Engineering at the U. S. Navy Training School, University of Minnesota, Minneapolis

New Jersey

KESHEN, Charles G., Assistant Managing Engineer, Hoist Department, Sprague Electric Co., Bloomfield

New York

ANDERSON, George B., Jr., General Representative of Selling Agent, N. Y. & N. E. Districts, Pittsburgh Valve, Foundry & Construction Co., New York
BROOK, Victor, Publicity Engineer with title of "Field Service Manager," New York

CHATEL, Fred J., Ensign, U. S. N. R. F. U. S. S. "Huntington," New York
FRIEDMAN, Jno. H., Captain, Assistant Superintendent of Shops, Watervliet Arsenal, Watervliet
HYATT, John E., U. S. Naval Reserve Officers' Material School, Scarsdale
JACOBS, Loring H., U. S. Navy, Bureau of Construction and Repair, Avation Section, care Superintending Constructor of Aircraft, Buffalo
JARECKIE, Eugene A., Assistant Engineer of Honolulu Iron Works Co., New York
PARSONS, Loren E., Design Engineer, Western Electric Co., Inc., New York

Ohio

HARLAN, Jesse R., Sales Engineer, The Stuebing Truck Company, Cincinnati

Oklahoma

TABER, George H., Jr., General Manager, Gasoline Department, Sinclair Oil & Gas Company, Tulsa

Pennsylvania

STEVENS, Harold G., Captain, Ordnance Department, U. S. A., Superintendent Artillery Assembling Shops, Frankford Arsenal, Philadelphia
WHITAKER, John C., Production Engineer, Midvale Steel & Ordnance Co., Nicetown, Philadelphia

Canada

CHESNEY, Andrew M., Assistant Works Manager, Canadian Explosives Co., Limited, Beloeil Station, Quebec

France

KURTZ, Walter H., Senior Master Mechanic Engineer, 49th U. S. Engineers, American Expeditionary Forces

South America

WRENCH, Robert A., Assistant to Chief Electrical Engineer, Braden Copper Company, Rancagua, Chile

FOR CONSIDERATION AS JUNIOR

Arizona

HANSON, Ray, Apprentice Instructor and Mechanical Clerk, S. P. Shops, Tucson

California

PILLARS, Harry M., Chief Draftsman, Jos. Wagner Mfg. Co., San Francisco

Connecticut

BUXBY, Paul M., First Lieutenant, Ordnance Department, U. S. A., Remington Arms U. M. C. Co., Bridgeport

Delaware

KUO, Cheng C., Ship Building, Harlan & Holingsworth Corp., Wilmington

District of Columbia

OAKES, Charles E., Associate Electrical Engineer, Bureau of Standards, Washington

Illinois

ALLEN, Harold F., Mechanical Engineer, Link Belt Co., Chicago

Maryland

MOORE, Walter E. J., Chemical Warfare Section, Edgewood Arsenal, Edgewood

Massachusetts

ALEXANDER, Harold C., Machine Designer, The Lapointe Machine Tool Co., Hudson
DUNCAN, Joseph B., Industrial Engineer, New England Westinghouse Co., Chicopee Falls
LENK, David A., District Gauge Supervisor, Gauge Section, Insp. Division, Ordnance Department, U. S. A., Boston
WILLIAMS, Fred C., Jr., Assistant to Mechanical Engineer, The Fiberloid Corp., Indian Orchard

Michigan

CULVER, Edward P., Second Lieutenant, Air Service Aeronautics, U. S. A., Instrument Officer, Mt. Clemens
GILLIARD, Pierre G., Chief Engineer and Factory Manager, Michigan Wheel Co., Grand Rapids
HERBERT, Robert H., Inspector of Naval Gun Mounts, Linderman Steel Mach. Co., Muskegon

New Hampshire

NEWTON, Wilbur F., Marine Draftsman, Portsmouth Navy Yard, Portsmouth

New Jersey

GROB, John J., Construction Engineer for Main Power House, H. & M. R. R., Jersey City

New York

BIDERMANN, Frederick A., Junior Engineer, Bureau of Engineering, New York
CRAIG, Thomas H., Jr., Salesman, Manning, Maxwell & Moore, Inc. New York
FOX, Samuel M., Ensign, U. S. Naval Reserve Force, Aeroplane Inspection, Buffalo
GIES, Claude T., Mechanical Designer, Otis Elevator Co., New York
GUTHRIE, Robert G., Engineer, Laboratory of the Curtiss Aero Corporation. Buffalo
KOSWICK, Alexander A., Assistant to Buyer of Fabricated and Special Tools, Wright, Martin Aircraft Corp., New York

North Carolina

SHERRILL, Sloan S., Mechanical Engineer, Chemical Construction Co., Charlotte

Pennsylvania

BROWN, Charles H., Jr., Supervisor of Electric Machinery and Lines, Atlantic Refining Co., Philadelphia
DUDA, Wentzel R., Designer, United Engineering and Foundry Co., Pittsburgh
FAGERSTROM, Otto, Draftsman, Carnegie Steel Co., Duquesne

South Carolina

BLACKWELDER, Charles D., Assistant Chief Mechanical Engineer, American Machine & Manufacturing Co., Greenville

Texas

GRAEF, Louis F., Draftsman, American Smelting & Refining Co., El Paso

Vermont

KEATOR, Simon P., Cost Engineer, Vermont Farm Mach. Co., Bellows Falls

Virginia

WIDELL, Berndt A., Jr., Assistant Engineer, Coast Artillery Corps, Fifth Training Co., Fort Monroe

CHANGE OF GRADING

PROMOTION FROM JUNIOR

Minnesota

HANSON, John J., First Lieutenant, Ordnance R. C., Inspection Section, Carriage Division, Minneapolis Steel & Machinery Co., Minneapolis

New York

FRITZ, Aime L. G., Superintendent of Construction, H. R. Kent & Co., New York
ROMAN, Henry, in Charge of the Designing of Liquid Air Plants, Air Nitrates Corp., New York

Pennsylvania

LAMOREE, James K., Mechanical Engineer, American Sheet & Tin Plate Co., Shenango Works, Newcastle

Rhode Island

BROWN, Wendall S., Industrial Engineer, F. P. Sheldon & Sons, Providence

PROMOTION FROM ASSOCIATE MEMBER

Connecticut

JENNINGS, Irving C., Vice President and General Manager, Chief Engineer, Nash Engineering Co., South Norwalk

Missouri

MacKINNON, James A., Superintendent of Forge Shop, Scullin Steel Co., St. Louis

New York

HUBBARD, Frank B., Plant Engineer, Pierce Arrow Motor Car Co., Buffalo
MOORE, William J., Consulting Engineer, Inter-Continental Machinery Corp., New York

Pennsylvania

FICKES, Alfred C., Mechanical Engineer, Lancaster Iron Works, Inc., Lancaster
FREEMAN, Perry J., Engineer of Tests, Pittsburgh Testing Laboratory, Pittsburgh

PROMOTION FROM ASSOCIATE

Philippine Islands

DUFFY, Owen, Superintendent and Chief Engineer, Insular Cold Storage and Ice Plant, Manila

SUMMARY

New applications	161
Applications for change of grading:	
Promotion from Junior	5
Promotion from Associate-Member	6
Promotion from Associate	1
Total	173

SUMMARY SHOWING AVERAGE AGE AND POSITIONS OF APPLICANTS ON BALLOT SEPTEMBER 23, 1918

Average age of applicants:	
Members	40
Associates	39
Associate-Members	31
Juniors	25
Calculator	1
Chemical Engineer	1
Chief Engineer	4
Contracting Engineer	2
Construction Engineer	4
Consulting Engineer	1
Designers	6
Draftsmen	5
Chief Draftsmen	7
Estimator	1
Electrical Engineer	1
Executives (Pres., Vice Pres., Secy. Treas., Mgrs.)	27
Foremen	2
Assistant Foreman	1
Inspectors	2
Assistant Inspector	1
Instructors	2
Industrial Engineer	1
Managing Engineer	1
Master Mechanics	2
Mechanical Engineers	40
Assistant Mechanical Engineers	2
Power Engineers	2
Production Engineers	2
Professors	2
Purchasing Assistant	1
Resident Engineer	1
Sales Agent	1
Sales Engineers	6
Sales Managers	2
Superintendents	12
Assistant Superintendents	5
Supervising Engineers	2
Works Engineers	2
Miscellaneous	35
UNITED STATES GOVERNMENT SERVICE:	
Majors	2
Captains	2
First Lieutenants	6
Second Lieutenants	3
Ensigns	2
Sergeant	1

SELECTED TITLES OF ENGINEERING ARTICLES

THE section Selected Titles of Engineering Articles comprises an index to current articles on mechanical engineering and related subjects.

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Chief attention is paid to articles directly concerned with the branches of mechanical engineering. When it is thought they will be of interest or value to mechanical engineers, however, other articles are listed, in the realms of physics and chemistry; civil, mining and electrical engineering, technology, etc.; and in subjects in broadly related fields such as training and education, safety engineering, fire protection, employment of labor, welfare work, housing, cost keeping, patent law, public relations, etc. Cross-references are introduced and where the titles themselves are not sufficiently descriptive, explanatory sentences are appended. The main abbreviations used in the items are given at the bottom of this page.

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AERONAUTICS

Aerostatics

Military Aerostatics. H. K. Black. Aerial Age, vol. 7, nos. 22 and 23, Aug. 12 and 19, 1918, p. 1064, 1 fig., pp. 1118-1119, 1 fig. (Aug. 12). Features of the Cacquot observation balloon; (Aug. 19). Action of automatic valve. (Continuation of a serial.)

Altitudes

The Flight of an Aeroplane at Different Altitudes. L. de Bazillac. (Translated from original French by B. Bruce Walker). Flight, vol. 10, nos. 28 and 29, July 11 and July 18, 1918, pp. 779-781, 4 figs., and pp. 811-813, 3 figs. (July 11). Equations involved in the study of two ways of flying the aeroplane under the thrust of contact: 1, at constant speed and increasing altitude, the engine running normally all the time; 2 keeping altitude constant by reducing speed of engine in proportion in which the oil and petrol are consumed. (July 18). Curves and formulæ; resistances per unit weight in terms of angle of attack. (Continuation of serial.)

Engine Pistons

Report on Aluminum Pistons from 230 HP Benz Engines. Aeronautics, vol. 15, no.

NOTE.—The abbreviations used in indexing are as follows: Academy (Acad.); And (&); American (Am.); Associated (Assoc.); Association (Assn.); Bulletin (Bul.); Bureau (Bur.); Canadian (Can.); Chemical or Chemistry (Chem.); Electrical or Electric (Elec.); Electrician (Elecn.); Engineer [s] (Engr. [s]); Engineering (Eng.); Gazette (Gaz.); General (Gen.); Geological (Geol.); Heating (Heat.); Industrial (Indus.); Institute (Inst.); Institution (Instn.); International (Int.); Journal (Jl.); London (Lond.); Machinery (Machy.); Machinist (Mach.); Magazine (Mag.); Marine (Mar.); Materials (Matls); Mechanical (Mech.); Mining (Min.); Municipal (Mun.); National (Nat.); New England (N. E.); New York (N.Y.); Record (Rec.); Refrigerating or Refrigeration (Refrig.); Review (Rev.); Railway (Ry.); Scientific or Science (Sci.); Society (Soc.); United States (U. S.); Ventilating (Vent.); Western (West.); State names (Ill., Minn., etc.); Proceedings (Proc.); Transactions (Trans.); Supplement (Supp.).

247, July 10, 1918, pp. 46-48, 4 figs. Details of design and result of a metallurgical analysis of the composition of the alloy carried out by R.A.E. Engine was taken from the Aviatik biplane G.130, captured Feb. 12, 1918. Issued by Technical Dept., Aircraft Production, Ministry of Munitions. Account also published in Flight, vol. 10, no. 27, July 4, 1918, pp. 744-745, 4 figs. Automotive Industries, vol 39, no 9, Aug. 29, 1918, p. 361, 2 figs.; Aviation, vol. 5, no. 2, Aug. 15, 1918, p. 93, 1 fig.; Engineering, vol 106, no. 2740, July 5, 1918, p. 18, 4 figs.

Engine Temperature Control

Making the Aviation Engine Fit for Any Altitude. Sci. Am., vol. 119, no. 6, Aug. 10, 1918, p. 109. Automatic temperature control used in Sturtevant engine.

Engines

The 180 hp. Mercedes Aero-Engine. Aviation, vol. 5, no. 2, Aug. 15, 1918, pp. 98-101, 10 figs. Report on design of engine issued by the Technical Department, Aircraft Production, British Ministry of Munitions.

The Design of Aeroplane Engines, John Wallace. Aeronautics, vol. 15, nos. 247 and 248, July 10 and July 17, 1918, pp. 44-46, 5 figs., and pp. 59-61, 3 figs. (July 10), Air and water cooling of the cylinders; indicator diagram; compression ratio; mean effective pressure; (July 17), power; construction of theoretical indicator diagram; comparison of results. (Continuation of serial.)

Individual Types

Report on the Friedrichshaffen Bomber. Flight, vol. 10, nos. 27, 28 and 29, July 4, 11 and 18, 1918, pp. 737-741, 770-773, 41 figs., and pp. 793-796, 15 figs. F.D.H. G.3 brought down by anti-aircraft fire at Isbergues on Feb. 16. Construction of wings, struts, ailerons, fin and fixed tailplanes; elevators, rudders, bracing, fuselage, engines, radiators, oil pump, petrol tanks, pipings, and propeller. Issued by Tech. Dept., Aircraft Production, Ministry of Munitions. (July 18), Controls; landing gear; instruments; bombs and bomb gear; fabric. (Concluded.)

Some War-Time French Airplanes and Hydroplanes. Automotive Eng., vol. 3, no. 7, Aug. 1918, pp. 304-309, 5 figs. Details of the machine design and construction, also their machine-gun and other equipment. Type of motor mostly used. Some well-known fighting planes of widely varying types. (Second of series.)

The L.V.G. Biplane Type C.V. (Translation from L'Aérophile). Aerial Age, pp. 1122-1123. Comparative specifications of L.V.G. biplanes C.II, C.IV, C.V, and Rumpler C.IV.

The Roland Single-Seater Chaser, D II. Flight, vol. 10, no. 28, July 11, 1918, pp. 765-767, 8 figs. Dimensions, construction of fuselage, form of planes, shape of tail, and armament. (Translated from L'Aérophile.) Also published in Automotive Industries, vol. 39, no. 7, Aug. 15, 1918, pp. 267-268, 2 figs. Mechanical details of fast machine of light construction; fuselage built of plywood covered with fabric.

The S.E. 5A Single Seater Fighter. Automotive Industries, vol. 39, no. 8, Aug. 22, 1918, pp. 315-317, 2 figs. Mechanical details of British machine adopted by U. S. Army authorities; weighs 1554 lb. without load and is equipped with 200 hp. Hispano engine.

Instruments

Navigation Instruments of Our Aerial Pilots. Sci. Am., vol. 119, no. 7, Aug. 17, 1918, pp. 141-142. Tachometer, air speed indicator, altimeter, airplane compass, airplane clocks, pressure gages, radiator thermometer, banking indicator and Aldis sight.

Italian Air Service

Plans and Accomplishments of the Italian Air Service. Automotive Industries, vol. 39, no. 7, Aug. 15, 1918, pp. 272-276, 13 figs. Types of machines that have been developed.

Metal Fittings

Strut Sockets and Other Sheet-Metal Airplane Fittings, Fred H. Colvin. Am. Mach., vol. 49, no. 6, Aug. 8, 1918, pp. 253-256, 15 figs. Illustrated description of making of built-up combinations of sheet-metal stampings and of forgings and stampings.

Model Aeroplanes

Model Aeroplane Building as a Step to Aeronautical Engineering. Aerial Age, vol. 7, no. 22, Aug. 12, 1918, 1 fig. Drawing giving size and dimensions. (To be continued.)

Model Aeroplanes, F. J. Camm. Aeronautics, vol 15, no. 248, July 17, 1918, p. 68. Study of problem of maintaining coincidence of centers of pressure and gravity in aeroplane flying. (To be continued.)

Mufflers

Exhaust Headers and Mufflers for Airplane Engines, Archibald Black. Gas Eng., vol. 20, no. 9, Sept., 1918, pp. 429-436, 14 figs. Types that have been used and are being used; figures from tests of loss due to muffler; list of references to other literature. Also published in Automotive Industries, vol. 39, no. 4, July 25, 1918, pp. 145-157, 15 figs. Paper presented before S.A.E.

Propellers

Notes on Airscrew Analysis, M. A. S. Riach. Aeronautics, vol. 15, no. 247, July 10, 1918, pp. 41-42, 2 figs. Modifications introduced into the original theory, outlined in The Screw Propeller in Air, Proc. Aero. Soc., Mar. 21, 1917, in order to take account, in a quantitative manner, of the conception of a rotation set up in the fluid both before and behind the actuator disk. (Continuation of serial.)

Predicting Strength and Efficiency of Airplane Propellers, F. W. Caldwell. Automotive Industries, vol. 39, no. 4, July 25, 1918, pp. 152-155. Formulæ and curves; Conventional design compared to adjustable-pitch propeller; efficiency under climbing conditions; comparison of climbing rates; engine with constant torque. (Concluded.) Also published in Aerial Age, vol. 7, no. 21, Aug. 5, 1918, pp. 1011-1018, 14 figs.

The Efficiency of an Airscrew, M. A. S. Riach. Aeronautics, vol. 15, no. 247, July 10, 1918, pp. 38-39. Examination of the quantities in the formula for the efficiency of any blade element, $N^1_x = \tan A/\tan (A^1 + \gamma^1)$ derived in "The Screw Propeller in Air," Proc. Aero. Soc., Mar. 21, 1907.

Wooden Wings for the Modern Mercury. Motor Boating, vol. 22, no. 2, Aug. 1918, pp. 22-23. Various processes employed by the French in the manufacture of propellers for their airplanes.

Royal Aircraft Factory

Products of the Royal Aircraft Factory. Automotive Industries, vol. 39, no. 6, Aug. 8, 1918, pp. 236-238, 12 figs. Models of planes developed by British Government. Further development work left to private concerns.

Standards

International Aircraft Standards. Aeronautics, vol. 15, no. 248, July 17, 1918, pp. 66-67. Specifications for aeroplane spar varnish; specifications for mercerized cotton aeroplane fabric. (Continued.)

Steel Tubes

Steel Tubes Manipulation and Tubular Structures for Aircraft, W. W. Hackett and A. G. Hackett. Automotive Eng., vol. 3, no. 7, Aug. 1918, pp. 315-318. Front forks for cycles; tapered tubes; tubular liners or reinforcements; tube manipulation; tubular joints in aircraft construction; soft-soldered joints; tests on soldered joints; brazing; silver-soldering; welding. (Second of series.)

Wing Fabrics

Cotton Airplane Fabric, S. Wakefield. Textile World Jl., vol. 54, no. 7, Aug. 17, 1918, pp. 37-39, 1 fig. Construction of yarn and cloth for standard specifications.

Wing Ribs

A New Method for the Testing of Airplane Wing Ribs, I. H. Cowdrey. Automotive Industries, vol. 39, no. 4, July 25, 1918, pp. 140-144, 5 figs. Shows how load application and distribution are controlled by a series of rubber bands, and describes apparatus employed.

See also Machine Tools (Propeller-Shaping Machine); Military Engineering (Anti-Aircraft Firing); Testing and Measurements (Balloon Fabrics).

AIR MACHINERY

Lubrication

Lubrication of Air Compressor Cylinders, W. H. Callan. Power, vol. 48, no. 7, Aug. 13, 1918, pp. 229-230. Résumé of experience showing that a light mineral oil is the lubricant to use.

Soot Blowers

Soot Blowers for Vertical and Hollow Stay-Bolt Boilers. Power, vol. 48, no. 7, Aug. 13, 1918, pp. 222-228, 21 figs. Details of various systems employed; protection for blower elements in high-temperature zones; blowers for hollow-staybolt boilers; continuous ash removal.

Tire Pumps

Official Test of Tire Pumps. Automotive Industries, vol. 39, no. 6, Aug. 8, 1918, p. 243, 1 fig. Curve showing r.p.m. of pump against seconds required to inflate tire, drawn from results obtained at laboratory of Automobile Club of America, New York, with the Cassco power tire pump.

Turbo Compressors

Turbo Air Compressor at the Holbrook Colliery. Engineer, vol. 126, no. 3267, Aug. 9, 1918, pp. 113-115, 7 figs. A 750-hp., 2-stage, reciprocating air compressor driven through helical gearing by a mixed-pressure turbine. Description of unit and its auxiliaries.

Ventilating Fan

New Ventilating Fan at Hardwick Collieries. Iron & Coal Trades Rev., vol. 97, no. 2630, July 26, 1918, p. 91, 1 fig. A 15-ft. fan replaced by smaller one of the multi-blade type.

See also Mines and Mining (Sprayers).

BRICK AND CLAY

Canadian Clay

Report of the Clay Resources of Southern Saskatchewan, N. B. Davis. Can. Department of Mines, no. 468, 1918, 93 pp., 21 figs. Report based on field work and laboratory tests, containing information regarding geological position, locality, and availability of each deposit, and behavior of samples tested in laboratories.

Clay Burning

Burning Clay Wares, Ellis Lovejoy. Clay-Worker, vol. 70, no. 2, Aug. 1918, pp. 128-130. Machine handling and setting; open-top continuous kilns. (Continuation of serial.)

Fire Brick—the Age of Clay Products. Brick & Clay Rec., vol. 53, no. 5, Aug. 27, 1918, pp. 369-371. How two plants in Pennsylvania are turning out their product.

See also Pipe (Clay Pipe).

BRIDGES

Concrete Bridges

Canadian Pacific Railway Viaducts at Toronto. Can. Engr., vol. 35, no. 6, Aug. 8, 1918, pp. 123-124. How it was possible to build two reinforced-concrete bridges 386 ft. long and 90 ft. high, having spans of 35 ft.

Concrete Highway Bridge Design. Surveyor, vol. 54, no. 138, July 5, 1918, p. 8. Ontario Highway Department's specifications.

Rebuilding the C. B. & Q. R. R. Bridge Over the Platte River, Near Grand Island, Neb. Ry. Rev., vol. 63, no. 4, July 27, 1918, pp. 117-120, 10 figs. Reinforced-concrete slabs on concrete piers with reinforced-concrete pile foundation.

Steel Bridges

Bridge Across the River Vistula at Warsaw. Engineer, vol. 126, no. 3265, July 26, 1918, pp. 80-81, 5 figs. Description of 504-meter bridge completed at outbreak of war.

Four-Span Steel Bridge Over the Nicolet River. Contract Rec., vol. 32, no. 27, July 3, 1918, pp. 519-520. Dimensions and brief account of erection.

The Economics of Steel Arch Bridges, T. K. Thomson, C. E. Fowler, W. B. Farr and H. P. Van Cleve. Proc. Am. Soc. Civ. Engrs., vol. 44, no. 6, Aug. 1918, pp. 843-870, 9 figs. Study and classification of 100 structures. Discussion of J. A. Waddell's paper. (Concluded.)

The Hell Gate Arch Bridge and Approaches of the New York Connecting Railroad Over the East River in New York City, C. E. Chase and O. H. Ammann. Proc. Am. Soc. Civ. Engrs., vol. 44, no. 6, Aug. 1918, pp. 759-766. Discussion of O. H. Ammann's paper.

Stresses

Why Do Some Bridges Stand Up? E. H. Darling. Contract Rec., vol. 32, no. 34, Aug. 21, 1918, pp. 655-656, 2 figs. Table of estimated stresses under various conditions.

Truss Spans and Towers

New Bridge on the B. & L. E. a Notable Structure. Ry. Age, vol. 65, no. 8, Aug. 23, 1918, pp. 345-351, 16 figs. Continuous trusses and unique construction methods noted.

Oregon-Washington Railroad and Navigation Company's Portland Bridge. Ry. Gaz., vol. 29, no. 2, July 12, 1918, pp. 46-50, 3 figs. Structure and substructure details of the three riveted truss spans and of the two towers between which the central span is lifted vertically.

Wilson Bridge

Wilson Bridge, Over the Rhone, at Lyon (Le pont Wilson, sur le Rhone, à Lyon), A.

Dumas. Génie Civil, vol. 73, no. 2, July 13, 1918, pp. 21-28, 15 figs. Details of construction, sections and dimensions.

BUILDING AND CONSTRUCTION

Coaling Station

An Example of Modern Coaling Station Construction. Ry. Gaz., vol. 29, no. 5, Aug. 2, 1918, pp. 127-128, 4 figs. Ground plan showing track arrangement and elevation of towers of new reinforced-concrete structure at Manchester, N. Y.

Condensation on Under Surface of Roof

See Roof Construction below.

Coördination

Coördination Saves Six Weeks' Construction Time on Big Building. Eng. News-Rec., vol. 81, no. 7, Aug. 15, 1918, pp. 300-304, 5 figs. Duplicate equipment throughout eliminates plant delays; manual operations proceed on time-table schedule, promoting *esprit de corps*.

Grain Warehouse

New Reinforced-Concrete Grain Warehouse in Genoa (Nuovo magazzino in cemento armato per grani nel porto di Genova). Ingegneria Italiana, vol. 2, no. 30, July 11, 1918, pp. 17-23, 11 figs. General plans and dimensions.

Mill Buildings

A Very Modern Manufacturing Plant, W. H. Roberts. Wood-Worker, vol. 37, no. 6, Aug. 1918, pp. 32-33, 6 figs. Notes on the fireproof construction, equipment, methods, safety devices, ventilation, lighting, and sprinkler system of Weiss Mfg. Co., Monroe, Mich., manufacturers of sectional bookcases, office furniture, etc.

Is Wood a Suitable Material for the Construction of Mill Buildings? W. Kynoch and R. J. Blair. Contract Rec., vol. 32, no. 32, Aug. 7, 1918, pp. 622-623, 2 figs. Examination of facts from a technical standpoint.

Roof Construction

The Relative Effectiveness of Various Types of Roof Construction in Preventing Condensation on the Under Surface, W. S. Brown. Building News, vol. 115, no. 3317, July 31, 1918, pp. 80-81, 1 fig. Graphs obtained mainly from experiments made in testing laboratory of F. P. Sheldon and Son, Providence, R. I. Paper before Nat. Assn. Cotton Mfrs.

Shipyard

Concrete Shipyard at Wilmington, N. C., A. G. Monks. Int. Mar. Eng., vol. 23, no. 8, Aug. 1918, pp. 452-454. Description of plant erected by Liberty Shipbuilding Co., Boston, Mass., for building concrete ships.

Stacks

Boiler House as Stack Foundation, L. C. Huff. Power, vol. 48, no. 5, July 30, 1918, pp. 150-152, 5 figs. Four-story concrete building used as foundation for 240-ft. steel stack; supports and bracing to withstand wind pressure.

Warehouse

Army Depot at Chicago is Large Concrete Warehouse, A. Epstein. Eng. News-Rec., vol. 81, no. 6, Aug. 8, 1918, pp. 269-270, 1 fig. Floor area 29 acres in 6-story building; tracks on first floor; tunnels for trucking and utilities.

See also Cement and Concrete (Roofs); Labor (Housing).

CEMENT AND CONCRETE

Buildings

Economy in the Design of Concrete Buildings, C. W. Mayers. Contract Rec., vol. 32, no. 34, Aug. 21, 1918, pp. 659-662. Remarks and suggestions. Paper before Am. Concrete Inst.

Cement Gun

Varied Applications of the Cement Gun. Eng. & Cement World, vol. 13, no. 3, Aug. 1, 1918, p. 40. Recent uses and composition of mixture applied by cement gun.

Columns

Economy in the Design of Columns for Concrete Buildings, Clayton W. Mayers. Contract Rec., vol. 32, no. 36, Sept. 4, 1918, pp. 712-716, 6 figs. Aberthaw Construction Co. Before Am. Concrete Inst.

Temperature Tests on Concrete Columns, W. A. Hull. Contract Rec., vol. 32, no. 31, July 31, 1918, pp. 605-607. Résumé of tests on gravel and limestone concrete columns carried out in the U. S. Bureau of Standards. Abstract of paper before Am. Concrete Inst.

Dams

Lukewarm Concrete Enough Precaution for Zero Weather Dam Work. Eng. News-Rec., vol. 81, no. 6, Aug. 8, 1918, pp. 260-262, 3 figs. Perfect bond and sound concrete secured by placing 50-deg. mixture on frozen surfaces; concreting kept up in heavy frosts.

Deterioration

Action of Sea Water on Concrete in Structures Exposed to Tides (Action de l'eau de mer sur les ouvrages en béton exposés aux marées), E. R. Matthews. Mémoires et Comptes Rendus des Travaux de la Société des Ingénieurs Civils de France, year 71, nos. 1-3, Jan.-Mar. 1918, pp. 40-42. Results of experiments made at Hull, England, on 6-in. cubes. Abstract of paper before Soc. of Civ. Engrs., France.

Concrete in Alkali Soil at Saskatoon, H. McI. Weir. Jl. Eng. Inst. of Canada, vol. 1, no. 4, Aug. 1918, pp. 153-154. Physical condition and appearance of a number of cases in alkali ground and comparison of these with conditions found in ground free from alkali.

Deterioration of Concrete, B. Stuart McKenzie. Jl. Eng. Inst. of Canada, vol. 1, no. 4, Aug. 1918, pp. 150-152. Examples of deterioration under various conditions and results of experiments conducted by City Analyst of Winnipeg.

Foreign Concrete Regulations

English and Canadian Concrete Regulations, W. W. Pearse. Can. Engr., vol. 35, no. 7, Aug. 15, 1918, pp. 143-147. Comparison between Toronto's by-law regulating reinforced-concrete construction and new by-law of London County Council which adopts 180 lb. per sq. in. shearing stress and favors hooking the ends of reinforcing in beams.

Mortars

Ancient and Modern Mortar, W. J. Dibdin. Concrete Age, vol. 28, no. 5, Aug. 1918, p. 19. Abstract of paper before Faraday Soc. of London.

Proportioning the Materials of Mortars and Concretes by Surface Areas of Aggregates, L. N. Edwards. Contract Rec., vol. 32, No. 31, July 31, 1918, pp. 599-604, 12 figs. Methods, materials used, results obtained and phenomena observed in a series of experimental tests undertaken to develop the practical application of this method. Abstract of paper before joint meeting of Am. Concrete Inst. and Am. Soc. for Testing Materials.

Mixing

Effect of Time of Mixing on the Strength of Concrete, D. A. Abrams. Can. Engr., vol. 35, no. 6, Aug. 8, 1918, pp. 132-134, 5 figs. Comparison of hand and machine mixing; effect of rate of rotation of mixer drum; effect of age on strength; curves showing temperature of mixing water against compressive strength; yield and density of concrete. (Concluded.)

Reinforced Concrete

Discussion on Final Report of the Special Committee on Concrete and Reinforced Concrete, C. S. Bissell. Proc. Am. Soc. Civ. Engrs., vol. 44, no. 6, Aug. 1918, pp. 897-903. Method for designing reinforced beams and slabs from equations given in report. (Concluded.)

Roofs

Concrete Roof Specifications. Contract Rec., vol. 32, no. 36, Sept. 4, 1918, p. 716. Recommendations of Sandusky Cement Co.

Strength of Concrete

Some Tests on the Effect of Age and Condition of Storage on the Compressive Strength of Concrete, H. F. Gonnerman. Can. Engr., vol. 35, no. 6, Aug. 8, 1918, pp. 135-137, 4 figs. Results of tests made at the Univ. of Ill. Paper before Am. Concrete Inst.

Swimming Pools

How to Build Reinforced Swimming Pools. Concrete Age, vol. 28, no. 5, Aug. 1918, pp. 10-12, 3 figs. Suggestions for designing.

Ties

Concrete on Railways. Ry. Gaz., vol. 29, no. 3, July 19, 1918, pp. 72-74, 7 figs. Shapes and sizes of blocks used as ties for rails.

Trestles

Reinforced Concrete Trestles at North Toronto. Ry. Age, vol. 65, no. 7, Aug. 16, 1918, pp. 289-291, 7 figs. Unique details developed in viaducts designed as a substitute for steel construction.

See also Fuel and Firing (Waste Heat); Marine Engineering (Concrete Ships).

CHEMICAL TECHNOLOGY

Ammonia

Notes on the Catalytic and Thermal Synthesis of Ammonia, E. B. Maxted. Jl. Soc. Chem. Industry, vol. 37, no. 14, July 31, 1918, pp. 232T-235T, 3 figs. Discussion of some points in the Haber synthesis and of methods employed and results obtained in connection with measurement of ammonia equilibrium at high temperatures.

The "Direct" Process of Sulphate Making in Gas-Works, W. S. Curphey. Gas Jl., vol. 143, no. 2879, July 16, 1918, pp. 111-113. Experiments on rotation system; effect of seasonal changes on ammonia; discussion of results of investigations carried out at various works. From annual report of chief alkali inspector. (Continuation of serial.)

Analysis, Steel

Combustion Train for Carbon Determination, J. B. Stetser and R. H. Norton. Iron Age, vol. 102, no. 8, Aug. 22, 1918, pp. 443-445, 1 fig. Apparatus giving results in 6 min. and meeting color-test inaccuracies arising from varying heat treating of samples.

The Determination of Cobalt and Nickel in Cobalt Steel, W. R. Schoeller and A. R. Powell. Iron & Steel Inst. of Canada, vol. 1, no. 7, Aug. 1918, pp. 304-306. Application of process based on precipitation of hexammine cobaltons and hexammine nickelous iodides by means of potassium iodide in strongly ammoniacal solution, the precipitation of the trivalent metals by the ammonia being prevented by addition of tartaric acid. Paper before British Iron & Steel Inst. Published also in Blast Furnace & Steel Plant, vol. 6, no. 9, Sept. 1918, pp. 359-360; Proc. British Iron & Steel Inst., May 2-3, 1918, Paper no. 22, 5 pp.

Analysis (Varia)

A Method for the Separation and Determination of Barium Associated with Strontium, F. A. Gooch and M. A. Soderman. Am. Jl. of Sci., vol. 46, no. 273, Sept. 1918, pp. 538-540. Results of attempt to adapt process used for separating barium from calcium and magnesium, which consists in throwing the barium out of solution by the addition of a 4:1 mixture of concentrated hydrochloric acid and ether.

A New Method of Estimating Zinc in Zinc Dust, L. A. Wilson. Eng. & Min. Jl., vol. 106, no. 8, Aug. 24, 1918, pp. 334-336, 1 fig. Abstract from paper before Am. Soc. for Testing Materials.

Charcoal

Charcoal and Allied Industries (La destilación de la madera). Boletín de la Sociedad de Fomento Fabril, year 35, no. 4, Apr. 1918, pp. 244-249. Processes used with different woods; obtainable by-products and their temperatures of distillation. (To be continued.)

Coal-Tar Products

Constituents of Coal Tar, P. E. Spielmann. Gas Jl., vol. 143, no. 2879, July 16, 1918, p. 114. Enumeration of multiple six-ring and of five-member ring hydrocarbons. (Continuation of serial.)

Notes on the Commercial Fractional Separation of Benzene, Toluene, and Xylenes, T. H. Butler. Jl. Soc. Chem. Industry, vol. 37, no. 14, July 31, 1918, pp. 220T-222T, 5 figs. Factors making efficiency in plants of coal-tar hydrocarbons.

The Recovery of Light Oils and Refining of Toluol. Engineering, vol. 106, no. 2743, July 26, 1918, pp. 83. Sources of light oils, coal gas, water gas and oil gas; outline of processes; scrubbers, heat exchangers, superbeater and stripping still, wash-oil cooler, condenser, separator, crude rectifying stills, agitator and rectifying stills.

Dyestuffs

Dyestuffs, L. J. Matos. Jl. Franklin Inst., vol. 186, no. 2, Aug. 1918, pp. 187-209, 8 figs. History of development of dye industry; chemistry of industry; diagrams illustrating manufacture of certain dyestuffs.

Filter

A New Form of Ultra-Filter. Jl. Am. Chem. Soc., vol. 40, no. 8, Aug. 1918, pp. 1226-1230, 2 figs. Laboratory arrangement consisting essentially of dializer and pervaporator connected by a siphon.

Glass

Electrothermic Methods of Glass Manufacture (Métodos electrotérmicos para la fabricacion del vidrio). Boletin de la Sociedad de Fomento Fabril, year 35, no. 3, Mar. 1918, pp. 161-170, 10 figs. Four types of furnaces: Becker, Brown, Jablochkoff, and Sauvageon.

Scientific Glassware, Morris W. Travers. Jl Soc. Chem. Industry, vol 37, no. 14, July 31, 1918, pp 235T-239T. Account of efforts to replace Jena glass in recently established factory at Walthamstow England.

The Manufacture of Optical Glass, S. A. Hand Am. Mach., vol 49, no. 9, Aug. 29, 1918, pp 367-372, 7 figs. History of demand for optical glass and attempts to produce it finally resulting in success at Jena. The solving of the problem in America and its production here.

Laboratory

Equipping a Shop Laboratory. Machy., vol. 24, no. 12, Aug. 1918, pp. 1087-1090, 5 figs. Arrangement of shop laboratory and brief explanation of methods used in analysis of iron and steel.

Nitrates

The Nitrogen Problem in Relation to the War, A. A Noyes. Sci. Am. Supp., vol. 86, no 2224, Aug. 17, 1918, pp. 98-99. Resources and methods for making materials required for explosives. Paper before joint meeting of Wash. Acad. of Sciences and Chem. Soc. of Wash. From Jl. of Wash. Acad. of Sciences.

Oil Industry

A New British Oil Industry, E. H. Cunningham Craig, F. M. Perkin, A. G. V. Berry and A. E. Dunstan. Jl Inst. Petroleum Technologists, vol. 4, no. 15, Apr. 1918, pp. 110-134. Processes to obtain oil by distillation from oil-shales, coal, cannel coals and torbanites, blackband ironstones, lignite and peat.

Make More Gasoline From Petroleum, and Toluol, Too, Louis Bond Cherry. Automotive Eng., vol. 3, no. 7, Aug. 1918, pp 319-320. Further details of process described in Jan. 1918 issue.

The Burton Process of Refining Petroleum, Burton. Petroleum Rev., vol. 39, nos. 833 and 834, July 6 and 13, 1918, pp. 5-6 and 31. How it was invented and developed. From address before Am. Chem. Soc.

Oils, Vegetable

On Refining of Niitzu Crude Oil (in Japanese), M. M. Ozuta and Kenzo Sato. Jl. Soc. M. E., Tokyo, vol. 21, no. 53, July 1918.

Peat

Galeine and Houlbert Apparatus for the Distillation of Peat (Appareil, système Galcine et Houlbert, pour la distillation des tourbes). Génie Civil, vol. 73, no. 2, July 13, 1918, pp. 31-35, 2 figs. Scheme and operation.

The Nitrogen Distribution in Peat from Different Depths, C. S. Robinson and E. J. Miller. Jl. Am. Peat Soc., vol. 11, no. 3, July 1918, pp. 158-191, 8 figs. Experimental work: Study of variation in nitrogen partition in peat with depth or age and state of decomposition; comparison of its composition with that of pure proteins; nitrogen availability as determined by the alkaline permanganate method. Reprint of Mich. Agri. College, Tech. Bul. no. 35.

Periodic Table

A Modification of the Periodic Table, Ingo W. D. Hackh. Am. Jl. of Sci., vol. 46, no. 273, Sept. 1918, pp. 481-501, 2 figs. Prediction that no new gas can be discovered from periodic curves obtained by plotting the atomic weights of the known elements by their relative position in the displacement series and by their polar numbers; account for formation of such groups as Fe-Co-Ni, Ra-Rh-Pd, Os-Ir-Pt, and the rare earths; tables showing the close relationship between polar number and isomorphism and the periodicity of the specific gravity; system of the radioactive elements.

Potash

The Estimation of Potash, B. Blount. Chem. News, vol. 117 no. 3052, July 19, 1918, pp. 242-244. Method for the estimation of potash in siliceous rocks, clays, etc., by treatment with hydrofluoric and sulphuric acids.

The Prospects of Founding a Potash Industry in This Country, K M Chance. Iron & Coal Trades Rev., vol. 97, no. 2630, July 26, 1918, pp. 86-87. Paper, with discussion, before Soc. of Chem. Industry, Bristol, July 1918.

Rubber

The Object of the Vulcanization Process. India-Rubber Jl., vol. 56, no. 2, July 13, 1918, p. 9. Description of changes brought about.

What the Rubber Chemists Are Doing. India Rubber World, vol. 58, no. 5 Aug. 1, 1918, pp. 651-655. Influence of sodium sulphate, formalin, soda, bisulphite of soda, sodium thiosulphate, sodium acetate, and sulphurous acid on the inherent properties; determination of nitrogen; comparative physical tests.

Sulphite

Bisulphite Liquor and Its Constituents, J. Beveridge. Paper, vol. 22, no. 23, Aug. 14, 1918, pp 11-14. Study of the waste problem and suggestions for the recovery of useful materials.

Sulphite Pulp Manufacture, R. E. Cooper. Paper, vol 22, no. 25, Aug. 28, 1918, pp. 11-13. Chemistry of process and details of various operations.

Wool

Present Practice in Wool Carbonization, Textile World Jl., vol. 54, no. 6, Aug. 10, 1918, pp. 25-27. Comparison of methods in present practice.

See also Coal Industry (Coking.)

CLAY

(See Brick and Clay)

COAL INDUSTRY

Briquetting

The Briquetting of Lignites, R. A. Ross. Jl. Eng Inst. of Canada, vol. 1, no. 4, Aug. 1918, pp. 162-166. Feasibility of meeting fuel requirements in Saskatchewan and Manitoba by utilizing prepared lignites and sub-bituminous coals.

The Briquetting of Western Lignites, R. A. Ross. Contract Rec., vol. 32, no. 34, Aug. 21, 1918, pp 651-654. Present state of the art of producing carbonized lignite briquets; equipment recommended; commercial conditions; procedure. From report to Advisory Council for Scientific and Industrial Research.

Carbonization

Aspects of Low Temperature Carbonization of Coal, E. C. Evans. Jl. Soc. Chem. Industry, vol. 37, no. 14, July 31, 1918, pp. 212T-219T. Historical notes; theory of coking process; main differences in oven design for high- and low-temperature carbonization processes; cost of plant. Published also in Colliery Guardian, vol. 116, no. 3304, July 26, 1918, pp. 176-177; Iron & Coal Trades Rev., vol. 97, no. 2630, July 26, 1918, pp. 88-89. Paper before Soc. of Chem. Industry.

Low Temperature Carbonization of Coals, J. L. Stevens Chem. Eng. & Min. Rev., vol. 10, no. 114, March 1918, pp. 167-170, 2 figs. Mashek process for carbonizing lignite up to 500 deg. cent.; chemistry of coal. (Continuation of serial.)

Coal Deposits

Coal Deposits in the Llapo District (Los yacumientos carboniferos del distrito de Llapo), A. P. Figuerola. Boletin del Cuerpo de Ingenieros de Minas del Perú, no. 89, 24 pages, 1 map. Geography of the carboniferous district of Llapo; coal deposits; quality of the coal.

The Santo Tomas Cannel Coal, Webb Co., Tex. George H. Ashley. Department of the Interior, U. S. Geol Survey, Bul. 691-I, July 25, 1918, pp. 251-270, 12 figs. General features of the region; physical and chemical properties of the coal; analyses, geologic relations of coal beds; mines and mining.

Coking

An Innovation in the Coke Industry, John L. Gans. Coal Age, vol. 14, no. 6, Aug. 8, 1918, pp. 256-257. Entrance of beehive coke interests into the realm of by-product coke manufacture.

Some Characteristics of American Coals in By-Product Coking Practice, F. W. Sperr. Jl. Franklin Inst., vol. 186, no. 2, Aug. 1918, pp. 133-163, 20 figs. Relations of the by-product coke industry to modern warfare; technical phase of the subject.

The By-Product Coke Oven; Its Products, W. H. Blauvelt. Blast Furnace & Steel Plant, vol. 6, no 9, Sept. 1918, p. 392. Coke oven gas; recovery of benzol. Paper before Am. Inst. Min. Engrs.

Labor Situation

The Labor Situation, R. Dawson Hall. Coal Age, vol 14, no. 8, Aug. 22, 1918, pp. 365-367. General review of labor question in coal mines.

Micro-Chemical Examination

Micro-Chemical Examination of Coal in Relation to its Utilization, J. Lomax. Gas World, vol. 69, no. 1772, July 6, 1918, pp. 18-19. Methods used; results and their significance; carbonization results.

Mining

Can Output Be Increased Scientifically? W. E. Joyce. Coal Age, vol. 14, no. 8, Aug. 22, 1918, pp. 356-357. Writer believes a little modern science would increase coal output.

Coal Mining in Carbonado, Washington, F. G. Jarrett. Coal Age, vol. 14, no. 7, Aug. 15, 1918, pp. 308-312, 7 figs. Description of operations in very rough country.

Methods of Operation, J. F. K. Brown. Coal Age, vol. 14, no. 7, Aug. 15, 1918, pp. 313-315. Conditions influencing methods of coal mining.

Scraper Mining of Thin Bed Anthracite, E. P. Humphrey. Coal Age, vol. 14, no. 7, Aug. 15, 1918, pp. 316-318, 4 figs. Loading coal by means of a V-scraper driven by power.

Wasteful Methods in Mining, R. G. M. Bathgate. Sci. & Art of Min., vol. 28, no. 26, July 27, 1918, pp. 473-475. Conditions in Indian coalfields. From presidential address before Mining and Geological Inst. of India.

War Conditions

The Coal Problem Under War Conditions, H. H. Stoek, Coal Age, vol. 14, no. 9, Aug. 29, 1918, pp. 393-396. Discussion, with suggestions, of present situation.

Washing

A New Method of Separating Slate from Coal, H. M. Chance. Jl. Engrs' Club of Phila., vol. 35-8, no. 165, Aug. 1918, pp. 369-377 and (discussion) 377-378, 6 figs. Survey of apparatus in present use; new methods of effecting separation by means of agitated mixture of sand and water constituting a fluid mass of relatively high specific gravity, in which the coal floats and the slate sinks; application of this principle to other ore-dressing problems. Paper before Engrs.' Club.

Notes on Coal Washing, L. Crawford. Gas World, vol. 69, no. 1172, July 6, 1918, pp. 14-15. Principle of the separation by washing of two particles of equal diameter; table of variations in size or in density necessary to produce appreciable variations in rate of fall, calculated from Rittinger's empirical formula for the limiting velocities of fall of various particles.

The Rheolaveur, W. Galloway. Proc. South Wales Inst. of Engrs., vol. 34, no. 2, July 19, 1918, pp. 105-112, 7 figs. Description of appliance for washing small coal along a sloping trough in a stream of water. From Bul. de la Société de l'Industrie Minérale.

CONCRETE

(See Cement and Concrete)

CONVEYING

(See Hoisting and Conveying)

DESICCATION

(See Drying)

DOCKS

France

American-Built Docks in France Completed by Pacific Coast Engineers, Robert K. Tomlin, Jr. Eng. News-Rec., vol. 81, no. 5, Aug. 1, 1918, pp. 208-216, 22 figs. Illustrated account of building of 4100-ft. structure.

New Orleans

New Orleans Builds Inner Harbor and Navigation Canal. Eng. News-Rec., vol. 81, no. 7, Aug. 15, 1918, pp. 304-307, 3 figs. Provides ocean docks and industrial sites on fixed level waterway between Mississippi River and Lake Pontchartrain.

DRYING

Evaporators

Liquid Level Control. Paper Mill, vol. 41, no. 36, Sept. 7, 1918, pp. 22-23 and 46, 2 figs. Device for automatically maintaining liquid levels in evaporators, closed and open tanks, etc., also for draining condensate from heating, drying, cooking and evaporating apparatus.

Low Temperature

Marmier and Canonne Apparatus for drying or Concentrating Liquids at Low Temperatures (Appareil Marimier et Canonne pour la dessiccation ou la concentration des liquides à basse température). Génie Civil, vol. 73, no. 4, July 27, 1918, p. 72, 1 fig. Apparatus operates under reduced pressure down to 37 deg. and is designed for preparation of concentrated serums and organic liquids.

Warm-Air Circulation

Drying by Warm Air Circulation. Eng. Rev., vol. 32, no. 1, July 15, 1918, pp. 14-16, 3 figs. Description of system adopted by the Sturtevant Eng. Co.

ELECTRICAL ENGINEERING

A. C. Motors

Calculation of Performance of Induction Motors Working in Conjunction with Flywheels and Slip Regulators, Herbert Vickers. Elecn. vol. 81, no. 12, July 19, 1918, pp. 248-250. Mathematical treatment of both the continuous and the intermittent slip regulator; also automatic slip regulator and Ward Leonard system.

Control of Induction Motors, C. E. Clewell. Elec. Wld., vol. 72, no. 10, Sept. 7, 1918, pp. 438-441, 12 figs. Fundamental methods outlined and explained; resistance-type starter, auto-transformer method, the use of the choke-coil feature and of so-called preventive resistance; automatic compensator.

The Commercial Application of Synchronous Motors, M. J. McHenry. Elec. News, vol. 27, no. 13, July 1, 1918, pp. 33-36, 2 figs. Attempt to point out principal characteristics which make synchronous motors applicable to certain classes of service, and discussion of industrial use of these motors in relation to central station and its customers.

A. C. Rectifier

An Interesting Alternating Current Rectifier for Charging Accumulators. Wireless World, vol. 6, no. 65, Aug., 1918, pp. 271-272, 1 fig. Device operating by means of a vibration tongue, which, actuated by magnets in circuit with alternating supply, automatically connects line first to one pair of contacts, then the other, in synchronism with supply current.

Armature Heating

Armature Heating in Traction Motors, L. Adler. Elecn. vol., 81, no. 2099, Aug. 9, 1918, pp. 311-312, 5 figs. Abstract of an article in Electrotechnische Zeitschrift, no. 26, 1917.

Bells

Electricity in Mining, L. Fokes, Sci. & Art of Min., vol. 28, no. 26, July 27, 1918, pp. 472-473, 1 fig. Construction, operation and comparison of trembler and single-stroke bells; resistance of bell coils. (Continuation of serial.)

Condensers

Static Condensers, W. B. Taylor. Gen. Elec. Rev., vol. 21, no. 8, Aug., 1918, pp. 565-569, 8 figs. Effect in service of using static condensers on circuits of low power factor, and comparison of this service with that afforded by installing additional feeder copper.

Dynatron

The Dynatron, A. W. Hull. Wireless Age, vol. 5, no. 11, Aug., 1918, pp. 941-951, 12 figs. Formulæ and calculations for the dynatron, a vacuum tube claimed to possess negative electric resistance; applications of the dynatron to radio work. (Continued.)

Electrodeposition

Construction and Operation of Electrolytic Copper Refinery, J. E. McAllister. Eng. & Min. Jl., vol. 106, no. 8, Aug. 24, 1918, pp. 337-341, 1 fig. From first report of Cadanian Munition Resources Commission.

Experiments with the Copper Cyanide Plating Baths, Frank C. Mathers. Metal Indus., vol. 16, no. 8, Aug., 1918, pp. 359-360. Paper before Am. Electro-Chem. Soc., May, 1918.

The Process of Depositing Silver on Glass and China, Howard Pearsall. Brass World, vol. 14, no. 6, June 1918, pp. 157-158. Formulæ and directions.

Electromagnets

The Stroke of an Alternating-Current Electromagnet, A. Thomälen. Elecn., vol. 81, no. 2097, July 26, 1918, pp. 267-268, 6 figs. Abstract of an article in Electrotechnische Zeitschrift, no. 39. A mathematical treatment.

Frictional Electricity

Experiments on Tribo-Electricity, P. E. Shaw. Elecn., vol. 81, no. 10, July 5, 1918, p. 209. Experiments in frictional electricity with solid bodies rubbed together under different physical conditions. Abstract of paper in Proc. of the Royal Soc.

Furnaces

Electric Furnace for Melting Alloys, William H. Easton. Elec. World, vol. 72, no. 7, Aug. 17, 1918, pp. 295-297, 3 figs. Control apparatus must be carefully selected to provide for heavy fluctuation of load; graphic records of power demand when melting nichrome and nickel steel in electric furnaces.

Temperature Uniformity in an Electric Furnace, J. B. Ferguson. Phys. Rev., vol. 12, no. 1, July 1918, pp. 81-94, 9 figs. Discussion of essential conditions for a proper control of temperature distribution and of previous attempts made to secure these conditions; description of a type of horizontal furnace designed for investigation requiring a uniform temperature over the range 620-1190 deg.

Fuses

The Development of 2500-Volt Fuses, Robert Charles Cole. Elec. World, vol. 72, no. 10, Sept. 7, 1918, pp. 436-437. Experimental investigations leading to development of a fuse that is not destroyed by modern high-power short circuits.

Generators

A Direct-Current Generator for Constant Potential at Variable Speed, S. R. Bergman. Proc. Am. Inst. Elec. Engrs., vol. 37, no. 8, pp. 1011-1018, 6 figs. Theory, diagrams of connections, and performance curves of a machine claimed to be self-excited and capable of inherent and instantaneous regulation independent of speed, load and heating.

Generators Employed in Telephone Exchanges. Elec. Rec., vol. 24, no. 3, Sept. 1918, pp. 67-69, 12 figs. Construction and use in modern common-battery telephone exchanges.

High-Speed Turbo-Generators. Practical Engr., vol. 58, no. 1641, Aug. 8, 1918, pp. 64-66, 7 figs. Survey of various methods of construction adopted by manufacturers in design of turbo alternators, and consideration of special characteristics of turbo direct-current machines.

Magnetic Pull in Electric Machines, E. Rosenberg. Proc. Am. Inst. Elec. Engrs., vol. 37, no. 9, Sept. 1918, pp. 1069-1113, 19 figs. Investigates whether in a given machine there is a "critical induction" which gives a higher unbalanced pull than any other induction, and also the permissible deflection of machine parts in connection with the unbalanced pull, and influence of latter on critical speed.

One Way of Raising the Output of an Electric Generator (Sur un moyen de forcer la puissance d'un générateur électrique), Ch. Vallet. L'Industrie Electrique, year 27, no. 626, July 25, 1918, pp. 265-267. Numerical comparison of three systems of cooling an electric machine. (Concluded.)

Harmonics

Higher Harmonics in Polyphase Electric Systems, V. Karapetoff. Elecn., vol. 81, no. 12, July 19, 1918, pp 250-251. Abstract of paper before Am. Assn. for Advancement of Science.

Inductive Interference

Inductive Effects of Alternating Current Railroads on Communication Circuits, H. S. Warren. Proc. Am. Inst. Elec. Engrs., vol. 37, no. 8, Aug. 1918, pp. 1019-1048. Discussion of inductive interference in general and in electrified railroads, including reference to work of Joint Committee on Inductive Interference in California; description of four important installations of railroad electrification and specific means adopted in each case for preventing interference, with degree of success which has been met with.

Lamps

Lamp Policy of the Fuel Administration. Elec. World, vol. 72, no. 10, Sept. 7, 1918, pp. 457-460. Program of Federal authorities, by eliminating inefficient types of incandescent lamps, is expected to save more than 1,000,000 tons of coal a year.

Lightning Arresters

The Oxide Film Lightning Arrester, Crosby Field. Gen. Elec. Rev., vol. 21, no. 9, Sept., 1918, pp. 597, 6 figs. Description of construction and principle of apparatus.

The Oxide Film Lightning Arrester, Charles P. Steinmetz. Gen. Elec. Rev., vol. 21, no. 9, Sept. 1918, pp. 590-596, 8 figs. Short history of lightning protection of electric systems, ranging from the early communication circuits to the present high-tension, high-capacity transmission lines, employing small air gaps and the aluminum-cell lightning arrester; oscillograph records of tests on the oxide film arrester and discussion of its principle of operation.

Magnetos

Non-Distributor and Multipolar Magnetos, F. I. Hoffman. Automotive Industries, vol. 39, no. 6, Aug. 8, 1918, pp. 222-223, 16 figs. Discussion of practical possibilities of magnetos designed for use with separate distributors on the engine camshaft—multipolar magnetos delivering up to six sparks per revolution.

Motor Mounting

Notes on Electric Motor Mounting (Note sur le montage des moteurs électriques), A. Curchod. Revue Générale de l'Electricité, vol. 4, no. 5, Aug. 3, 1918, pp. 145-150, 20 figs. Diagram of connections for each of different types.

Power Factor

Effect of Power Factor on Central-Station Operation, Will Brown. Elec. Rev., vol. 73, no. 6, Aug. 10, 1918, pp. 199-202, 6 figs. Good voltage regulation and transmission efficiency can be obtained by installing synchronous motors.

Improving Power Factor by Static Condenser. Elec. Rev., vol. 73, no. 9, Aug. 31, 1918, pp. 317-320, 6 figs. Importance of high power-factor; application and sphere of the static condenser, with concrete examples and instances of its use.

Practical Limitations to Power Factor Correction, Ralph Kelly. Elec. Rev., vol. 73, no. 7, Aug. 17, 1918, pp. 243-244, 3 figs. Influence of location of corrective apparatus upon generator and conductor capacity and voltage regulation; proportioning of kilovolt-amperes and kilowatts; summation of individual power factors.

Radio Engineering

High Power Stations, C. H. Taylor. Wireless Age, vol. 5, no. 11, Aug. 1918, pp. 931-936, 2 figs. Features of the long-distance stations of the Am. Marconi Co. (Continued.)

Present State of Long Distance Radio-Telegraphy and the French Transoceanic Network (L'etat actuel de la radiotélégraphie a grande distance et le réseau transocéanique français), Leon Bouthillon, Génie Civil, vol. 73, no. 5, Aug. 3, 1918, pp. 84-98, 22 figs. Principles of operation of apparatus used and description of processes in large stations.

Progress in Radio Science. Wireless Age, vol. 5, no. 12, Sept. 1918, pp. 979-985, 10 figs. Apparatus devised for rectifying spark gap for high-tension alternating current; details of spark discharge for radio frequency oscillation circuits; x-ray tube wherein length of focus of cathode rays is varied at will of operator.

Progress of Wireless Telephony, E. E. Bucher. Wireless Age, vol. 5, no. 12, Sept. 1918, pp. 1014-1019, 7 figs. Diagram of Espenschied's duplex system and Englund's duplex simultaneous telephone and telegraph system.

Single-Impulse Radiography (Instantaneous): Its Limitations and Possibilities, R. Knox. Jl. Inst. Elec. Engrs., vol. 56, no. 275, June 1918, pp. 352-358. Development of method; comparison of exposures obtained from single-impulse set with mercury dip interrupter and from Siemens impulse outfit; types of apparatus, experiments to show differences obtained when exposing through screen on to plate and through glass on to plate and screen; standardization and technique.

Sub-tations

The Standard Outdoor Substation, J. T. Bronson. Gen. Elec. Rev., vol. 21, no. 9, Sept. 1918, pp. 640-651, 22 figs. Requirements of outdoor switching apparatus; outline of types and equipments of outdoor substations.

Telephones

Automatic Telephones at Australia House London. Elecn., vol. 81, no. 2099, Aug. 9, 1918, pp. 317-318, 2 figs. Description of automatic exchange providing for 200 lines.

Construction and Operation of the Field Telephone and Buzzer, R. D. Greeman. Wireless Age, vol. 5, no. 12, Sept. 1918, pp. 1033-1035, 2 figs. Design of 4000-ft. signal set intended for junior military organizations.

European Telephone Practice, F. W. Scholz. Telephone Engr., vol. 20, nos. 2 and 3, Aug. and Sept. 1918, pp. 83-87, 9 figs., pp. 130-133, 6 figs. (Aug.) Artificial lines; location of defects in underground cables; Castelli apparatus for simultaneous telegraphing and telephoning; French measures to save materials. (Sept.) Chemical and physical theory of lead storage battery; some points on wireless telephony; new telephone selector used in France. (Translations from Revue Générale de l'Electricité and Annales des Telephones.)

Telephone Exchange Transfers and Their Organization, G. C. Baldwin. Jl. Inst. Elec. Engrs., vol. 56, no. 275, June 1918, pp. 390-410, 24 figs. Operations for actual transfer and consideration of engineering processes accompanying work.

Transformers

Current Transformer Ratio and Phase Error by Test Ring Method, H. S. Baker. Proc Am. Inst. Elec. Engrs., vol. 37, no. 9, Sept. 1918, pp. 1173-1183, 6 figs. Method of testing by connecting the primary and secondary of transformer under test respectively in series with the primary and secondary of a special current transformer in which number of turns in secondary coil is varied until primary and secondary ampere turns in special transformer are equal to each other.

Radiator Tank Transformer, H. O. Stephens and A. Paline. Gen. Elec. Rev., vol. 21, no. 8, Aug. 1918, pp. 556-559, 8 figs. Construction rules and details of the latest forms.

Transient Phenomena

Reactance and Short Circuit Current, R. E. Doherty, Gen. Elec. Rev., vol. 21, no. 8, Aug. 1918, pp. 562-564, 7 figs. Non mathematical dissertation of quantitative effect of reactance on short-circuit currents.

Short Circuit Windings in Direct-Current Solenoids, O. R. Schurig. Gen. Elec. Rev., vol. 21, no. 8, Aug. 1918, pp. 560-562, 2 figs. Application to designs of the phenomenon consisting in the prolongation of time taken by flux to decay after removal of the magnetizing force when a short-circuited winding surrounds a magnetic core.

Transmission Lines

Aerial Cable Construction Kinks. Telephony, vol. 75, no. 6, Aug. 10, 1918, pp. 13-15. Methods and devices developed in construction of section between New York and Albany which facilitated rapid placing of cable.

Aerial Line Construction in France, H. G. A. Sansom. Transmitter, vol. 28, no. 3, July 18, 1918, pp. 19-24, 11 figs. Lecture before Victorian Postal Elec. Soc.

Detective and Protective Devices for Electric Cables. Engineer, vol. 126, no. 3267, Aug. 9, 1918, p. 116, 3 figs. Description of protective system for use with test sheath cables.

Resistance and Reactance of Iron Transmission Lines, A. Press. Elecn., vol. 81, no. 2097, July 26, 1918, pp. 275-277, 3 figs. A mathematical treatment.

Voltage Regulators

Voltage Regulator for Combined Lamp and Motor Circuits. Electricity, vol. 32, no. 1445, July 19, 1918, p. 379, 4 figs. Circuits and vector relationship of "stabilizer" developed by the General Electric Co.

ENGINEERING MATERIALS

Babbitt Metal

Babbitt Metals: Conservation of Tin. Elec. Power Club, Bul. no 703, July 1918, p. 1. Composition of two babbitt mixtures used by the General Electric Co. and of two tin alloys used by Westinghouse Elec. & Mfg. Co.

Bluestone

Methods of Quarrying Bluestone. Stone, vol. 39, no. 8, Aug. 1918, pp. 366-368. Characteristic structure of bluestone; difference between bluestone quarrying and other types.

Boiler Plates

A Cause of Failure in Boiler Plates, W. Rosenhain and D. Hanson. Proc. British Iron & Steel Inst., May 2-3, 1918, Paper no. 15, 12 pp., 18 figs. Results of analysis, mechanical tests and microscopic examination of a boiler plate, 1¾-in. thick, 4 ft. 4 in. wide by 11 ft. long, which failed in the last stage of its manufacture.

Brass

Cast Brass, Its Use and Reclamation, R. C. Brown. Railroad Herald, vol. 22, no. 9, Aug. 1918, pp. 186-187. Suggested scheme to gage service efficiency of the brass account of a railroad.

Bronze (Phosphor)

The Manufacture of Phosphor Bronze, W. W. Rogers. Mach. World, vol. 63, no. 1642, June 21, 1918, p. 297. Composition, method of manufacture, and physical properties. From pamphlet published by Stamford (Conn.) Rolling Mills Co.

Cadmium

The Allotropy of Cadmium, E. Cohen. Jl. Am. Chem. Soc., vol. 40, no. 8, Aug. 1918, pp. 1149-1156, 3 figs. Aiming to demonstrate that in assumptions made by F. H. Getman (vol. 39, 1917, p. 1806), there are errors which when removed, make his results identical with those obtained by Cohen and Helderman.

Copper

Copper. Circular of the Bureau of Standards, no. 73, June 25, 1918, 103 pp., 25 figs. Source, metallurgy, refining and uses of commercial grades; possible allotrophy; chemical and physical properties; casting; deoxidation, working, welding, hardening and electrodeposition; heat treatment; effect of impurities on physical properties; definitions and specifications.

Ferrochrome

Ferrochrome, R. M. Keeney. Colo. School of Mines Mag., vol. 8, no. 8, Aug. 1918, pp. 143-147. Process of manufacturing ferrochrome from domestic chromite, recovery and carbon control as affected by grade of ore smelted, grade of product desired, and constituents of the charge.

Flint

Domestic Flint Pebbles and Linings Supplant the Foreign. Eng. & Cement World, vol. 13, no. 3, Aug. 1, 1918, pp. 61-62. Sources of grinding pebbles or substitutes thereof produced in the United States during the last few years.

Paving Blocks

Paving Blocks from Kettle River Quarries. Eng. & Cement World, vol. 13, no. 3, Aug. 1, 1918, p. 64. Appearance of rock, method employed in quarrying it, and result of analysis.

Sand

Tests Uncover Domestic French Sand Substitute, C. P. Karr. Foundry, vol. 66, no. 313, Sept. 1918, pp. 402-403. Thorough investigation conducted with different molding sands shows Zanesville product closely approaching French sand in desirable qualities.

Scrap Metal

Standard of Classification for Old Metals. Steel & Metal Digest, vol. 8, no. 8, Aug. 1918, pp. 479 and 515. Adopted by the Nat. Assn. of Waste Material Dealers.

Silica

Economic Uses of Silica and Its Occurrence in Eastern Canada, Heber Cole. Iron & Steel Inst. of Canada, vol. 1, no. 7, Aug. 1918, pp. 306-310. Requirements of silica in glass industry; in manufacture of brick, ferro-silicon, sodium silicate; in pottery and enameling; in paint manufacture; for use as a flux; in producing carborundum; in steel foundries.

Stellite

Notes on Stellite (Quelques observations sur "le stellite"), L. Guillet and H. Godfroid. Revue de Métallurgie, year 15, no. 4, July-Aug. 1918, pp. 339-346, 7 figs. Physical characteristics; structure; chemical analysis; report of author's tests.

Tantiron

Tantiron. Engineering, vol. 106, no. 2745, Aug. 9, 1918, pp. 154-156, 8 figs. Description of a silica iron used for manufacturing chemists' materials, that resists certain corrosive actions.

Textiles

Investigations on Textile Fibers, W. Harrison. Proc. Roy. Soc., vol. 94, no. A 663, July 1, 1918, pp. 460-469, 12 figs. Report of investigations on the effect of stress, moisture and heat; probable cause of the double refraction exhibited by natural fibers and effect of chemical treatment on it; experiments with artificial samples to ascertain in what manner internal stresses can arise in fibers.

Zinc

General Congress of the "Genie Civil." Work done by Section IV (Congrès général du Génie civil. Travaux de la Section IV), Demenge and Maneuvrier. Revue Générale de l'Electricité, vol. 4, no. 5, Aug. 3, 1918, pp. 157-161. Report on production and utilization of zinc throughout the world. (Continuation of serial.)

New Uses for Zinc, A. P. Cobb. Steel & Iron Digest, vol. 8, no. 8, Aug. 1918, pp. 477-479. Suggestions to dispose of the world's production—greatly increased by the war. Address before Am. Zinc Inst.

See also Aeronautics (Wing Fabrics), Building and Construction (Mill Building), Cement and Concrete, Metallurgy, Railroad Engineering, Steam (Rail Failures); Refractories; Steel and Iron; Testing (Balloon Fabrics.)

FACTORY MANAGEMENT

Cost System

Factory Order and Cost System, W. H. Rohr. Wood-Worker, vol. 37, no. 6, Aug 1918, pp. 23-25, 7 figs. System designed and operated by Waddell Mfg. Co., Grand Rapids, Mich., manufacturers to order of carvings, turnings, twist work, etc., for interior finish factory trade.

Managership

Under New Management—The Manager, Charles M. Horton. Indus. Management, vol. 56, no. 2, Aug. 1918, pp. 113-116. The human qualities of the manager who will succeed in the immediate future.

Mechanical Handling of Materials

Mechanical Material Handling System Reduces Labor and Hauling Costs and Eliminates Waste in Construction of Michigan Road. Eng. & Contracting, vol. 50, no. 10, Sept. 4, 1918, pp. 233, 4 figs.

Non-Repetitive Work

Managing Non Repetitive Work, Norman Howard. Indus. Management, vol. 56, no. 2, Aug. 1918, pp. 94-96, 3 figs. How to set times on lathe work in tool making.

Organization

The Spirit of the Organization, William Judson Kibby. Indus. Management, vol. 56, no. 2, Aug. 1918, pp. 117-118. How it is created and sustained.

Rate System

Automatic Rate System Is Fair to All, Harold W. Clapp. Elec. Ry. Jl., vol. 52, no. 6, Aug. 10, 1918, pp. 230-231. A year's experience with a service-at-cost franchise in Westerville, Ohio, shows desirability of flexible fares automatically adjusted.

Railway Stores

Railway Stores Methods and Problems, W. H. Jarvis. Ry. Gaz., vol. 29, nos. 2, 3, 4 and 5, July 12, 19, 26, Aug. 2, 1918, pp. 42-44, 75-78, 102-105 and 130-133, 1 fig. Storage and distribution of material; stores fittings; limitation of stock on hand; standard numbering of items; traffic stores requisitions. (Continuation of serial.)

Economic Factors Connected With Storing, H. B. Twyford. Iron Age, vol. 102, no. 7, Aug. 15, 1918, pp. 395-398, 2 figs. Proper quantities of materials and supplies to keep in stock; consideration of maximum and minimum limits.

Snow Removal

Snow Removal, H. Richards, G. T. Donoghue and W. J. Galligan. Jl. West, Soc. Engrs., vol. 23, no. 3, Mar. 1918, pp. 175-191. Reports of Chicago commissioners describing work carried out in their respective districts. Paper before Western Soc. of Engrs. Published also in Contract Rec., vol. 32, no. 36, Sept. 4, 1918, p. 720.

Stocks

Fixing Quantities of Materials in Stock, E. W. Taft. Cassier's Eng. Monthly, vol. 54, no. 1, July 1918, pp. 43-45, 1 fig. A method to determine and periodically to revise maxima and minima of materials stocked by industrial concerns.

See also Industrial Organization.

FORGING

Machine Forging

Machine Forging in Automotive Plants. Automative Industries, vol. 39, no. 8, Aug. 22, 1918, pp. 327-329. Methods employed in the production of upset or annular forgings.

FOUNDRY

Brass Castings

Expansion and Contraction of Brass Castings, P. W. Blair. Metal Indus., vol. 16, no. 8, Aug. 1918, p. 351. Table of contractions.

Cast-Iron Joints

The Manufacture of Metal Beds, Frank A. Stanley. Am. Mach., vol. 49, no. 10, Sept. 5, 1918, pp. 427-431, 16 figs. Illustrates and describes methods used in pouring cast-iron joints with work set up in assembling fixtures and with chills for each joint in which parts are gripped and held ready to receive the metal.

Copper Castings

Copper Castings for Electrical Purposes, G. F. Comstock. Brass World, vol. 14, no. 8, Aug. 1918, pp. 229-230. Difficulty of making copper castings of sufficient soundness without decreasing electrical conductivity of the copper.

Cores

Accuracy in Setting Cores, J. V. Hunter. Am. Mach., vol. 49, no. 10, Sept. 5, 1918, pp. 439-440, 3 figs. Methods for supporting cores by walls of flask.

Exceptional Gang Core Boxes, J. V. Hunter. Am. Mach., vol. 49, no. 9, Aug. 29, 1918, pp. 377-380, 10 figs. Description of a method of greatly increasing number of cores in a gang box; gang boxes of "Cook" type.

Deformation of Steel Castings

The Deformation of Steel Castings, T. Brown. Foundry, vol. 66, no. 313, Sept. 1918, pp. 411-413. From paper before British Foundrymen's Assn.

Die Casting

Aluminum-Bronze Die Casting, H. Rix and H. Whitaker. Metal Ind., vol. 6, no. 8, Aug. 1918, pp. 361-363, 1 fig. The effects of iron and manganese on copper-aluminum alloys. A paper before the British Institute of Metals.

Electric Brass Furnace

A Rocking Electric Brass Furnace, H. W. Gillett and A. E. Rhoads. Brass World, vol. 14, no. 18, Aug. 1918, pp. 217-220, 2 figs. Review of electric brass furnaces and description of one used by Bureau of Mines.

Foundries

How One Steel Foundry Met the Need for Ship and Railway Castings, H. Cole Estep. Foundry, vol. 66, no. 313, Sept. 1918, pp. 415-423, 15 figs. Description of plant of Birdsboro (Pa.) Steel Foundry & Machine Co.

FUELS AND FIRING

Canada

Fuels of Western Canada, James White. Jl. Eng. Inst. of Canada, vol. 1, no. 4, Aug. 1918, pp. 155-162. Availability of coal, natural gas, petroleum, electricity, peat and wood in Manitoba, Saskatchewan, Alberta and British Columbia.

Change-Fuel Systems

Auxiliary Steam Plant for Seattle, J. H. Longfellow. Jl. of Electricity, vol. 41, no. 4, Aug. 15, 1918, pp. 152-153. Fuel-oil operation with provision for change over to a coal-fired system in new 100,000-kw. installation.

Coal Selection

Coal and Its Selection, R. June. Brick & Clay Rec., vol. 53, no. 5, Aug. 27, 1918, pp. 389-392, 4 figs. Classification of coals; graphs showing relation of coal to combustion space, influence of moisture, and effect of ash on heating value of Illinois screenings. (Continuation of serial.)

Combustion Losses

Management of the Power Plant, Robert June. Textile World Jl., vol. 54, no. 10, Sept. 7, 1918, pp. 81-87, 2 figs. Combustion losses and how they may be reduced (Third of a series. First two in July 6 and Aug. 24 issues.)

Education of Firemen

Education of Boiler-Room Men Necessary, Edwin A. Hunger. Elec. World, vol. 72, no. 8, Aug. 24, 1918, pp. 344-347. Human element important factor in fuel-conservation efforts; means of fostering interest of firemen; notes on experience of several companies.

Fuel Conservation

Canadian Factory Reduced Coal Bill, B. K. Read. Can. Mfr., vol. 38, no. 9, Sept. 1918, pp. 23-27, 3 figs. Methods adopted and tables of tests on furnaces made by the Dominion Forge & Stamping Co. (To be concluded.)

Coal Conservation in Fact, C. R. Knowles. Contract Rec., vol. 32, no. 36, Sept. 4, 1918, pp. 719-720. Remarks on present waste.

Coal Conservation in New England, Ira N. Hollis. Indus. Management, vol. 56, no. 2, Aug. 1918, pp. 89-93. Outlines Massachusetts plan and scheme of organization to reach every factory and reduce and eliminate the present wastage of fuel.

Coal Saving by the Scientific Control of Steam Boiler Plants, D. Brownlie. Engineering, vol. 106, no. 2741, July 12, 1918, pp. 25-27. Average figures for 250 typical plants covering period from 1910 to the present, showing economy that can be effected by adoption of scientific methods in the boiler-house.

Coal Storage Conservation Rules, W. D. Langtry. Ice & Refrig., vol. 54, no. 5, May 1918, pp. 256-257. Oxidation in storage; action of pyrites; spontaneous heating; deterioration; avoiding dangers. Paper before Ill.-Wis. Ice Dealers' Assn.

Conservation of Fuel in California, R. J. C. Wood. Elec. World, vol. 72, no. 8, Aug. 24, 1918, pp. 348-350, 1 fig. By interconnection of systems with different load characteristics one company alone will save nearly a million barrels of fuel oil. Hydroelectric development must continue to meet growing demand for energy.

Fuel Conservation on the Santa Fe, Charles E. Parks. Ry. Rev., vol. 63, no. 4, July 27, 1918, pp. 124-125. Savings of upwards of $2,000,000 made in nine years by the present fuel organization of this road; methods used are explained.

Important Phases of the Fuel Conservation Problem, H. C. Woodbridge. Ry. Age, vol. 65, no. 8, Aug. 23, 1918, pp. 335-336. Suggestions to railway men of all departments regarding economical use of coal. Abstract of paper before Railway Club of Pittsburgh.

Methods for More Efficiently Utilizing Our Fuel Resources. Part XXI. The Coal Fields of the United States, Marius R. Campbell. Gen. Elec. Rev., vol. 21, no. 9, Sept. 1918, pp. 602-619. Detailed statistics of available reserves, present production of each coal region, and map showing all known coal deposits and quality of coal in each region. Abstract from professional paper 100-A, U. S. Geol. Survey, 1917.

Methods for More Efficiently Utilizing Our Fuel Resources, R. H. Fernald. Gen. Elec. Rev., vol. 21, no. 8, Aug. 1918, pp. 542-555, 11 figs. Importance of fuel; statistics of world's coal supply and production; comparative heating values of coal; peat; petroleum and natural gas: conservation.

Reducing Water Waste to Save Coal. Mun. Jl., vol. 43, no. 7, Aug. 17, 1918, pp. 128-129. Figures derived from data obtained in cities of New York; ways by which water waste and leakage can be reduced.

Ways and Means of Saving Coal in the Boiler Room and Shop. Brick & Clay Rec., vol. 53, no. 4, Aug. 13, 1918, pp. 300-301. Recommendations of U. S. Fuel Administration concerning generation and use of power, light and heat.

Gas Fuel

Some Notes on Gas-Firing Boilers, T. M. Hunter. Proc. South Wales Inst. of Engrs., vol. 34, no. 2, July 19, 1918, pp 127-155, 4 figs. Dry and wet processes of gas cleaning; losses involved in boiler firing by gas; essentials for economical combustion and present methods of burning gas; conclusion drawn from a number of experiments upon a Lancashire boiler; tables showing results following upon the combustion of three typical gases, with different quantities of air dilution.

Kerosene

The Boiling Point of the Paraffins, G. le Bas. Chem. News, vol. 117, no. 3052, July 19, 1918, pp. 241-242. Table showing behavior of compounds in disagreement with Hinrichs-Newmann's rules correlating the boiling point and chemical constitution.

Low-Grade Fuels

Sawdust and Wood Burning. Power Plant Eng., vol. 22, no. 16, Aug. 15, 1918, pp. 647-654, 9 figs. A symposium dealing with furnace designs, conditions to maintain, conveying and storage systems, and value of sawdust and wood as fuels.

The Use of Lignite, Bagasse and Wood Waste for Power Generation and Other Purposes, John B. C. Kershaw. Engineer, vol. 126, no. 3267, Aug. 9, 1918, pp. 121-122, 3 figs. Chemical and physical properties of lignite; power generation from air-dried lignite; briquetting.

Oil Fuel

France and the Use of Petroleum, M. Henri Berenger. Petroleum Rev., vol. 39, nos. 833 and 834, July 6, and 13, 1918, pp. 11-12 and 27-28. Uses for heating engine boilers; liquid fuel in internal-combustion motors (Diesel type); international problem of petroleum and heavy oils. (Continued from vol. 38, p. 406.)

Petroleum from Coal. Petroleum Rev., vol. 39, no. 838, Aug. 10, 1918, p. 87. Report of committee of Technologists' Instn. on production of oil from cannel coal and allied minerals.

Petroleum Under the Microscope, James Scott. Petroleum World, vol. 15, no. 214, July 1918, pp. 282-283, 3 figs. Some unrefined compounds.

Supply of Oil Available from Shales, G. Egloff and J. C. Morrell. Oil & Gas Jl., vol. 17, nos. 11 and 12, Aug. 16 and 23, 1918, pp. 42-46 and 45-48. Treatment in retorts; comparative yields from oil shales; source of oil shale used; experimental methods; distillation analysis, aromatic hydrocarbons; analysis of water resulting from the thermal decomposition of the oil shale; phenols and its derivatives; heterocyclic nitrogen compounds; compounds isolated from oil-shale retorting.

Peat

Peat Occurrences in Illinois. Jl. Am. Peat Soc., vol. 11, no. 3, July 1918, pp. 148-152. Results obtained from the Manito (Mason Co.) experiment field on deep peat where treated plots and untreated strips were cropped. Suggestive treatments for different types of peat soils.

Possibilities of Using Peat as Fuel in Some Places. Jl. Am. Peat Soc., vol. 11, no. 3, July 1918, pp. 140-144. Fuel value and method of preparation. From U. S. Geol. Survey Press Bul., June 19, 1918.

Value of Peat Fuel for the Generation of Steam. Engineer, vol. 126, no. 3267, Aug. 9, 1918, pp. 123-124, 1 fig. Reprint of Bulletin No. 17, Canadian Department of Mines.

Pulverized Fuel

General Utilization of Pulverized Coal, Henry G. Barnhurst. Chem. Eng. & Min. Rev., vol. 10, no. 114, March 1918, pp. 174-177. Paper before Cleveland Eng. Soc.

Smokeless Combustion

Fuel Economy in the Operation of Hand Fired Power Plants. Contract Rec., vol. 32, no. 27, July 3, 1918, pp. 527-531, 4 figs. Chemical analysis of combustion and discussion of the fundamental conditions necessary for complete and smokeless combustion. From Univ. of Ill. Bul.

Smoke Prevention—Coal Saving Suggestions. Paper, vol. 22, no. 25, Aug. 28, 1918, p. 32. Brief outline of suggestions based on long experience of Westinghouse Elec. & Mfg. Co.'s combustion engineers.

Storage

Storage and Handling of Gas Coal, H. H. Stoek. Gas Age, vol. 42, no. 4, Aug. 15, 1918, pp. 145-149. Review of investigations by the Experiment Station of the University of Illinois. (To be continued.)

The Storage of Bituminous Coal, with Reference to its Liability to Spontaneous Combustion in Storage Heaps, Bunkers or Cargo. John H. Anderson, Trans. Inst. Marine Engrs., vol. 30, paper no. 236, June 1918, pp. 81-98 and discussion pp. 98-117. Record of methods employed, which so far have given satisfaction.

The Storage of Bituminous Coal, H. H. Stoek. Power Plant Eng., vol. 22, no. 15, Aug. 1, 1918, pp. 614-616, 3 figs. Abstract of paper before Western Soc. of Engrs.

Waste Heat

Waste Heat Utilization in Cement Works, H. D. Baylor. Ferro-Concrete, vol. 9, no. 12, June 1918, pp. 430-433, 2 figs. Data obtained with a boiler recently installed by the Louisville Cement Co. From paper before Am. Inst. of Chem. Engrs.

See also Chemical Technology (Oil Industry); Coal Industry.

FURNACES

Design

Development of Power from the Standpoint of the Boiler Room, C. F. Hirshfeld. Power, vol. 48, no. 8, Aug. 20, 1918, pp. 284-286, 2 figs. J. E. Alfred Lectures on Engineering Practice, Johns Hopkins University.

Graf Furnace

Graf Gas Consuming Furnace, John Nelson. Iron Age, vol. 102, no. 6, Aug. 8, 1918, p. 339, 1 fig. Air introduced above bridge wall burns gases ordinarily wasted in boilers.

Radiation Furnaces

Superficial Radiation Furnaces (Fours à radiation superficielle), M. P. Negrier. Revue de Métallurgie, year 15, no. 4, July-Aug. 1918, pp. 391-398, 4 figs. Combustion; scheme of burners and mixers; applications of superficial radiation.

Two-Zone Furnace

The Two-Zone Furnace, O. H. Hertel. Popular Engr., vol. 10, no. 1, July 1918, pp. 26-27. Features of the two zone boiler furnace.

See also Electrical Engineering (Furnaces); Foundry (Electric Brass Furnaces); Steel and Iron (Electric Furnace Melting).

HEATING

Condensation

Returning Condensation in High and Low-Pressure Heating Systems, Charles L. Hubbard. Domestic Eng., vol. 84, no. 7, Aug. 17, 1918, pp. 236-238, 6 figs. Notes on various methods of saving condensation. (Concluded.)

Hot-Water Heating

Expansion of Water in Hot Water Heating Systems, Howting. Plumbers' Trade Jl., vol. 65, no. 5, Sept. 1, 1918, pp. 277-279, 4 figs. Allowance for expansion in design, construction or installation.

Radiators

Meeting the High Cost of Heating and Ventilating Apparatus, George T. Mott. Heat. & Vent. Mag., vol. 15, no. 8, Aug. 1918, pp. 18-24, 3 figs. Advocates use of wall radiators rather than pipe coils as a matter of economy.

Room Temperature

A Study of Degrees of Discomfort. Heat. & Vent. Mag., vol. 15, no. 8, Aug. 1918, pp. 11-14, 1 fig. Based on temperature comfort tests made at Chicago Normal College by Prof. J. W. Shepherd.

School Buildings

School Building Heating and Ventilation, Samuel R. Lewis. Heat. & Vent. Mag., vol. 15, no. 8, Aug. 1918, pp. 29-35, 4 figs. First article of series.

HOISTING AND CONVEYING

Coal Handling

An Electrically Interlocked Car Haul and Car Feeder, R. P. Hines. Coal Age, vol. 14, no. 7, Aug. 15, 1918, pp. 300-302, 4 figs. A car feeder within the mine and a car haul leading to tipple are so connected electrically that feeder cannot be started until haul is running at normal speed. Both apparatus may be stopped at various points.

Effective System of Coal Handling at Providence, G. K. Jenckes. Gas Age, vol. 42, no. 4, Aug. 15, 1918, p. 158, 1 fig. Extension through use of locomotive crane.

The Britannia Colliery, Pengam, Mon., George Hann. Colliery Guardian, vol. 116, no. 3004, July 26, 1918, pp. 173-175, 2 figs. Illustrated description of plant and equipment; all haulage mechanical. From a paper before South Wales Inst. of Engrs.

Conveyors

Conveyors for Chemical Works, W. H. Atherton. Cassier's Eng. Monthly, vol. 54, no. 1, July 1918, Supp. pp. i-viii, 9 figs. Forms and sizes of oxide and coal conveyors. (Continuation of serial.)

Cranes

Large Navy Floating Crane Made Safe by Regenerative Braking. Elec. Contractor-Dealer, vol. 17, no. 11, Sept. 1918, pp. 100-101, 3 figs. Data of new giant crane said to have lifted a complete tugboat from its berth on the harbor bottom after sinking.

Wall Cranes, E. G. Beck. Mech. World, vol. 64, no. 1646, July 19, 1918, pp. 30-31, 4 figs. Mathematical analysis of a frame under specified loading. (Continuation of a serial; preceding article published May 24.)

Elevators

Factors Governing Elevator Drive, C. E. Clewell. Elec. World, vol. 72, no. 8, Aug. 24, 1918, pp. 340-343, 8 figs. Standard safety features usually embodied in control equipment; power requirements of elevators and types of motors suited to the service; direct and alternating—current elevator motors.

Lift Controllers

Lift Controllers and Controlling Gear for D. C. Lift. Electricity, vol. 32, no. 1445, July 19, 1918, pp. 381-382, 2 figs. Diagrams for car-switch and push-button control systems. (Continuation of serial.)

Marine Railway

Features of an Electrically Operated Marine Railway. Elec. Rev., vol. 73, no. 8, Aug. 24, 1918, pp. 290-292, 3 figs. Installation on Illinois River served by central-station company; boats carried through channel.

Overhead Carriers

Lifeboat Transporting and Lowering Gear. Shipping, vol. 4, no. 7, Aug. 17, 1918, pp. 13-14. Plan and elevations of Ross-Anderson device, consisting of a series of athwartship and fore-and-aft girders carried on columns and forming overhead tracks for trolleys with angular pull bearing.

Notes on the Overhead Koepe Winding Plant at Plenmeller Colliery, Haltwhistle, Northumberland, George Raw. Trans. Inst. Min. Engrs., vol. 55, part 3, July 1918, pp. 170-186, and (discussion), pp. 186-188, 9 figs. Study of operation of plant.

Ropeways

Ropeways in War Time, Telpher. Mech. World, vol. 63, no. 1612, June 21, 1918, pp. 295-296, 9 figs. Explanation of various forms and details of mono-cable and bi-cable lines.

Slag Haulage

Molten Slag Is Hauled by Rail for Making Embankments. Eng. News-Rec., vol. 81, no. 6, Aug. 8, 1918, pp. 267-268, 1 fig. Union Railroad at Pittsburgh handles hot materials in ladle cars; fills made in layers prove very substantial.

Trucks, Industrial

Karry-Lode Industrial Trucks, Tractors and Trailers. Automotive Industries, vol. 39, no. 6, Aug. 8, 1918, pp. 242-243, 3 figs. Trucks employ roller-pinion type of internal drive and are provided with automatic safety switch for use on steamship piers, in railway yards and industrial plants.

Transportation by Power Trucks, Reginald Trautschold. Indus. Management, vol. 56, no. 2, Aug. 1918, pp. 97-101, 7 figs. Features of a number of types of special trucks for mechanical handling of materials, with paragraphs on operating costs.

Turntables

Bronze Turntable and Movable Bridge Discs, O. E. Selby. Foundry, vol. 46, no. 312, Aug. 1918, pp. 368-371. Existing specifications discussed and changes recommended to users and brass foundrymen.

Wire Ropes

Wire Ropes, "Kinetics." Practical Engr., vol. 58, no. 1638, July 18, 1918, pp. 28-29, 4 figs. Details of construction of guide, rubber and sinking ropes; winding speeds; factors of safety. (Previous articles published Jan. 3, Feb. 14, Mar. 28, May 2 and June 20.)

See also Transportation (Marine Terminals.)

HYDRAULICS

Bazin Weir Formula

Verification of the Bazin Weir Formula by Hydro-Chemical Gaugings, C. Herschel. Proc. Am. Soc. Civ. Engrs., vol. 44, no. 6, Aug. 1918, pp. 835-842. Discussion of F. A. Nagler's paper.

Caissons, Concrete

Concrete Caisson of New Type Used in Breakwater. Eng. News-Rec., vol. 81, no. 6, Aug. 8, 1918, pp. 258-260, 5 figs. Trapezoidal shape adopted for economy; caissons launched, sunk in place and filled to carry monolithic concrete superstructure.

Cast-Iron Linings of Wells

Special Cast Iron Lining of Two Large Bore Wells, W. H. Maxwell. Eng. & Contracting, vol. 50, no. 7, Aug. 14, 1918, pp. 172-175, 3 figs. Reprint from Water and Engineering, London.

Dams

Facing Leaky Rock-Fill Dam with Timber Planks, George M. Bull. Eng. News-Rec., vol. 81, no. 5, Aug. 1, 1918, pp. 229-231, 2 figs. After dam was raised 25 ft., old concrete facing leaked, so 3 rows of creosoted boards were placed on face.

Improving Arch Action in Arch Dams, W. P. Creager and S. H. Woodward. Proc. Am. Soc. Civ. Engrs., vol. 44, no. 6, Aug. 1918, pp. 871-873. Discussion of L. R. Jorgensen's paper in May issue.

Drainage Channels

Keeping Land Drainage Channels Clear of Growth and Debris in the South, Albert S. Fry. Eng. News-Rec., vol. 81, no. 6, Aug. 8, 1918, pp. 263-266. Experiences in removal of willow and other sprouts and maintaining cross-section in two drainage districts; cost data given.

Flood Control

Detention Reservoirs with Spillway Outlets as an Agency in Flood Control, I. E. Houk and K. C. Grant. Proc. Am. Soc. Civ. Engrs., vol. 44, no. 6, Aug. 1918, pp. 827-834, 3 figs. Discussion of paper by the late H. M. Chittenden.

Friction in Pipes

Water Friction in Pipes and Elbows, E. H. Peterson. Ice & Refrig., vol. 54, no. 5, May 1918, pp. 274-275, 2 figs. Charts showing for different sizes the friction loss in pounds per square inch for various capacities in gallons of water per minute.

Ice Diversion

Ice Diversion, Hydraulic Models, and Hydraulic Similarity, E. E. R. Tratman and B. F. Groat. Proc. Am. Soc. Civ. Engrs., vol. 44, no. 6, Aug. 1918, pp. 797-822, 3 figs. Theory of hydraulic models; theory of dynamic similarity; factors of safety. Discussion of B. F. Groat's paper.

Hydroelectric Installations

Hydroelectric Development at Rochester, N. Y. Street Ry. Bul., vol. 18, no. 8, Aug. 1918, pp. 349-351, 7 figs. New 25,000-kva. station of the Railway and Light Co., located in the gorge of the Genesee River.

Junction Development Power Plant. Power, vol. 48, no. 8, Aug. 20, 1918, pp. 258-262 6 figs. Description of 16,500-kw. hydroelectric plant supplying Grand Rapids.

New Plant Added to Michigan System. Elec. World, vol. 72, no. 6, Aug. 10, 1918, pp. 244-248, 6 figs. Description of junction development, the largest hydro-electric plant in Michigan, which is connected with Grand Rapids by 140,000-volt line.

Interesting Small-Capacity Low-Head Hydroelectric Development. Elec. Rev., vol. 73, no. 5, Aug. 3, 1918, pp. 158-160, 5 figs. Description of Geddes plant of 1000-kw. capacity operating under a working head of 15 ft.

The New Copco Development, C. B. Merrick. Jl. of Electricity, vol. 41, no. 4, Aug. 15, 1918, pp. 150-152. Features of construction and operation of hydroelectric plant at Copco, Cal.

The New 300,000-Hp. Hydro Development. Elec. News, vol. 27, no. 13, July 1, 1918, pp. 36-38, 2 figs. Layout of scheme and cross-section of development works at power house of Chippawa plant, Niagara Falls, Ont.

Shutting Off Water

Possiblities of Shutting Off Water, M. A. LaVelle. Gas & Oil Jl., vol. 17, no. 8, July 26, 1918, pp. 48-50. Facts on shutting off bottom water by cement in Kansas and Oklahoma wells; use of cement and importance of excluding water from oil wells.

Silt Deposits

Calculating and Preventing Silt Deposits in Reservoirs, F. Drouhet. Contract Rec., vol. 32, no. 27, July 3, 1918, pp. 522-523. Results obtained in Switzerland from a study of the geographic and hydraulic conditions of water courses.

Storage Reservoirs

Determining the Regulating Effect of a Storage Reservoir, Robert E. Horton. Eng. News-Rec., vol. 81, no. 10, Sept. 5, 1918, pp. 455-458, 3 figs. Differential equation for inflow, outflow and storage relations solved by using time interval as independent variable.

Water Works

American Army's Water Works Projects in France Number About Four Hundred, Robert K. Tomlin, Jr. Eng. News-Rec., vol. 81, no. 10, Sept. 5, 1918, pp. 434-437, 5 figs. Great range in size and character of supply; several mechanical filters under way; laboratory division controls quality of water.

Construction of Collection and Transmission System for Marin Municipal Water District. Western Eng., vol. 9, no. 9, Sept. 1918, pp. 355-365, 10 figs. Work done in Marin Co., Cal., containing six towns; system consists mainly of two storage reservoirs with a total capacity of 380,000,000 gal.

Effect of War Conditions Upon Construction, Operaton and Maintenance of Water Works. Eng. & Contracting, vol. 50, no. 7, Aug. 14, 1918, pp. 176-177. Findings of special committee of Am. Water Works Assn., with data obtained from about 50 municipally and corporately owned water works in the United States.

Plant Extensions of Public Utilities Financially Considered, John W. Ledoux. Jl. Engrs. Club of Phila., vol. 35-37, no. 164, July 1918, pp. 337-338. Suggestions regarding waterworks extensions.

Rural Community Water Supplies, E. L. Miles. Jl. Eng. Inst. of Canada, vol. 1, no. 4, Aug. 1918, pp. 145-150, 3 figs. Account of author's observations while acting as government inspector of water supplies in Province of Saskatchewan. Also published in Can. Engr., vol. 35, no. 7, Aug. 15, 1918, pp. 161-164 and 166, 3 figs. Before Second General Meeting of Eng. Inst. of Can.

The Water Supply of New York. Engineer, vol. 126, 3267, Aug. 9, 1918, pp. 109-111, 8 figs. Engineering features of dams, tunnels, aqueducts, etc.

War Burdens of Water-Works of United States Increase. Eng. News-Rec., vol. 81, no. 7, Aug. 15, 1918, pp. 308-312, 3 figs. From a report to executive committee of Am. Water-Works Assn.

Water-Works Operation. Min. Jl., vol. 45, nos. 6, and 7, Aug. 10 and 17, 1918, pp. 107-108 and 111 and 129-130. Repairing leaks and breaks in water mains and underground appurtenances; preventing recurrence of leaks; leaking valves.

INDUSTRIAL ORGANIZATION

Cost of Service the Chief Factor in Rate Regulation, William G. Raymond. Eng. News-Rec., vol. 81, no. 10, Sept. 5, 1918, pp. 451-454. Rational "fair value" held to be sum of interest on investment and profit on operating expenses, capitalized at "fair return" rate.

Elimination of Idleness by Systematic Study, Charles Whiting Baker. Eng. News-Rec., vol. 81, no. 10, Sept. 5, 1918, pp. 450-451. Graphic chart shows significance of increase in efficiency by reducing machinery idleness among industries.

Organization and Coöperation. David J. Champion. Boiler Maker, vol. 18, no. 8, Aug. 1918, pp. 229-231. Trade organization necessary for progress; closer coöperation among boiler manufacturers badly needed. Address before annual convention, Boiler Manufacturers' Assn.

Capital Charges

Discussion of Mr. David M. Mowat's Paper on "Capital Charges Considered along with Current Expenses." Trans. Inst. Min. Engrs., vol. 55, part 3, July 1918, pp. 190-195. Paper appeared in Trans. 1917-1918, vol. 54, p. 317 and vol. 55, pp. 54-133.

City War Organization

Milwaukee's Organization for War, Willits Pollock. Indus. Management, vol. 56, no. 2, Aug. 1918, pp. 121-123. Trying out general staff idea in an industrial city.

Demobilization

Contract Prices During Demobilization, W. P. Digby. Elecn., vol. 81, no. 2099, Aug. 9, 1918, pp. 308-309, 4 figs. Abstract of paper before Inst. Elec. Engrs. Experience of previous wars; increase in wages and prices of materials in the past few years.

Depreciation

Some Pitfalls in Regulating Depreciation, John Bauer. Elec. Ry. Jl., vol. 52, no. 8, Aug. 24, 1918, pp. 326-328.

See also Factory Management.

INTERNAL-COMBUSTION ENGINEERING

Carburetors

Four New Carburetion Devices. Motor Age, vol. 34, no. 6, Aug. 8, 1918, pp. 40-42, 6 figs. Universal Airgas, Manifold, Hodges and Kerosene Equipment, with their characteristics.

The Carburettor. Technicus. Auto, vol. 33, no. 30, July 26, 1918, pp. 532-534, 2 figs. Technical study of the factors determining its successful operation. (Concluded from p. 516.)

Diesel Engines

Operation of Submarine Diesel Engines, F. C. Sherman. Gas Eng., vol. 20, no. 9, Sept. 1918, pp. 425-429. Causes of troubles and their elimination.

Random Remarks on Modern Marine Diesel-Engines, H. R. Setz. Motorship, vol. 3, no. 9, Sept. 1918, pp. 10-12, 7 figs. Effect of length of stroke on efficiency; distinction between mechanical and physical strokes; technical details of the new Tosi merchant-marine Diesel engine.

Heavy-Oil Engines

The Heavy-Oil Engine, Charles E. Lucke. Engineer, vol. 126, no. 3265, July 26, 1918, pp. 80-83. Its application; tendencies in design. From paper before Engrs. Club of Phila., Jan. 1918, and printed in Journal of Club, June, 1918.

High-Speed Engines

High-Speed Internal Combustion Engines. Harry R. Ricardo. Mech. World, vols. 63 and 64, nos. 1646 and 1647, June 14 and July 26, 1918, p. 284 and pp. 45-46, 1 fig. Features of high-speed engine design. From paper before North-East Coast Inst. of Engrs. and Shipbuilders. (To be continued.)

Ignition System

A Simple Dual Ignition System, G. F. Crouch. Motor Boat, vol. 15, no. 15, Aug. 10, 1918, pp. 22-23, 2 figs. Switch invented by E. S. Brainard, Sacramento, Cal., to use battery and coil with high-tension magneto.

Individual Types

Buda Model "H T U" Engine. Automotive Industries, vol. 39, no. 7, Aug. 15, 1918, pp. 282-283, 5 figs. Model with detachable cylinder head, force-feed lubrication, special crankcase construction, heavier flywheel for tractor use, and vaporizing manifold for burning kerosene, designed for truck and tractor service.

Kahlenburg Heavy-Oil Engine. Motorship, vol. 3, no. 9, Sept. 1918, p. 13, 1 fig. General features of motor of the surface-ignition class built at Two Rivers, Wis.

The Possibilities of the Hvid Engine. Nat. Gas Engine Assn. Bul., vol. 4, no. 2, Sept. 1918, pp. 6-17. Discussion of paper by E. B. Blakely, published in Aug. Bulletin.

Knocking

Knocking in Gas Engines. Practical Engr., vol. 58, no. 1638, July 18, 1918, pp. 31-32. Significance and possible causes.

Multiple Valves

Increasing the Engine's Volumetric Efficiency, Morris A. Hill. Automotive Eng., vol. 3, no. 7, Aug. 1918, pp. 295-297, 5 figs. Further comment on multiple valves, and designs which aim to give multiple-valve effect without its numerous parts. (Fifth of series.)

Pulverizers

Oil-Engine Sprayers or Pulverizers, A. H. Goldingham and C. T. O'Brien. Motorship, vol. 3, no. 9, Sept. 1918, pp. 19-20, 4 figs. Description of four types. (Continued.)

Sub-Pistons

Gile Engine Employs Sub-Piston. Automotive Industries, vol. 39, no. 6, Aug. 8, 1918, pp. 229 and 238, 2 figs. Longitudinal and cross-sections of engine designed to work on two-stroke principle, with piston-controlled port for inlet and a poppet valve in the head for exhaust.

Turbines

Internal Combustion Turbines. Practical Engr., vol. 58, no. 1639, July 25, 1918, pp. 40-42, 10 figs. Some types of gas turbines.

See also Aeronautics (Engine Pistons, Engine Temperature Control, Engines, Mufflers); Motor-Car Engineering (Piston Displacement); Producer Gas and Gas Producers.

IRON

(See Steel and Iron)

LABOR

Bethlehem Award

Labor Board's Award in Bethlehem Case. Iron Age, vol. 102, no. 6, Aug. 8, 1918, pp. 326-327. Text of finding in case of machinists and electrical workers vs. Bethlehem Steel Co.

Business Management

Significant Changes in Business Management. Am. Mach., vol. 49, no. 5, Aug. 1, 1918, pp. 191-193. Suggestions regarding policy to meet changes in relations between capital and labor.

Housing

Company Residences for Railroad Employees, C. B. & Q. R. R. Ry. Rev., vol. 63, no 6, Aug. 10, 1918, pp. 197-200, 6 figs. Description with plans of cottages and rooming houses.

Labor Costs

Report on Estimating Labor Costs. Elec. Rev., vol. 73, no. 4, July 27, 1918, pp. 125-131, 7 figs. Compiled by the Electrical Estimators' Assn. of Chicago and presented at the Cleveland Convention of the National Assn. of Electrical Contractors and Dealers.

Negroes

Negroes a Source of Industrial Labor, Dwight Thompson Farnham. Indus. Management, vol. 56, no. 2, Aug. 1918, pp. 123-129, 10 figs. Experiences of author with this type of labor.

Piecework Rates

Determining of Piecework Rates from Charts, Otto M. Burkhardt. Am. Mach., vol. 49, no. 9, Aug. 29, 1918, pp. 383-387, 6 charts. A simple method of figuring piecework prices by means of charts when the necessary time elements are known.

Railroad Employees

Classification, Working Conditions and Wages of Mechanical Department Employees. Ry. Rev., vol. 63, no. 5, Aug. 3, 1918, pp. 154-157. Supplement no. 4 to general order no. 27, Director General of Railroads.

Training

Intensive Training in an Aircraft Plant, Frank L. Glynn. Automotive Industries, vol. 39, no. 9, Aug. 29, 1918, 7 figs. Curtiss Co.'s school has capacity of 200 to 300 operatives per week. Women develop skill after short instruction period.

Steel Plant Educates Foreign Employees. Blast Furnace & Steel Plant, vol. 6, no. 9, Sept. 1918, pp. 384-385. Youngstown Sheet & Tube Co. establishes system of free schools primarily for educating and Americanizing foreign-born employees in all parts of the mills.

The Training of Engineers, E. J. Silcock. Can Engr., vol. 35, nos. 6 and 7, Aug. 8 and 15, 1918, pp. 138-140 and p. 150. Scope of education of civil engineer and amount of specialization necessary for those who intend to practice as water-works engineers. Paper before Inst. Water Engrs., England. Published also in Surveyor, vol. 54, no. 1381, July 5, 1918, pp. 3-4.

Training Metallurgists in Schools and Metallurgical Works, H. C. H. Carpenter. Can. Min. Jl., vol. 39, no. 14, July 15, 1918, pp. 246-248. Extracts from presidential address, Inst. of Metals, London, March 1918.

Training 150 Operators Per Week. Automotive Industries, vol. 39, no. 7, Aug. 15, 1918, pp. 277-280. How the vestibule school of Remington Arms Company is meeting the demand for skilled workers of both sexes; how operatives are routed through plant.

Women

Employment of Women in Munition Factories. Jl. Inst. Mech. Engrs., no. 5, June 1918, pp. 223-238. Records of several plants presented by members of Institute.

The Efficient Utilization of Labor in Engineering Factories, B. H. Morgan. Jl. Inst. Mech. Engrs., no. 5, June 1918, pp. 239-265. Special reference to women's work.

Women in Railway Work. Ry. Rev., vol. 63, no. 4, July 27, 1918, pp. 122-123, 4 figs. Women employed by railways in various capacities.

See also Coal Industry (Labor Situation.)

LIGHTING (ILLUMINATION)

Automobile Plants

Improved Lighting of Automobile Manufacturing Plants, F. H. Bernhard. Elec. Rev., vol. 73, no. 6, Aug. 10, 1918, pp. 205-211, 12 figs. Advisability of utilizing latest lighting developments; features that need special improvement.

Edison Lamps

Edison Mazda Lamps for Protective Lighting. Edison Lamp Wks. of Gen. Elec. Co., Bul. no. 43,412, July 1918, pp. 1-14, 26 figs. Application of contrast to protective lighting; glare; available apparatus; sketches illustrating arrangement in various systems.

Illumination

Fundamentals of Illumination Design, Ward Harrison. Gen. Elec. Rev., vol. 21, no. 8, Aug. 1918, pp. 535-541, 10 figs. Solution of problems covering the lighting requirements of a large general office, the main floor of a clothing store, a furniture factory, and an industrial plant manufacturing tools and other similar metal parts. (Concluded.)

Indirect Lighting

Illumination, Harold W. Brown. Elec. Contractor-Dealer, vol 17, no. 11, Sept. 1918, pp. 86-91, 23 figs. Applications of indirect lighting to hospitals, churches, reading rooms, stores and houses.

Laws on Lighting

Laws Regulating Insufficient Lighting, Chesla C. Sherlock. Am. Mach., vol. 49, no. 9, Aug. 29, 1918, pp. 381-382. Résumé of some court findings.

Printing Plants

The Lighting of Printing and Book-Binding Plants, F. H. Bernhard. Elec. Rev., vol. 73, no. 8, Aug. 24, 1918, pp. 279-286, 11 figs. Importance of best possible lighting to printer; general features of lighting problem and suggestions for effective illumination of principal departments.

War Conservation

Lighting Curtailment, Preston S. Miller. Jl. Engrs.' Club, Phila., vol. 35-8, no. 165, Aug. 1918, pp. 381-391 and (discussion) pp. 391-399, 2 figs. Considers that since coal used in production of electric light is less than 2 per cent of total output of country and standards of illumination intensity before the war were in general too low, it is practicable to effect much larger savings by other methods with less disadvantage to the public.

War Conservation of Power and Light, Chas. E. Stuart. Jl. Engrs.' Club, Phila.,

vol. 35-8, no. 165, Aug. 1918, pp. 400-403. Practical scheme of operations of power and light division of U. S. Fuel Administration.

See also Electrical Engineering (Lamps.)

LUBRICATION

Selection

Important Factors in Choosing Lubrichants, F. H. Conradson. Petroleum Rev., vol. 39, no. 838, Aug. 10, 1918, pp. 85-86. Lubrication problems in connection with new designs, service conditions and requirements.

See also Air Machinery (Lubrication); Steam Engineering (Lubrication, Engine Cylinder); Testing and Measurements (Lubricants Testing, Viscosimeter.)

MACHINE PARTS

Ball Bearings

Ball Bearings for Machine Shop Equipment, Edward K. Hammond. Machy., vol. 24, no. 12, Aug. 1918, pp. 1097-1103, 6 figs. Discusses the advantages of ball bearings, their construction, lubrication, design of mountings and felt packings.

Ball-Races in Machine Tools, J. Horner. Mech. World, vol. 64, no. 1646, July 19, 1918, pp. 26-27, 6 figs. Application of Skefko ball bearings to various machines. (Continuation of a serial; preceding article published June 28.)

Belts

Belts for Driving High-Speed Cutterheads. Wood-Worker, vol. 37, no. 6, Aug. 1918, pp. 40-41, 2 figs. Suggestions recommending light double belts for this service.

Cam Profiles

Cam Profiles (I). W. K. Wilson. Mech. World, vol. 64, no. 1647, July 26, 1918, pp. 43-44, 3 figs. Investigation of effect a modification of cam profile can produce upon inertia pressure to which valve gear is subject. (To be continued.)

Gears

A Note on Spiral Gears. Mech. World, vol. 64, no. 1647, July 26, 1918, p. 39, 1 fig. Suggestions in calculation of engine gears.

Gear Standardization, B. F. Waterman. Machy. Market, nos. 926 and 927, Aug. 2 and 9, 1918, pp. 17 and 19. General aspect of the problem; application of standards, worm making; inspection committee. Abstract of paper before Am. Gear Mfrs.' Assn.

Strength of Spiral Type Bevel Gears, Reginald Trautschold. Mach., vol. 24, no. 12, Aug. 1918, pp. 1111-1115, 2 figs. Formulæ for determining strength of spiral type bevel gears.

Thermal Refinement of Gear Blanks, C. R. Poole. Page's Eng. Weekly, vol. 33, no. 724, July 26, 1918, p. 41. Difference between carbonized and heat-treated types of gears. Paper before Am. Gear Mfrs.' Assn.

MACHINE SHOP

Balancing

Dynamic Balancing of Rotating Sections, Carl Hering. Elec. World, vol. 72, no. 9, Aug. 31, 1918, pp. 389-390, 1 fig. Dynamic balancing additional to static balance; rational unit for expressing and measuring the tolerance allowed.

Blacksmith Shop

The Engineer's Smith, Joseph Horner. Mech. World, vol. 63, no. 1642, June 21, 1918, p. 294, 2 figs. Character of the layout, and nature of the practice of present day shops. (To be continued.)

Bolt Making

Bolt Manufacture in Railway Shops, M. H. Williams. Ry. Mech., Eng., vol. 92, no. 8, Aug. 1918, pp. 465-470, 7 figs. Consideration of methods and tools necessary for rapid production.

Chatter Marks

Elimination of Chatter Marks from Machined Work. Am. Mach., vol. 49, no. 8, Aug. 22, 1918, pp. 349-354, 11 figs. Some of the main causes of chatter marks and means taken to eliminate them.

Crank Repairs

Crank Repairs, C. E. Anderson. Power Plant Eng., vol. 22, no. 16, Aug. 15, 1918, pp. 667-669, 4 figs. Difficulties encountered and remedies employed.

Cutting of Metal

Cutting Heavy Forging Ingots, W. B. Perdue. Jl. Acetylene Welding, vol. 2, no. 2, Aug. 1918, pp. 80-86, 2 figs. Methods used by Judson Mfg. Co., Oakland, Cal.

The Cutting of Cast Iron with Oxygen. Acetylene & Welding Jl., vol. 15, no. 177, June 1918, pp. 106-109, 2 figs. Table of data and results from a series of tests. (Concluded.)

The Cutting of Iron and Steel by Oxygen, M. R. Amedeo (Translated from original French by D. Richardson). Acetylene & Welding Jl., vol. 15, no. 177, June 1918, pp. 102-105, 3 figs. Microphotographs showing decarbonization of metal with central jet oxy-acetylene cutting blowpipe. (Continuation of serial.)

Drilling-Machine Work

Unusual Operations on Drilling Machines, Edward K. Hammond. Machy., vol. 24, no. 12, Aug. 1918, pp. 1091-1093, 6 figs. Use of drilling machines for milling, broaching, driving studs and assembling.

Foil Manufacture

The Manufacture of Tin and Lead Foil, L. J. Krom. Metal Indns., vol. 16, no. 8, Aug. 1918, pp. 352-354, 7 figs. Brief illustrated description of process.

Friction Clutch

Manufacturing the Johnson Friction Clutch. Am. Mach., vol. 49, no. 6, Aug. 8, 1918, pp. 263-266, 11 figs. Details of manufacturing operations.

Gages

Flush-Pin Versus Limit Gages, Albert H. Dowd. Am. Mach., vol. 49, no. 7, Aug. 15, 1918, pp. 283-284, 5 figs. Describes several types of flush pin gages both for work and inspection and gives examples of their use.

Indicating Fixtures for the Gaging of Automobile Parts, Albert A. Dowd. Am. Mach., vol. 49, no. 7, Aug. 15, 1918, pp. 299-302, 5 figs. Description of several indicating gages.

Surface Gage with Fine Adjustments, J. G. J. Mech. World, vol. 64, no. 1646, July 19, 1918, p. 27, 1 fig. Sketch of a surface gage with adjustment for height.

Galvanizing Sheets

Modern Practice in Galvanizing Sheets, Clement F. Poppleton. Iron Age, vol. 102, no. 8, Aug. 22, 1918, pp. 433-436, 2 figs. Methods of constructing and operating galvanizing pots; preparation of material and costs; some hitherto unpublished facts.

Gas-Engine Construction

Gas Engine Work on the Pacific Coast, Frank A. Stanley. Am. Mach., vol. 49, no. 8, Aug. 22, 1918, pp. 343-347, 17 figs. Description of certain operations in making marine and stationary engines.

Machining Pistons, Flywheels and Cylinders of Gasoline Engines, M. E. Hoag. Am. Mach., vol. 49, no. 10, Sept. 5, 1918, pp. 443-444, 5 figs. Work of Potter & Johnson automatics with special fixtures and tooling.

Heat Treatment

Effect of Mass on Heat Treatment, E. F. Law. Proc. British Iron & Steel Inst., May 2-3, 1918, Paper no. 16, 15 pp., 17 figs. Report of experiments: Sets of heating and cooling curves of 18-in. cubes, each weighing 1¾ cwts., heated to a temperature of 1650 deg. fahr. and allowed to remain in the furnace for 4½ hr.; microphotographs of sections cut from test-pieces representing the steel cube from outside to center; survey of results obtained by other investigators; conclusions and further experiments on 12-in. cubes.

Electric Furnace for Heat Treating Small Airplane Parts, Dwight D. Miller. Am. Mach. vol. 49, no. 9, Aug. 29, 1918, pp. 373-376, 2 figs. Description of electric furnace for heat treating metal parts and operations involved.

Electric Treatment of Airplane Forgings, Dwight D. Miller. Iron Age, vol. 102, no. 7, Aug. 15, 1918, pp. 381-385, 4 figs. Details of Bailey furnace for heat treating axle forgings at plant of Ingalls-Shepard Forging Co.

Time Effect in Tempering Steel, A. E. Bellis. Ry. Jl., vol. 24, no. 8, Aug. 1918, pp. 27-28. Report of tests made on rifle-barrel steel. Abstract of A. I. M. E. paper.

Hobbing

Charts Giving Time Required to Hob Spur Gears, V. P. Rumley. Machy., vol. 24, no. 12, Aug. 1918, pp. 1085-1086, 2 charts.

Hobs and Hobbing, F. G. Hoffman. Mech. World, vol. 64, no. 1646, July 19, 1918, pp. 27-28. Proposed ideal system of cutting gears developed from a study of the various methods in use at present. Am. Gear Mfrs. Assn. paper.

Reclamation Work

Connecticut Company Centralizes Reclamation Work at New Haven. Elec. Ry. Jl., vol. 52, no. 9, Aug. 31, 1918, pp. 364-367, 14 figs. By segregating heavy repairs, manufacturing operations and reclaiming of damaged equipment this company has achieved substantial economies.

Rubber Insulators

Moulds for Hard Rubber Insulators, Effero. India-Rubber Jl., vol. 56, nos. 1, 2 and 3, July 6, 13 and 20, 1918, pp. 9-10, 33-34, 16 figs, and 57-61, 8 figs. Design features of the rotating distributor arm and stationary carbon holder for the high tension magneto. (Serial.)

Sand Blast

Sand-Blast Operation, D. Evans. Mech. World, vol. 64, no. 1646, July 19, 1918, p. 32, 4 figs. Pressure required for cleaning steel; description of four types of sand-blast equipment. (To be continued.)

Screw Cutting

Cutting and Verifying Accurate Screw Threads (La taille et la correction des vis de précision), Génie Civil, vol. 73, no. 5, Aug. 3, 1918, pp. 81-84, 10 figs. Bryant Symons screw-cutting lathe.

Screw-Cutting Simply Explained for Munition Workers, G. Gentry. Model Engr. & Elecn., vol. 39, no. 899, July 18, 1918, pp. 37-38. Calculating wheels for cutting metric threads on metric lathes and on English lathes. (Continuation of serial.)

Shafting Brackets

Hanger and Bracket Fixings for Rolled-Steel Joists, F. R. Parsons. Mech. World, vol. 64, no. 1646, July 19, 1918, p. 31, 9 figs. Suggested methods of attaching shafting brackets, hangers, bearings, idler or gallows pulleys to rolled-steel joists, in such a manner as will permit a certain amount of latitude of adjustment in order to bring them and the shafting into alignment.

Welding

A. C. Arc Welding and Cutting. Automotive Industries, vol. 39, no. 6, Aug. 8, 1918, p. 241, 1 fig. Light-weight machine of Electric Arc Cutting & Welding Co., Newark, N. J., consisting of a special transformer with no moving parts.

Bibliography of Electric Welding, 1918-1914, William F. Jacob. Gen. Elec. Rev., vol. 21, no. 9, Sept. 1918, pp. 652-658. Includes references to theory, various uses, methods of application, and costs.

Boiler Repairs by Electric Welding, R. S. Kennedy. Boiler Maker, vol. 18, no. 8, Aug. 1918, pp. 225-227. Development of arc-welding process; description of equipment; examples of application of process to boiler repairs. From paper before Inst. of Marine Engrs., London.

Electric Arc Welding, A. M. Candy. Proc. Am. Inst. Elec. Engrs., vol. 37, no. 9, Sept. 1918, pp. 1159-1171, 21 figs. History of process; present practice; manipulation of arc and weld; carbon vs. metallic electrodes.

My Method of Welding with the Electric Arc and Work Which I Have Done, E. D. Johnson. Boiler Maker, vol. 18, no. 8, Aug. 1918, pp. 219-222, 14 figs. Suggestions from author's nine years' experience.

The Autogenous Welding of Lead (Lead Burning), P. Rosenberg. Acetylene & Welding Jl., vol. 15, no. 177, June 1918, pp. 100-101, 5 figs. History of the manufacture of sulphuric acid and of autogenous welding. Enumeration of four processes for lead: hydrogen and air, hydrogen and oxygen, acetylene and air, acetylene and oxygen. (To be continued.)

The Relation to Welding Problems of the Properties of Iron and Steel and Their Heat Treatment. Jl. Acetylene Welding, vol. 2, no. 2, Aug. 1918, pp. 74-76. Difficulties in welding cast iron and suggested remedies to overcome them. (Continuation of serial.)

Welded Seams and Connections Correct Faults in Big Converters. Jl. Acetylene Welding, vol. 2, no. 2, Aug. 1918, pp. 70-73, 9 figs. Details of operation in welding a flange to a cotton converter.

Welding Methods at Columbus Shop. Ry. Mech. Eng., vol. 92, no. 8, Aug. 1918, pp. 473-474, 4 figs. Carbon- and metallic-arc welding both used; special building erected for welding.

Welding Truck Side Frames, Bolsters and Arch Bars. Ry. Jl., vol. 24, no. 8, Aug. 1918, pp. 23-24. Committee report before M. C. B. Assn.

See also Aeronautics (Metal Fittings.)

MACHINERY

(See Metal-Working Machines, Woodworking Machines.)

MARINE ENGINEERING

Concrete Ships

Concrete Barges. Louis L. Brown. Int. Mar. Eng., vol. 23, no. 8, Aug. 1918, pp. 450-452, 8 figs. Brief description of design, method of construction, materials used, method of waterproofing and launching. From a paper before Am. Concrete Inst., June 1918.

Concrete Barges Designed for New York State Barge Canal. Eng. News-Rec., vol. 81, no. 6, Aug. 8, 1918, pp. 271-272, 4 figs. Shipping Board prepares plans for 500-ton towboats to be operated by Federal Railroad Administration.

Concrete Ship of 3500 Tons Deadweight Designed by Emergency Fleet Corporation. Int. Mar. Eng., vol. 23, no. 8, Aug. 1918, pp. 446-449, 9 figs. Conclusions of the Concrete Ship Department; details of the standard ship.

Design and Construction of Self-Propelled Reinforced Concrete Seagoing Cargo Steamers Now Building in Great Britain, T. G. Owens Thurston. Int. Mar. Eng., vol. 23, no. 8, Aug. 1918, pp. 455-464, 15 figs. Paper before Inst. of Naval Architects, London, March 1918.

Progress in the Application of Concrete to Barge and Shipbuilding, J. E. Freeman. Jl. West. Soc. Engrs., vol. 23, no. 3, Mar. 1918, pp. 205-220. Review of progress in concrete-boat building from its earliest inception; discussion of various problems entering into application of reinforced concrete to such construction.

Reinforced Concrete Tugs (Les remorqueurs en béton armé), G. Espitallier. Génie Civil, vol. 73, no. 4, July 27, 1918, pp. 61-64, 14 figs. Type Pelnard-Considère, Caquot & Co.; principles for computation of dimensions; protection; prevention of leaks.

Seagoing Reinforced Concrete Ships Sogaaende Jaernbetonskine), H. Glysing. Ingenioren, vol. 27, no. 58, July 20, 1918, pp. 413-415.

The Building of a Concrete Barge, L. L. Livingston. Contract Rec., vol. 32, no. 32, Aug. 7, 1918, pp. 629-630. Method recently employed at New York. Read before the Am. Concrete Inst.

The Building of Concrete Ships. Contract Rec., vol. 32, no. 33, Aug. 14, 1918, pp. 645-647. Am. Concrete Inst. paper.

The Design of Concrete Ships, H. Devereux. Western Eng., vol. 9, no. 9, Sept. 1918, pp. 343-358, 27 figs. Formulæ and curves.

Control Mechanism

Mechanical Interlock Between Telegraph and Main Engine Control Lever. Shipbuilding and Shipping Rec., vol. 12, no. 4, July 25, 1918, pp. 83-84, 1 fig. Mechanism to prevent the engine-control lever being moved in contradiction to the telegraph indications.

Corrosion

Corrosion of Ships. Nautical Gaz., vol. 94, no. 8, Aug. 24, 1918, p. 89. Causes and protectors. From Liverpool Jl. of Commerce.

Deadrise Cruisers

Model Experiments on Express Cruisers of Deadrise Type, T. A. Gamon. Int. Mar. Eng., vol. 23, no. 8, Aug. 1918, pp. 473-476, 7 figs. For high-speed length ratio, deadrise type proves superior to round bilge model; resistance of appendages investigated.

Electric Fittings

Construction and Uses of Marine Electrical Fittings. Elec. Rec., vol. 24, no. 3, Sept. 1918, pp. 61-66, 25 figs. Details of fittings and illustrations of typical, special and standardized types.

Furness Company's Shipyard

A New Furness Shipyard. Engineering, vol. 106, no. 2743, July 26, 1918, p. 82, 9 figs. Short notice of new enterprise, with illustrations of the work in progress. Also published in Engineer, vol. 26, no. 3265, July 26, 1918, pp. 73-74, 7 figs.

Hog Island

A Record of Achievements at Hog Island, W. H. Blood, Jr. Elec. Rev., vol. 73, no. 5, Aug. 3, 1918, pp. 155-157, 4 figs. Statistics on the work in progress and results already secured.

Launching

End-Launching of Vessel in Narrow Stream, Max Hausen. Int. Mar. Eng., vol. 23, no. 8, Aug. 1918, pp. 469-470, 1 fig. Vessel started down ways at high velocity and brought to a standstill at end of ways by means of a brake.

Motorships

Novel Large Britsh "Diesel"-Driven Tanker. Motorship, vol. 3, no. 9, Sept. 1918, pp. 14-15, 2 figs. General dimensions of Santa Margharita, a motorship of 11,000 tons d-w-c., fitted with solid-injection Vickers oil engines of 2500 b.hp. and with auxiliary motors of 1150 b.hp.

The Australian Motorship "Cethana." Motorship, vol. 3, no. 9, Sept. 1918, p. 15. Details of acceptance trials of American-built Diesel-engined wooden merchant vessel of the single well-deck type.

Trials of M. S. "Alabama." Motorship, vol. 3, no 9, Sept. 1918, p. 21. Speed tests of new 1000-b.hp. Diesel-driven vessel of 4000 tons deadweight capacity.

Repairs

Emergency Repairs to a Battleship. Shipbuilding & Shipping Rec., vol. 12, no. 5, Aug. 1, 1918, pp. 113-115. Details of work involved in substitution by the engine-room staff of the "Arkansas," of an electric motor for the wrecked starboard main circulating pump.

Reversing Rudders

Reversing and Control Rudder. The Rudder, vol. 34, no. 9, Sept. 1918, pp. 436-437, 7 figs. Experiments with a 25-ft. power boat showing the possibility of eliminating reversing turbines from turbine-propelled ships.

Rivetless Ship

See Welded Ships, below.

Submarines

Propelling Machinery for Submarine Boats (in Japanese), Genjiro Hamabe. Jl. Soc. M. E., Tokyo, vol. 21, no. 53, July 1918.

Tuckahoe

The Building of the "Tuckahoe," E. A. Suverkrop. Am. Mach., vol. 49, no. 7, Aug. 15, 1918, pp. 278-281, 10 figs. Record of the progress in building this 5500-ton collier in 27 days.

Turbo-Electric Propulsion

Electric Propulsion of Ships, Eskil Berg. Int. Mar. Eng., vol. 23, no. 8, Aug. 1918, pp. 477-479. Results obtained with electric drive on the "Jupiter"; installations for battleships and cruisers.

The Ljungström Turbo-Electric System of Ship Propulsion. Engineering, vol. 106, no. 2741, July 12, 1918, pp. 30-31, 16 figs. Description of the radial-flow steam turbines built for S. S. Wulsty Castle.

Welded Ships

An Electrically Welded Barge. Engineering, vol. 106, no. 2745, Aug. 9, 1918, pp. 142, 2 figs. Description of experimental rivetless ship constructed in Great Britain.

Britain's First Rivetless Ship. Nautical Gaz., vol. 94, no. 7, Aug. 17, 1918, p. 79. Discussion of possibilities and claimed disadvantages of the electric welding process.

Electrically-Welded Barge. Engineer, vol. 126, no. 3267, Aug. 9, 1918, pp. 122-123, 2 figs. Description of 275-ton rivetless barge constructed in Great Britain.

Electrically-Welded Ships. Elecn., vol. 81, no. 2099, Aug. 9, 1918, pp. 319-320, 1 fig. Description of experimental 275-ton rivetless barge constructed in Great Britain.

See also Building and Construction (Shipyard); Hoisting and Conveying (Overhead Carriers); Internal-Combustion Engineering (Diesel Engines.)

MATHEMATICS

Closed Curves

On Closed Curves Described by a Spherical Pendulum, Arnold Emch. Proc. Nat. Acad. of Science, vol. 4, no. 8, Aug. 1918, pp. 218-221. Results of analytical investigation of properties of these curves.

Hypergeometric Functions

The Practical Importance of the Confluent Hypergeometric Function, H. A. Webb and J. R. Airey. Lond., Edinburgh & Dublin, Phil. Mag., vol. 36, no. 211, July 1918, pp. 129-144, 10 figs. Tables and graph designs, differential equations solvable by means of these, and properties of the functions used in constructing the tables.

Single-Side Surface

A Surface Having Only a Single Side, C. Hering. Jl. Franklin Inst., vol. 186, no. 2, Aug. 1918, pp. 233-241, 13 figs. Equation and analytical investigation of the properties of a surface generated by a line moving along a circle, always remaining in planes passing through the axis of the circle and simultaneously revolving around the circle as its axis at half the angular rate of its movement along the circle.

Theory of Numbers

Arithmetical Theory of Certain Hurwitzian Continued Fractions, D. N. Lehmer. Proc. Nat. Acad. of Sci., vol. 4, no. 8, Aug. 1918, pp. 214-218. Arithmetical study of series of numbers which satisfy certain difference equations.

On the Representation of a Number as the Sum of Any Number of Squares, and in Particular of Five or Seven, G. H. Hardy. Proc. Nat. Academy of Sciences, vol. 4, no. 7, July 15, 1918, pp. 189-193. Research to deduce formulae for $s = 5$ and $s = 7$ from the theory of elliptic functions.

See also Electrical Engineering (Harmonics.)

MECHANICS

Beams

Distribution of Internal Work in Beams and Slabs, Henry T. Eddy. Eng. News-Rec., vol. 81, no. 10, Sept. 5, 1918, pp. 460-462, 1 fig. Difference in amounts of energy stored in steel indicates dissimilarity in structural functions of concrete.

Long Span Concrete Beams Should Have Fixed Ends, W. S. Tait. Eng. News-Rec., vol. 81, no. 8, Aug. 22, 1918, pp. 359-361, 5 figs. Method given by which computation of rigid frame may be readily made.

Maximum Positions of Moving Loads on Beams, F. K. E. Mech. World, vol. 64, no. 1646, July 19, 1918, p. 31, 1 fig. Information for finding the maximum bending moments and shears on beams due to the action of loads moving over them. From a paper read before the Inst. of Local Government Engrs. of Australasia.

Columns and Struts

Discussion on Final Report of the Special Committee on Steel Columns and Struts, W. H. Burr and R. von Fabrice. Proc. Am. Soc. Civ. Engrs., vol. 44, no. 6, Aug. 1918, pp. 875-895, 4 figs. Comparison of committee's results with present practice. (Concluded.)

Disks, Rotating

The Strength of Rotating Disks, H. Haerle. Engineering, vol. 106, no. 2745, Aug. 9, 1918, pp. 131-134, 8 figs. A mathematical treatment applied to steam turbines.

Dynamics

The Fundamentals of Dynamics, W. S. Franklin and B. MacNutt. Science, vol. 48, no. 1231, Aug. 2, 1918, pp. 113-116. Criticism of Prof. E. V. Huntington's discussions of elementary mechanics in Mar. 3, 1916, issue.

Earth Pressures

Computing Lateral Pressure of Saturated Earth, A. G. Husted. Eng. News-Rec., vol. 81, no. 10, Sept. 5, 1918, pp. 441-442, 2 figs. Proposed method takes account of separation of hydrostatic from earth pressure, but allows full hydrostatic pressure.

Gyroscopic Phenomena

On Stability Phenomena in a Ship Gyroscope and Single Rail Railroads (Om Stabilitetsfaenomeneme ved Skibsgyroskopet og Enskinnebanen), A. Bendixsen. Ingenioren, vol. 27, no. 56, July 13, 1918, pp. 399-406, 5 figs.

Indeterminate Structures

Equivalent Uniform Loads for Indeterminate Structures, D. B. Steinman. Eng. News-Rec., vol. 81, no. 5, Aug. 1, 1918, pp. 231-232, 3 figs. Method worked out for ordinary trusses applied to curve influence lines; wheel-load complications avoided.

Truss Members

Effect of Initial Stress on Redundant Truss Members, H. T. Booth. Aviation, vol. 5, no. 2, Aug. 15, 1918, pp. 91-93, 3 figs. Equations for the calculation of load stresses in diagonal tension braces when an initial tension is present; example of the action when diagonals are similar; illustration of the stress calculation for redundant members, with initial tension in two of them.

See also Bridges (Stresses); Pipe (Curved Pipe.)

METAL ORES

Manganese

Manganese, M. A. Allen and G. M. Butler. Univ. of Ariz. Bul. no. 91, Min. Tech. Series, no. 19, Aug. 1918, 32 pp. Composition of manganese minerals—Psilomelane, pyrolusite, manganite, wad, braunite, rhodochrosite, rhodonite and alabandite; tests

of manganese; occurrence and origin of ores; Arizona deposits; uses; manufacture of alloys.

Radium

Radium Ore Deposits, Richard B. Moore. Eng. & Min. Jl., vol. 106, no. 9, Aug. 31, 1918, pp. 392-393. From paper before Colorado meeting of Am. Inst. of Min. Engrs., Sept. 1918.

Rare Metals

Rare Earths and Rare Minerals. Eng. & Cement World, vol. 13, no. 3, Aug. 1, 1918, p. 78. Chief ores and uses of zirconium; method of refining graphite; preparation of ground mica.

Sulphur

Sulphur and Pyrites in 1917, Philip S. Smith. Am. Fertilizer, vol. 49, no. 4, Aug. 17, 1918, pp. 36-42 and 56-82. Production, imports, exports and character of domestic deposits of sulphur; qualities, uses, production and deposits of pyrites in the United States.

War Ores

War Materials of Colorado, A. H. Hubbell. Eng. & Min. Jl., vol. 106, no. 9, Aug. 31, 1918, pp. 382-384. Lead, zinc, gold, silver, tungsten and copper ores. Uranium, vanadium and radium produced from carnotite, vanadinite and pitchblende ores.

METAL-WORKING MACHINES

Drilling Spindles

A Vertical Slide and Drilling Spindle for the 2 in. Precision Lathe, C. H. C. Copeland. Model Engr., vol. 39, no. 898, July 11, 1918, pp. 19-21, 2 figs. Details of design.

Planers

Some New Ideas in Planer Practice. Woodworker, vol. 37, no. 6, Aug. 1918, pp. 26-27, 3 figs. Suggests advisability of shifting more of the feeding gear below the cutterhead so that it may pull the stock instead of pushing it, also slightly beveling the infeed edge of the bedplate under the cutterhead of single surfacers.

Portable Machines

Taking Machines to the Work, Edward K. Hammond. Machy., vol. 24, no. 12, Aug. 1918, pp. 1073-1081, 23 figs. Methods of applying portable machines in performance of shop operations, and advantages thus secured.

Presses

Ferracute Presses. Am. Mach., vol. 49, no. 10, Sept. 5, 1918, p. 450, 1 fig. Description with dimensions and other data of a single-action power press recently redesigned by the Ferracute Machine Co., Bridgeton, N. J., adapted for cutting and forming sheet-metal work of large area, such as coal hods, metal shingles, etc.

Railway Shop

Machine Tools and Appliances in Railway Workshops. Ry. Gaz., vol. 29, no. 5, Aug. 2, 1918, pp. 134-138, 8 figs. Illustrates and describes improvements in designs and types effected during the last 50 years.

Shell-Drilling Machine

Special Shell-Drilling Machines, Donald A. Baker. Machy., vol. 24, no. 12, Aug. 1918, pp. 1131-1132, 4 figs.

Tool Slide

A Tool Slide for the Drummond 4 in. or Similar Lathe, W. Baker. Model Engr. & Electn., vol. 39, no. 899, July 18, 1918, pp. 29-31, 3 figs. Details of design.

Wheel-Forcing Machine

A New Wheel Forcing Machine. Ry. Gaz., vol. 29, no. 4, July 26, 1918, p. 105. Product of Hollings & Guest, Birmingham, for removing heavy Foden and similar car wheels.

Wooden Dies

Using a Punch Press in Lieu of Bending Rolls, J. V. Hunter. Am. Mach., vol. 49, no. 6, Aug. 8, 1918, pp. 243-245, 6 figs. Wooden dies and a punch press used to accomplish some awkward bending jobs.

See also Engineering Materials (Stellite.)

METALLURGY

Alloys

Some Miscellaneous Alloys Made by the Metal and Thermit Cooperation. Reactions, vol. 11, no. 2, Second Quarter 1918, pp. 29-30. Uses of phosphor copper, phosphor tin, manganese titanium, manganese boron, silicon copper, chromium copper, cobalt copper, nickel copper, vanadium copper, titanium copper and manganese aluminum.

Brass Rolling

Chemistry of the Brass Rolling Mill, or the Relation of the Chemical Laboratory to the Brass Rolling Mill, M. B. Karr. Iron & Steel Inst. of Canada, vol. 1, no. 7, Aug. 1918, pp. 297-299. Significance of chemical control. Paper before Montreal Metallurgical Assn.

Rolling of Brass (Laminado del laton), J. Borrell Maciá. Revista Minera, year 69, no. 2645, June 24, 1918, pp. 309-313, 7 figs. Microstructure; composition of alloy for cold-rolling.

Non-Ferrous Alloys

Metallography Applied to Non-Ferrous Metals, Ernest J. Davis. Foundry, vol. 66, no. 313, Sept. 1918, pp. 427-429, 5 figs. Elementary article dealing with the science embracing a study of the internal structure of metals and alloys.

The Constitution and Influence of a Cored Dendritic Structure in Alloys, O. Smalley. Jl. Soc. Chem. Industry, vol. 37, no. 13, July 15, 1918, pp. 191T-200T and discussion 200T-201T, 22 figs. Genesis of microstructure; relation of composition and structure to physical properties; influence of varying casting temperature on properties of phosphor-bronze castings poured from the same melt; effect of heat treatment on properties of Admiralty gun metal; influence of impurities on properties of 70:30 brass before and after removal of the cast structure; relation of impurities to ghosts.

Stibnite Smelting

Blast-Furnace Smelting of Stibnite. Eng. & Min. Jl., vol. 106, no. 5, Aug. 3, 1918, pp. 211-210, 1 fig. Details of experimentation, showing effects of varying flux charge; minimum economic limit of coke required.

See also Electrical Engineering (Electrodeposition.)

MILITARY ENGINEERING

Anti-Aircraft Firing

The Problem of Anti-Aircraft Firing, X. Reille. Jl. Wash. Academy of Sci., vol. 8, no. 14, Aug. 19, 1918, pp. 465-480, 8 figs. Technical study of the general problems which anti-aircraft warfare has presented to the minds of artillerymen.

Artillery

Developments in Artillery During the War, J. Headlam. Sci. Am. Supp., vol. 85, no. 2215, June 15, 1918, pp. 370-371. How the changes in tactics affect technical matters and how the demands of the soldier may upset the plans of the scientist. (To be continued.)

Ballistics

Internal Ballistics, A. G. Hadcock. Proc. Royal Soc., vol. 94, no. A 663, July 1, 1918, pp. 179-509, 6 figs. Explanation and illustration of method for obtaining pressure-volume relation of gases in the bore of a gun from the instant of ignition of charge to the instant when shot leaves the gun, and mathematical expressions to plot the indicator diagram of charge when its nature and weight are known.

See also Building and Construction (Warehouse); Motor-Car Engineering (Ambulances); Roads and Pavements (Military Roads); Varia (Explosives.)

MINES AND MINING

Cementation

Cementation Process Applied to Mining, A. H. Krynauw. Colliery Guardian, vol. 116, no. 3005, Aug. 2, 1918, pp. 227-229, 9 figs. From paper before Chemical, Metallurgical & Min. Soc. of South Africa, May 1918.

Drilling

A Gasoline-Driven Diamond Drill Outfit, J. M. Longyear, Jr. Eng. & Min. Jl., vol. 106, no. 8, Aug. 24, 1918, pp. 343-345. Nearly 7,000 ft. of holes put down at a total cost of $2.152 per ft.; easily portable apparatus.

Fires

Mine Fire at Utah-Apex Mine, V. S. Rood and J. A. Norden. Safety Eng., vol. 35, no. 6, June 1918, pp. 356-364, 3 figs. Geology, mining methods and conditions of workings; conditions during and after the fire; results of analyses of air at different openings. Proc., A. I. M. E., Utah Section.

Some Results of Analysis of Airs from a Mine Fire, A. C. Blakeley and H. H. Reist. Jl. Indus. & Eng. Chem., vol. 10, no. 7, July 1, 1918, pp. 552-553. Data from samples taken at an anthracite coal mine generating a large quantity of methane.

Shafts

Shafts for Water Hoisting and Ventilation. Coal Age, vol. 14, no. 9, Aug. 29, 1918, pp. 397-400, 8 figs. "Water seal" permits shaft to be used for both ventilation and water hoisting. Description of first installation in United States.

Steel Guides in Shafts, J. Whitehouse. Jl. of South African Inst. of Engrs., vol. 16, no. 11, June 1918, pp. 200-204, 5 figs. Results obtained by the use of slotted steel guides in the turf shaft of the Village Deep Mine; suggested system for replacing guides.

Sprayers

Sprayer for Stone-Dusting in Mines, A. Rushton. Trans. Inst. Min. Engrs., vol. 55, part 3, July 1918, pp. 219-220, and discussion pp. 220-221. T-shaped wrought-iron-tubing apparatus operated by compressed air.

Washing

Recuperation of Combustible from Slag and Wash Residium (Récupération du combustible utilisable dans les scories et résidus de lavage). L'Echo des Mines et de la Métallurgie, no. 2581, July 7, 1918. Treatment of slag from metallurgical furnaces; washing of schists from mining installations.

MOTOR-CAR ENGINEERING

Ambulances

U. S. A. Ambulance and Trailer. Automotive Industries, vol. 39, no. 4, July 25, 1918, pp. 152-155, pp. 148-149, 3 figs. Review of specifications for an ambulance body for the class A A or G. M. C. ¾-ton chassis. Details of the spare-parts trailer and field litter.

Headlights

Automobile Headlights and Glare-Reducing Devices, L. C. Potter. Gen. Elec. Rev., vol. 21, no. 9, Sept. 1918, pp. 627-632, 13 figs. Discussion of underlying principles of causes of glares; devices to prevent glare.

Omnibus

Omnibus Selection by Tests. Tramway & Ry. World, vol. 44, no. 2, July 11, 1918, p. 39, 1 fig. Specifications of 19-30 passenger type supplied to San Francisco Council.

Piston Displacement

Piston Displacement Chart for Four-Cylinder Engines, Any Bore and Stroke. Motor Age, vol. 34, no. 9, Aug. 29, 1918, p. 38. Gives piston displacement in cubic inches with 0.04 cu. in. limit of error.

Tractors

An Improved Chain Track for Tractors. Automotive Industries, vol. 39, no. 7, Aug. 15, 1918, p. 280, 2 figs. Chain of sheet-steel sections having guided rocking joints with dust excluder and enclosed track carrier, developed by Ralph Wishon, of San Francisco, Cal.

Steering Creeper and Two-Wheeled Tractors, A. C. Woodbury. Automotive Industries, vol. 39, no. 7, Aug. 15, 1918, pp. 269-270, 2 figs. Outline of various plans for steering tractors by other methods than that involved in Ackermann steering axle.

The Latest Electric Tractor. Auto, vol. 33, no. 30, July 26, 1918, pp. 535-536, 2 figs. Three-wheeled couple-gear tractor designed to do the same work as a horse team at greater speeds.

The Peoria Kerosene Tractor. Automotive Industries, vol. 39, no. 9, Aug. 29, 1918, pp. 366-367, 4 figs. Assembled of parts produced in specialized plants. Engine, clutch and transmission bolted together. Drawbar hitch can be laterally adjusted from driver's seat.

Tractor Gear Ratio Chart. Automotive Industries, vol. 39, no. 9, Aug. 29, 1918, p. 372. Diagram of curves to find gear reduction to give a certain tractor speed with a given engine speed and drive-wheel diameter.

Tractor Speed in Plowing, Fred M. Loomis. Motor Age, vol. 34, no. 9, Aug. 29, 1918, pp. 5-8, 3 figs. Study of effect of speed and soil conditions on plow draft and tractor drawbar pull.

Trucks

English and American Motor Oil Tank Trucks, Frank C. Perkins. Gas Eng., vol. 20, no. 9, Sept. 1918, pp. 413-417, 11 figs. Data and descriptions of several types.

Wheels

Making Cast Steel Wheels for U. S. Army Trucks. Foundry, Vol. 66, no. 313, Sept. 1918, pp. 396-401, 11 figs. Description of processes at Dayton Steel Foundry Co.

Wood Wheels Preferred by the Majority. C. N. Bonbright. Auto. Topics, vol. 50, no. 11, July 20, 1918, pp. 1102-1103 and 1107. Discussion of merits of materials for automobile wheels.

See also Hoisting and Conveying (Trucks, Industrial.)

MUNITIONS

Ansaldo Munition Factory

Ausaldo Steel Plants Rush Munitions. Mario de Biasi. Blast Furnace & Steel Plant, vol. 6, no. 9, Sept. 1918, 4 pp., following 358, 12 figs. Gio. Ansaldo & Co., employing over 100,000 men, manufacture guns, cannon, shells, aeroplanes, submarines, merchant and battleships.

Bullets

Resistance of Copper Crushers During Compression. H. W. R. Mason. Arms & Explosives, vol. 26, no. 310, July 1, 1918, pp. 90-92. Description of tests and tables of results.

Cunard Shell Factory

The Cunard National Shell Factory. Engineering, vol. 106, no. 2740, July 5, 1918, pp. 3-6, 26 figs. Illustrated description of the work, the machines and tools used and certain fixtures.

Field Guns

The 75-Mm. Field Gun, Model 1916, M.III. Special Correspondence. Am. Mach., vol. 49, no. 8, Aug. 22, 1918, pp. 323-328, 4 figs. Description of latest type of 75-mm. field gun built by U. S. Government.

Howitzers, 6-in., British

The British 6-in. Howitzer. I. William Chubb. Am. Mach., vol. 49, no. 6, Aug. 8, 1918, pp. 231-242, 24 figs. First of a series on gun-making and repairing in English privately owned shops. Part II. in Am. Mach., vol. 49, no. 10, Sept. 5, 1918, pp. 411-423, 6 figs. Machining and heat-treating of jacket; assembling howitzer; fitting of new A-tubes and repair of damaged howitzers.

Madsen Automatic Gun

The Madsen Automatic Gun. Sci. Am. Supp., vol. 86, no. 2224, Aug. 17, 1918, pp. 108-110, 6 figs. Details of weapon for which great efficiency is claimed. From the Engineer (London).

Marine Torpedoes

Early History of the Marine Torpedo. H. H. Manchester. Am. Mach., vol. 49, no. 10, Sept. 5, 1918, pp. 435-438, 11 figs. Historical sketch of prototype of modern torpedo, commencing with earliest known type, in 1285, and dealing with Bushnell's torpedo, 1810.

Naval Gun Cars

Gun Transport Car for the Navy. Ry. Mech. Eng., vol. 92, no. 8, Aug. 1918, pp. 457-459, 4 figs. Details of special car for transporting 16-in. guns.

Special Cars for Transporting Heavy Naval Guns. Ry. Age, vol. 65, no. 5, Aug. 2, 1918, pp. 212-214, 4 figs. Details and drawings.

Revolvers

Revolvers and Automatic Pistols (Les revolvers et les pistolets automatiques). L. Cabanes. Génie Civil, vol. 73, no. 4, July 27, 1918, pp. 64-67, 10 figs. Recent developments in manufacture of French type, Nagant Russian and Austro-Hungarian no. 1898. (To be continued.)

Shell, 18-lb., British

Special Machine-Tool Fixtures for Making the British 18-lb. Shell. Chester B. Hamilton, Jr. Am. Mach., vol. 49, no. 9, Aug. 29, 1918, pp. 395-396, 5 figs.

See also Metal-Working Machines (Shell Drilling Machine.)

PAINTS AND FINISHES

Ironwork

Corrosion of Ironwork. J. N. Friend. Surveyor, vol. 54, no. 1384, July 26, 1918, p. 43. Summary of results of author's researches on the usefulness of paint for protecting ironwork. Abstract of paper before Iron & Steel Inst. Also published in Can. Engr., vol. 35, no. 7, Aug. 15, 1918, p. 149.

Paint and Its Application to Railway Structures. Eng. Rev., vol. 32, no. 1, July 15, 1918, pp. 20-21. Preservative and decorative purposes in the industry. From report of Com. of Am. Ry. Bridge and Building Assn.

Standards for Protective Finishes for Iron. E. F. Later. Foundry, vol. 66, no. 313, Sept. 1918, pp. 424-426. Results of series of tests which indicate protective qualities of various metals and thickness of coatings.

(See also Mining Engineering (Corrosion.)

PHYSICS

Air

Physics of the Air. W. J. Humphreys. Jl. Franklin Inst., vol. 186, no. 2, Aug. 1918, pp. 211-232, 5 figs. Rocket, ball, sheet, beaded, return and dark lightning; length of streak; nature of the discharge; temperature; visibility; spectrum; thunder; rumbling; cerannograph; chemical effects, explosive effects. (Continuation of serial).

Electrolytes

Colloidal Electrolytes: Soap Solutions as a Type. J. W. McBain. Jl. Soc. Chem. Industry, vol. 37, no. 14, July 31, 1918, pp. 249 T-252 T. Results of experiments on the constitution, hydrolysis, conductivity, osmotic properties, and viscosity of soap solutions.

Electronic Frequency

Electronic Frequency and Atomic Number. Paul D. Foote. Phys. Rev., vol. 12, no. 2, Aug. 1918, pp. 115-121. Examination of Dr. Allen's formula for relation between atomic frequency and Moseley's atomic number, in the light of data on ionization potentials recently published by Franck, Davis, Bazzoni, Tate, Foote and Hughes.

Emulsions

Water-in-Oil Emulsions. A. U. Max Schlaepfer. Jl. Chem. Soc., vols. 113 and 114, no. 668, June 1918, pp. 522-526. Experiments performed with the aid of a finely divided solid, insoluble in both liquids, which is more easily wetted by the oil than by the water phase.

Flame Propagation in Gases

Flame Propagation in Gaseous Mixtures. G. A. Burrell and A. W. Gauger. Sci. & Art of Min., vol. 28, no. 26, July 27, 1918, p. 475. From technical paper 150 summarizing experiments of U. S. Bureau of Mines on limits of complete inflammability of mixtures of mine gases, etc.

Optics

On the Correction of Optical Surfaces. A. A. Michelson. Proc. Nat. Academy of Sciences, vol. 4, no. 7, July 15, 1918, pp. 211-212. Suggested modifications in Mr. Twyman's interferometer method.

Transmission of Light Through Water. S. L. E. Rose. Gen. Elec. Rev., vol. 21, no. 8, Aug. 1918, pp. 577-578, 2 figs. Table of experimental values of transmission factor T in the equation $I = I_0 \times T^f$ where I_0 is the initial intensity and I the intensity after passing through f feet of water.

Polarization

Polarization in Case of Moving Electrodes. Carl Barus. Science, vol. 48, no. 1236, Sept. 6, 1918, pp. 253-254. Experiments at Brown University in which a strong residual polarization in direction of charging current was obtained; elucidation of phenomenon.

Reciprocity

Law of Reciprocity (Loi de réciprocité). J. B. Pomey. Revue Générale de l'Electricité, vol. 4, no. 5, Aug. 3, 1918, pp. 131-132. Equation derived from the principle of virtual velocities, between the electromotive force e_k in each of the branches of a network and the function of the derivative of the energy with respect to the current α_k; also reciprocal equation for the current in terms of the derivatives with respect to the electromotive forces.

Relativity

General Relativity Without the Equivalence Hypothesis. L. Silberstein. Lond., Edinburgh & Dublin Phil. Mag., vol. 36, no. 211, July 1918, pp. 94-128. Chief aspects and illustrations of the physical implications of the principle of relativity as proposed by Einstein, but without placing gravitation in connection with the fundamental tensor which appears in the line-element of the world.

Spectra

Extreme Ultra-Violet Spectra of Hot Sparks in High Vacua. R. A. Millikan and R. A. Sawyer. Phys. Rev., vol. 12, no. 2, Aug. 1918, pp. 167-170, 1 fig. Report of experiments. Abstract of paper before New York meeting Am. Phys. Soc.

Structural Matter

On the Dynamics of the Electron. M. Nad Saha. Lond., Edinburgh & Dublin Phil. Mag., vol. 36, no. 211, July 1918, pp. 76-87. Theory aiming at the formulation of the dynamics of the electron without following the preconceived ideas of classical mechanics. Reasoning is based on Lorentz's theorem of ponderomotive force and the principle of relativity.

Some Properties of Metals Under the Influence of Alpha Rays. A. G. McGougan. Phys. Rev., vol. 12, no. 2, Aug. 1918, pp. 122-129, 4 figs. Yale University experimental research involving: An attempt to present a fresh clean surface of metal to incident x-rays by scraping the surface of the metal while in a high vacuum; similar experiment for a surface of mercury by method of overflow, thereby stretching the surface film and producing a new clean surface of mercury.

Surface Friction

Surface Friction of Fluids. E. Parry. New Zealand Jl. of Sci. & Technology, vol. 1, no. 3, May 1918, pp. 154-156. Proposes as general law of fluid friction: For geometrically similar surfaces, $R/\rho v^2$ is a function of lv/u, where R is the resistance per unit of area, ρ the density of fluid, v the relative velocity, l a dimension of the surface, and u the kinematic viscosity; deductions from experimental data in regard to flow of water in pipes.

Vibrations

On Ship Waves, and on Waves in Deep Water Due to the Motion of Submerged Bodies. G. Green. Lond., Edinburgh & Dublin Phil. Mag., vol. 36, no. 211, July 1918, pp. 48-63. Extension of Lord Kelvin's method for determining wave motion to any arbitrary conditions of applied surface pressure; discussion of the wave disturbance due to a cylinder and a sphere moving with constant velocity at a considerable depth beneath the surface.

Variably Coupled Vibrations—Both Masses and Periods Unequal. E. H. Barton and H. M. Browning. Lond., Edinburgh & Dublin Phil. Mag., vol. 36, no. 211, July 1918, pp. 36-57. Theory of general case for double-cord pendulum and experimental results. (Continued from Oct. 1917 and Jan. 1918 issues.)

Vibration: Mechanical, Musical and Electrical. Nature, vol. 101, no. 2545, Aug. 8, 1918, pp. 456-459, 5 figs. Brass instruments and the low "F"; monochord vibrations; violin vibrations. (Concluded.)

See also Steel and Iron (Electric Resistance of Steel; Magnetic Properties of Steel.)

PIPE

Costs

Cost of Laying Iron Pipe. Mun. Jl., vol. 45, no. 6, Aug. 10, 1918, pp. 111-112. Unit figures for estimating cost under various conditions as to size, depth of trench and costs of material and labor.

Clay Pipe, Vitrified

The Use of Vitrified Clay Pipe for Irrigation Lines. V. E. Piollet. Mun. & County Eng., vol. 55, no. 2, Aug. 1918, pp. 73-75. Requirements of construction.

Curved Pipe

Stresses in Curved Pipes. J. S. Henzell. Mech. World, vol. 64, no. 1646, July 19, 1918, pp. 28-29, 1 fig. Analytical study of the stresses in pipes which suffer external restraint. (Continuation of serial; preceding article published July 5.)

Joints

Methods of Making Sewer Pipe Joints. Contract Rec., vol. 32, no. 36, Sept. 4, 1918, pp. 718-719. Specifications for several joints. From discussion before Boston Soc. Civ. Engrs.

New Concrete Pipe Joint Designed for High Pressure. Eng. News-Rec., vol. 81, no. 5, Aug. 1, 1918, p. 216, 1 fig. Joint proves watertight under tests for heads up to 250 ft.; can be used for diameters as small as 4 in.

Pressure Pipe

Recent Developments in Reinforced Concrete Pressure Pipe for Water Supply Lines. W. R. Harris. Mun. & County Eng., vol. 55, no. 2, Aug. 1918, pp. 58-59, 3 figs. Present

maximum working pressure, structural features, types of expansion joints.

The Choice of Material for Pressure Pipes, Ralph Bennett. Jl. of Electricity, vol. 41, no. 3, Aug. 1, 1918, pp. 123-124. Study of available types (steel, concrete, wood stave).

Welded Pipe

The Manufacture of Welded Pipe, S. A. Hand. Am. Mach., vol. 49, no. 7, Aug. 15, 1918, pp. 285-288, 7 figs. Description of methods used by National Tube Co.

POWER GENERATION AND SELECTION

Aqueduct Construction

Construction of Famous Aqueduct Facilitated by Electricity, C. W. Geiger. Elec. Rev., vol. 73, no. 7, Aug. 17, 1918, pp. 241-242, 5 figs. Description of use of electricity in building the Los Angeles Aqueduct.

Auxiliaries, Drives for

Motor Driven Auxiliaries (I), C. Grant. Mech. World, vol. 63, no. 1641, June 14, 1918, p. 283. Comparison between turbine and electric-motor drives. (To be continued.)

Costs

Economic Proportion of Hydroelectric and Steam Power, Frank G. Baum, Proc. Am. Inst. Elec. Engrs., vol. 37, no. 9, Sept. 1918, pp. 1115-1119, 2 figs. Method for obtaining a curve showing "Total cost per kilowatt-year for hydroelectric and steam power" for any percentage combination of generation.

Electric Power Generation

A Review of Recent Electrical Engineering Progress, E. W. Rice, Jr. Elec. News, vol. 27, no. 16, Aug. 15, 1918, pp. 25-28. Efficiency in converting water to electric power; improvements in steam-producing devices; possibility of further advances in steam-turbo-electric unit; elements in the efficiency problem; linking of plants for exchange of power; electric furnace; electrification and transportation. Presidential address, A. I. E. E. convention.

Mills, Continuous

Operation of Motor-Driven Continuous Mills, H. C. Cronk. Blast Furnace & Steel Plant, vol. 6, no. 8, Aug. 1918, pp. 336-338. Operating data giving power consumption per ton, including auxiliary motors. Paper before Cleveland Section, Assn. Iron & Steel Elec. Engrs.

Mining

Electrical Manufacturers May Look to Metal Mining for Greater Output, W. A. Scott. Elec. Rev., vol. 73, no. 4, July 27, 1918, pp. 119-120, 3 figs. Present demand for metals creates increased mining activity; steadily widening field for electrical equipment and electric power in the metal mines.

Electricity in Coal Mining Operations, Frank Huskinson. Elec. Rev., vol. 73, nos. 7 and 8, Aug. 17 and 24, 1918, pp. 245-247, 8 figs., and 287-289, 6 figs. Mine haulage by electric locomotives; electric rotary drills, electric blasting; advantages of electric service.

How Electrical Methods Are Speeding Up Coal Mining Operations (III), T. R. Hay. Elec. Rec., vol. 24, no. 3, Sept. 1918, pp. 28-29, 8 figs. Details of manner in which electrical equipment is used inside and about the mine: electric mine hoists; pumping equipment; ventilating system; miscellaneous uses of electrical energy.

The Consideration of Items of Practical Importance in Connection with Mining Electrical Engineering, Chris. Jones. Proc. South Wales Inst. of Engrs., vol. 34, no. 2, July 19, 1918, pp. 159-206, 24 figs. Considerations, curves and data regarding the efficiency and cost of generating, distributing and applying electrical power in mines and kindred industries: periodicity of supply; power factor; earthed and insulated neutral; reactance; cables; transformers; earthing.

Tire Manufacture

Electricity in the Manufacture of Automobile Tires, R. B. Jackson. Elec. Rev., vol. 73, no. 4, July 27, 1918, pp. 121-124, 5 figs. Process of tire making; choices of motors and salient features of control, applying especially to plant of International India Rubber Co., South Bend, Ind.

Woodworking Machinery

Motor Drive for Woodworking Machinery, C. E. Clewell. Elec. World, vol. 72, no. 6, Aug. 10, 1918, pp. 253-256, 4 figs. Induction motors used extensively for timber sawing and planing; power requirements of typical machines; examples of successful motor applications.

POWER PLANTS

Rand Plant

Turbine House Plant Operation, wth Special Reference to the Rand Power Companies' Plants, T. G. Otley and V. Pickles. Trans. South African Inst. Elec. Engrs., vol. 9, part 5, May 1918, pp. 68-88, 11 figs. Discussion of some points in connection with efficient operation of turbine plant and its attendant auxiliaries.

Shaft Drive

More Power from Shaft by Use of Turbine. Elec. News, vol. 27, no. 15, Aug. 1, 1918, p. 33. General features of shaft drive, consisting of a low-pressure turbine and a Danbee reduction gear, recently installed in a Western Pennsylvania paper mill.

Small Power Plant

How to Manage Small Power Plants, W. T. Wardale. Model Engr. & Elecn., vol. 39, nos. 899 and 900, July 18 and 25, 1918, pp. 34-35, 2 figs, and pp. 47-48, 6 figs. Requirements of pump water gland packing; manner of packing. (Continuation of serial.)

Winona Plant

The New 5000-Kilowatt Station at Winona, Minn. Elec. Rev., vol. 73, no. 9, Aug. 31, 1918, pp. 321-324, 4 figs. Mechanical and electrical features of Wisconsin Railway, Light and Power Co.'s plant.

PRODUCER GAS AND GAS PRODUCERS

Suggestions for Gas Producer Operation, F. Denk. Blast Furnace & Steel Plant, vol. 6, no. 9, Sept. 1918, pp. 386-388, 5 figs. Tests and curves showing relations of factors influencing operation; depth and position of ash bed determined by unique device; careful attention essential in successful operation.

PUMPS

Air Lift

Performance of New Air-Lift Pumping Plant at Galesburg, Ill., J. Oliphant. Mun. & County Eng., vol. 55, no. 2, Aug. 1918, pp. 57-58. Conditions of operation and results of tests.

Deep-Well Pump

Importance of Diameter of Deep Wells. Mun. Jl., vol. 45, no. 6, Aug. 10, 1918, pp. 105-107. Where deep-well pumps are used, diameter of well limits size of pump; lower part may be of smaller diameter.

Lift Pumps

Lift and Force Pumps, John H. Perry. Domestic Eng., vol. 84, no. 7, Aug. 17, 1918, pp. 239-241, 5 figs. Construction and operation of pumps with steady flow and high efficiency.

Mine Pump

Handling Mine Water, Henry E. Cole. Coal Age, vol. 14, no. 6, Aug. 8, 1918, pp. 264-266, 2 figs. Work pump must perform; character of water; types of pumps.

Turbine Pump

Pumping Equipment at Thorold, Ont., W. L. Adams. Can. Engr., vol. 35, no. 6, Aug. 8, 1918, pp. 121-122. New installation consisting of a two-stage 1500-gal. turbine pump directly connected to a 250-hp. induction motor, with control and auxiliary apparatus.

RAILROAD ENGINEERING, ELECTRIC

Circuit Breakers

High-Speed Circuit Breakers for Chicago, Milwaukee & St. Paul Electrification, C. H. Hill. Gen. Elec. Rev., vol. 21, no. 9, Sept. 1918, pp. 623-626, 5 figs. Gives details of construction.

Electrification

Electrification of New York Connecting Railway. Ry. Gaz., vol. 29, no. 3, July 19, 1918, pp. 81-84. Method of operation; trolley supporting structures; catenary trolley system; communication lines; transmission lines.

Norfolk and Western Electrification Helping Directly to Win the War. Elec. Ry. Jl., vol. 52, no. 8, Aug. 24, 1918, pp. 322-325, 5 figs. Fifty per cent. increase in mountain-grade capacity through electrification.

Tendencies in Electrification, E. A. Palmer. Ry. Rev., vol. 63, no. 5, Aug. 3, 1918, pp. 176-178. Brief résumé of the leading steam railway electrification projects in the United States. From a paper before Pacific Coast Railway Club, June 1918.

The Electrification of the Chicago, Milwaukee & St. Paul Railway, A. E. du Pasquier. Trans. S. A. Inst. E. E., June 1918, pp. 94-126, 18 figs. Criticism of J. W. Kirkland's paper published in July and Aug. 1917 journals under same title; other railway electrification data in connection with Kirkland's inferences.

The Electrification of the Chicago, Milwaukee & St. Paul Ry., R. Beeuwkes. Elec. Ry & Tramway Jl., vol. 39, no. 932, Aug. 9, 1918, pp. 42-46, 5 figs. Regeneration on down grades; engineering and construction; results of operation; comparison of train delays and of steam and electric locomotive performance. (Continued from July 12 issue.)

Heating of Cars

Why Not Use Wasted Energy to Help Heat Cars? Elec. Ry. Jl., vol. 52, no. 7, Aug. 17, 1918, pp. 291-292, 2 figs. Possibilities of utilizing heat from car motors and resistance grids discussed and results of some tests given.

Line Construction

Applying Common-Sense in Line Construction, Charles R. Harte. Elec. Ry. Jl., vol. 52, no. 7, Aug. 17, 1918, pp. 278-282, 14 figs. Money and time can be saved by close cooperation of designer and constructor, and by attention to details commonly overlooked.

Locomotive Control

A New Type of Mine Locomotive Control, L. W. Webb. Gen. Elec. Rev., vol. 21, no. 9, Sept. 1918, pp. 620-622, 8 figs. A controller developed for use on large mine locomotives where the capacity of hand-operated drum controls would be exceeded. Wiring connections of two-, three- and four-motor controllers.

Metering Power

Study of Car Energy Saving at Dubuque, L. E. Gould. Elec. Ry. Jl., vol. 52, no. 8, Aug. 24, 1918, pp. 334-336, 4 figs. Tests made on level and hill lines show that savings as high as 26 per cent. can be obtained by the use of meters as checking devices.

Operation

High Passenger Density the Outstanding Feature of New Service to Hog Island. Elec. Ry. Jl., vol. 52, no. 10, Sept. 7, 1918, pp. 404-408, 8 figs. Details and data of Philadelphia Rapid Transit Co.'s cars, including new features of door control.

Increased Economy Results from Correct Operation of Car Equipment, C. W. Squier. Elec. Ry. Jl., vol. 52, no. 7, Aug. 17, 1918, pp. 275-277, 4 figs. Effects of various rates of acceleration and braking on the schedule speeds and power consumed; relation of number of stops and their length to cost of operation.

Selling Transportation on a Commercial Basis, Clarence Renshaw. Elec. Ry. Jl., vol. 52, no. 10, Sept. 7, 1918, pp. 415-416. Sale methods of other lines of business apply to electric railways; some requisites for good service.

Section Cars

Gasoline Motor Section Cars Decrease Labor and Cost of Track Maintenance, Clifford A. Elliott. Elec. Ry. Jl., vol. 52, no. 10, Sept. 7, 1918, p. 423, 3 figs. Maintenance-of-way department, Pacific Electric Rys., uses such cars and motor velocipedes in maintaining signals and tracks.

Single-Phase Locomotives

New Single-Phase Locomotives for the Swiss Bundesbahn, Hugo Studer. Elec. Ry. Jl., vol. 52, no. 10, Sept. 7, 1918, pp. 411-413, 8 figs. Description of four sample locomotives ordered for the Swiss Bundesbahn and several types developed by the Oerlikon Co. in connection with this electrification.

Track-Circuit Design

A Graphical Method of Solving D. C. Track-Circuit Problems, H. M. Proud. Ry. Engr., vol. 39, no. 463, Aug. 1918, pp. 157-159, 5 figs. Use of graphs showing total track conductance against volts on rails in finding volts on relay and train shunt. (Continuation of serial.)

Track Work

Special Track Work for Street Railways, J. V. Hunter. Am. Mach., vol. 49, no. 8, Aug. 22, 1918, pp. 335-338, 8 figs. Engineering work in connection with switches, frogs and crossovers.

RAILROAD ENGINEERING, STEAM

Bolsters, Truck

Design of Cast Steel Truck Bolsters. L. E. Endsley. Ry. Rev., vol. 63, no. 5, Aug. 3, 1918, pp. 152-154, 3 figs. States results in a bolster mast with no holes in side walls and subsequent results after holes were cut.

Brakes

A Mechanical Brake Control System for Railways. Engineer, vol. 126, no. 3264, July 19, 1918, pp. 58-59, 7 figs. Description of details of "Reliostop" railway brake control system.

Air Brake Association in Fuel Saving. Railroad Herald, vol. 22, no. 9, Aug. 1918, pp. 195-196. Recommendations tending to decrease leakage of brake pipes on freight trains in order to save 6,000,000 tons of coal annually. Report of committee.

Road Tests of the A. S. A. Brake. Ry. Mech. Eng., vol. 92, no. 8, Aug. 1918, pp. 453-456, 4 figs. 100-car train run on Virginian with A. S. A. and Westinghouse brakes.

Tests of the Automatic Straight Air Brake on the Virginian Railway. Ry. & Loco. Eng., vol. 31, no. 8, Aug. 1918, pp. 244-247, 6 figs. Résumé of equipment, data and chronograph records of five positions of brake valve and of speed and stop distances.

Cars

Cars for Special and Excursion Traffic, Victorian Railways. Ry Engr., vol. 39, no. 463, Aug. 1918, pp. 160-161, 3 figs. Arrangement details of a pattern car, weighing 26 tons, with capacity for 82 passengers, recently completed at the Government railway shops at Newport, England.

High Capacity Cars on a Narrow Gauge Railway in India. Frederick C. Coleman. Ry. Age, vol. 65, no. 6, Aug. 9, 1918, pp. 265-266, 3 figs. Description of freight cars of the Sheffield & Twinberrow type for the Kalka-Simla Ry.

Crossings

Concrete Slab Railroad Crossings. Eng. & Cement World, vol. 13, no. 3, Aug. 1, 1918, p. 34. How they were placed at Cedar Rapids, Ia.

Freight House

Pennsylvania Completes Freight House at Chicago. Ry. Age, vol. 65, no. 5, Aug. 2, 1918, pp. 215-219, 8 figs. Description of new structure of two-level type.

Hot Boxes

The Hot Box Problem. N. Marple. Railroad Herald, vol. 22, no. 9, Aug. 1918, pp. 196-198. Causes originating the hot box and suggestion to prevent them by making car owner responsible. Paper before Niagara Frontier Car Men's Assn.

Hump Yard

15,000-Car Hump Yard Near Chicago Planned by Illinois Central Railroad. Eng. News-Rec., vol. 81, no. 7, Aug. 15, 1918, pp. 313-316, 1 fig. Terminal for main-line trains, from which transfer trains will serve local yards, will have power-operated switches, motor-car service for car riders and L. C. L. transfer facilities for 450 cars daily.

Locomotive Boilers

Design and Maintenance of Locomotive Boilers. Boiler Maker, vol. 18, no. 8, Aug. 1918, pp. 231-232. Application of autogenous welding to construction and renewal of smokeboxes, flues, staybolts, fireboxes and mud rings. Report of Committee on Design and Maintenance of Locomotive Boilers, before joint meeting of Master Car Builders and Master Mechanics Assns. Also published in Ry. Jl., vol. 24, no. 8, Aug. 1918, pp. 21-23.

Reducing Maintenance Costs on Locomotive Boilers. W. R. Toppan. Railroad Herald, vol. 22, no. 9, Aug. 1918, p. iv-A. How a terminal system cut down its flue and staybolt work following installation of a water-softening plant.

The Arrangement of Tubes in Locomotive Boilers. H. C. Webster. Mech. World, vol. 64, no. 1646, July 19, 1918, p. 33, 4 figs. Study of the arrangement necessary to secure maximum efficiency.

Locomotive Engines

Modern Locomotive Engine Design and Construction. Ry. Engr., vol. 39, no. 463, Aug. 1918, pp. 151-156, 8 figs. Locomotive feedwater heating systems, superheated steam and methods of superheating. (Continuation of serial.)

Locomotive Exhaust Nozzles

Locomotive Exhaust Nozzles. Ry. & Loco. Eng., vol. 31, no. 8, Aug. 1918, pp. 251-253, 2 figs. Study of part played by form of aperture in results obtained, based on physical character of phenomenon.

Locomotives

A Three-Cylinder Locomotive. Engineer, vol. 126, no. 3265, July 26, 1918, pp. 70-72, 10 figs. Illustrations and drawings, and special reference to the Gresley valve gear. Locomotive in operation on the Great Northern Ry., England.

New 3-cylinder Locomotive, Great Northern Railway. C. S. Lake. Model Engr., vol. 39, no. 897, July 4, 1918, pp. 1-5, 6 figs. Features of locomotive recently built at the Doncaster Works, England.

Compound Mallet for the N. & W. Ry. & Loco. Eng., vol. 31, no. 8, Aug. 1918, p. 263, 1 fig. Dimensions of 2-8-8-2 type.

N. & W. 267-ton Mallet Locomotive. H. W. Reynolds. Ry. Mech. Eng., vol. 92, no. 8, Aug. 1918, pp. 445-450, 10 figs. Data, drawings and description of locomotive and its tender.

New Pacific and Mikado Type Locomotives for the Chicago, Burlington and Quincy Railroad. Ry. & Loco. Eng., vol. 31, no. 8, Aug. 1918, pp. 248-249, 2 figs. Dimensions of 4-6-2 and 2-8-2 types.

New 2-8-0 Type Locomotives for the Victorian Railways. Ry. Gaz., vol. 29, no. 2, July 12, 1918, pp. 51-52, 4 figs. Diagrams and dimensions.

First U. S. Standard Locomotive. Ry. Mech. Eng., vol. 92, no. 8, Aug. 1918, pp. 436-438, 5 figs. Description with drawings of the light Mikado type built by the Baldwin Locomotive Works.

The First of the U. S. Railroad Administration Locomotives. Railroad Herald, vol. 22, no. 9, Aug. 1918, pp. 194-195. General features of Mikado (2-8-2) type recently completed by the Baldwin Locomotive Works.

Baldwin Locomotive Works Completes the First of the U. S. Standard Locomotives. Mikado type, 2-8-2. Assigned to the Baltimore and Ohio. Ry. & Loco. Eng., vol. 31, no. 8, Aug. 1918, pp. 239-240, 1 fig. Description and dimensions.

Small Locomotives of Special Types. Engineer, vol. 126, no. 3267, Aug. 9, 1918, pp. 111-112, 2 figs. Descriptions with dimensions and data of gasoline-driven locomotives of 20 and 40 hp., used at present for trench railways, but applicable for industrial railways of various types.

The Influence of Type on Locomotive Performance. Ry. Gaz., vol. 29, no. 4, July 26, 1918, pp. 108-112, 6 figs. Criticism of design for an engine of the 4-4-0 type proposed in April 12 issue, and table of comparative particulars of express locomotives of this type.

Mexican Railways

Serious Condition of the Railways in Mexico. Ry. Age, vol. 65, no. 7, Aug. 16, 1918, pp. 307-309. Report by Latin-American Division of Bureau of Foreign and Domestic Commerce.

Rail Failures

Derailment from Rail Failures Due to Transverse Fissures. Railroad Herald, vol. 22, no. 9, Aug. 1918, pp. 190-192, 4 figs. Diagrams, micro-photos, and results of physical and chemical analyses of fractured rails. Report of Chief of Bureau of Safety, I. C. C., covering investigation of an accident which occurred on the Central of Ga.

Rail Renewing

Labor Saving Appliances in Rail Renewing on the C., B. & Q. R. R. Ry. Rev., vol. 63, no. 7, Aug. 17, 1918, pp. 229-233, 4 figs. Rail-laying machine, rail-drilling machine, tie sawing machine.

Repair Shop

A Western Railroad Repair Shop. Frank A. Stanley. Am. Mach., vol. 49, no. 6, Aug. 8, 1918, pp. 249-252, 15 figs. Describing some methods and tools used.

Locomotive Repair Developments in Great Britain. Railroad Herald, vol. 22, no. 9, Aug. 1918, pp. 183-184. Construction details of Great Eastern Railway recently built. Special shops capable of carrying out repairs on between 40 to 50 engines simultaneously.

Running Repairs of Locomotive Boilers and Approved Methods of Wash-Out of Boilers. Ry. & Loco. Eng., vol. 31, no. 8, Aug. 1918, pp. 241-243, 6 figs. Data of mileage between washouts made by passenger and freight locomotives; cost of washing; methods and tools used.

Signaling

Electro-Pneumatic Interlocking Plants. H. A. Wallace. Ry. Signal Engr., vol. 11, no. 8, Aug. 1918, pp. 250-253. Details and operation of switches and signals; air valve; electro-pneumatic machine; "SS" system of signal control. Abstract of paper before Tex. Regional Committee of Ry. Signal Assn.

New Mechanical Plant on Chicago and Alton. Ry. Signal Engr., vol. 11, no. 8, Aug. 1918, pp. 239-243, 3 figs. Interlocker on a double-track main line crossing single-track road, designed not to require night leverman.

Track

Interesting Reconstruction Work on the Erie. Ry. Age, vol. 65, no. 6, Aug. 9, 1918, pp. 248-252, 9 figs. Work on a 35-mile section of double-track line in Indiana including some heavy grade revision.

Labor-Saving Devices for Track Maintenance. Ry. Rev., vol. 63, no. 5, Aug. 3, 1918, pp. 172-176. From a paper by E. Stimson before New England Railroad Club, May 1918.

Trans-Australian Railway

The Trans-Australian Railway. Engineer, vol. 126, no. 3264, July 19, 1918, pp. 56-57, 1 map. Difficulties of construction; description of the route; progress of construction; special problems encountered; the country traversed.

Turntables

Construction, Care and Maintenance of Turntables. Ry. & Loco. Eng., vol. 31, no. 8, Aug. 1918, pp. 250-251, 2 figs. Features of improved types.

See also *Cement and Concrete* **(Ties)**; *Factory Management (Railway Stores)*; *Labor (Railroad Employees)*; *Munitions (Naval Gun Cars.)*

REFRACTORIES

Testing and Inspection of Refractory Brick. C. E. Nesbitt and M. L. Bell. Blast Furnace & Steel Plant, vol. 6, no. 8, Aug. 1918, pp. 341-344, 8 figs. Results of tests on spalling (resistance to sudden thermal change), crushing and slag penetration; conclusion drawn from differences in the figures obtained. Paper before Am. Soc. Testing Materials.

See also Testing and Measurements (Refractories, Testing).

REFRIGERATION

Ammonia-Absorption Machines

Gas Formation in Ammonia Absorption Refrigerating Machines, Its Causes and Remedy. E. C. McKelvy and A. Isaacs. Am. Soc. Refrig. Engrs. Jl., vol. 4, no 5, March 1918, pp. 447-463, 1 fig. Report of experimental work undertaken by special committee to investigate nature and sources of gases by means of an experimental bomb consisting of a piece of 4-in. steel pipe closed at both ends by clamped blind flanges with a female recess. Read before Am. Soc. Refrig. Engrs.

Ammonia Conservation

Conservation of Ammonia and Coal. E. N. Fiedmann and Van R. H. Greene. Ice & Refrig., vol. 54, no. 5, May 1918, pp. 268-269. Stuffing box and decomposition losses; temperature of cooling water and condenser pressure; saving coal; undesirable coal mixtures; increased evaporation. Paper before Long Island Ice Manufacturers' Assn.

Ammonia Leakage

Cost of Ammonia Leakage. Reactions, vol. 11, no. 2. Second Quarter 1918, pp. 31-36. Possibility of considerable loss of ammonia through apparently inconsiderable leaks.

Brine-Cooling System

The Practical Side of the Low Temperature Compression System. H. Solan. Am. Soc Refrig. Engrs. Jl., vol. 4, no. 6, May 1918, pp. 549-556, 4 figs. Description of three installations operated with brine-cooling systems.

CO_2 Machines

Carbonic Acid Refrigerating Machines. J. C. Goosmann. Ice & Refrig., vol. 54, no. 5, May 1918, pp. 272-274, 3 figs. Some conditions that have delayed general adoption of carbon-dioxide refrigerating machines; practical equality of three refrigerants; actual equality of horsepower required.

Cold Accumulators

Cold Accumulators and Their Application to the Refrigerating Industry. Am. Soc. Refrig. Engrs. Jl., vol. 4, no. 6, May 1918, pp. 541-548, 2 figs. Types of tanks and formulæ for calculations. Read before Milwaukee Section of A.S.R.E.

Hospital Refrigerating Plant

Service for the Sick. Power Plant Eng., vol. 22, no. 15, Aug. 1, 1918, pp. 605-610, 6 figs. Description of power plant at Blodgett

Memorial Ho[illegible] Grand Rapids, Mich.; [illegible]

Ice Making

Modern Station [illegible] Raw Water Ice Plant. [illegible] vol. 55, no. 3, Sept. 1, 1918, [illegible] 13 figs. Details of plant and complete equipment of plant; arrangement of engines, freezing and ice storage rooms; method of operation and details of [illegible] electrical equipment and cost of power.

Preventing Red Cores. Leon Block. Ice & Refrig., vol. 54, no. 5, May 1918, pp. 270-271, 1 fig. Results of a discussion at a meeting of Refrig. Engrs.

Refrigeration and Ice Making. Charles L. Hubbard. Indus. Management, vol. 56, no. 2, Aug. 1918, pp. 105-109, 11 figs. Examples of apparatus and machinery used in military camps and on shipboard.

Treatment of Water for Raw Water Ice Making. M. F. Newman. Am. Soc. Refrig. Engrs. Jl., vol. 4, no. 6, May 1918, pp. 527-540. Account of different processes. Presented before the A.S.R.E.

Ice Structure

The Crystal Structure of Ice. A. St. John. Proc. of the Nat. Academy of Sciences, vol. 4, no. 7, July 15, 1918, pp. 193-197. Photographic spectrum investigation by means of a Coolidge tube with tungsten target excited by an induction coil with mercury turbine interrupter.

Insulating Materials

Report Upon Tests of Heat Insulating Materials for Cold Storage Rooms, W. M. Thornton. Cold Storage, vol. 21, no. 244, July 18, 1918, pp. 177-178. Method of testing; relative efficiency from total ice melted; quantity of heat transmitted.

Liquefaction of Gases

Argon, Lighting and Industries Employing Very Low Temperatures (L'argon, l'éclairage et l'industrie des basses températures), Georges Claude. Mémoires et Compte Rendu des Travaux de la Société des Ingénieurs Civils de France, year 71, nos. 1-3, Jan.-Mar. 1918, pp. 66-72, 2 figs. Process of liquefaction of gases and description of apparatus for obtaining a liquid mixture of 75 to 80 per cent argon and the rest oxygen; argon and nitrogen in electric lamps.

Loss in Ammonia Manufacture

Sources of Loss During the Manufacture of Concentrated Ammonia Liquor, A. Marsden. Jl. Soc. Chem. Industry, vol. 37, no. 14, July 31, 1918, pp. 230T-232T. Suggestions to remedy sources of losses when making ammonia.

Salt Solutions

The Freezing Points of Concentrated Solutions and the Free Energy of Solution of Salts, W. H. Rodebush. Jl. Am. Chem. Soc., vol. 40, no. 8, Aug. 1918, pp. 1204-1213. Experimental determination of freezing-point concentration curves for the commoner salt solutions; thermodynamic equations for the free energy of solution and examples of their application.

See also Drying (Low Temperature.)

RESEARCH

Factory Chemical Laboratory

Relation of the Chemical Laboratory to the Factory, M. B. Karr. Can. Mfr., vol. 38, no. 9, Sept. 1918, pp. 21-23, 3 figs. Before Montreal Metallurgical Assn.

Factory Research Laboratory

Planning a Research Laboratory for an Industry, C. E. K. Mees. Jl. Soc. Chem. Industry, pp. 201T-202T. Two possible forms of organization "departmental" system and "cell" system. Abstract of paper before New York Section of Soc. Chem. Industry.

National Physical Laboratory

The National Physical Laboratory in 1917-18. Engineering, vol. 106, no. 2743, July 26, 1918, pp. 91-96. From the annual report, dealing with work of the various departments.

See also Testing and Measurements (Railroad Testing Laboratory.)

ROADS AND PAVEMENTS

Asphalt Roads

[illegible] Asphalt Pavements. Chas. A. Mullen. Better Roads & Streets, vol. 8, no. 6, June 1918, pp. 225-229 and 252-253, 5 [illegible]s. Paper before Fifth Can. Good Roads Congress.

[illegible] Construction and Maintenance [illegible] Rock Asphalt Roads, [illegible] Mun. & County Eng., vol. 55, [illegible] pp. 49-50. Characteristics [illegible] of these roads; recom[illegible]

Concrete Roads

[illegible] Pavements at New [illegible] Samuel H. Lea. Eng. News-Rec., vol. 81, no. 10, Sept. 5, 1918, pp. [illegible] townsite roadways of [illegible] throughout at Larg[illegible] special templet used for [illegible]

Concrete Road Construction During [illegible] Temperatures. Eng. & Contracting, vol. 50, no. 6, Aug. 7, 1918, pp. 147-148. Sand, water and subgrade heated before mixing and laying concrete; concrete protected by a covering of canvas and hay.

Concrete Roads in New Zealand. Surveyor, vol. 54, no. 1383, July 19, 1918, p. 30. Method of construction in Auckland City.

How to Get the Best Surface on a Concrete Road, A. H. Hunter. Mun. & County Eng., vol. 55, no. 2, Aug. 1918, pp. 47-49. Remarks on the construction of forms, operation of templets, building of joints, finishing surfaces and use of the roller and belt.

Cost Keeping

Cost Keeping System for County Highway Work. Contract Rec., vol. 32, no. 34, Aug. 21, 1918, pp. 657-659. Elements applying to all cases. From paper before Wash. Assn. of County Engrs. Also published in Eng. & Contracting, vol. 50, no. 6, Aug. 7, 1918, pp. 145-147.

Earth Roads

Method of Building Earth Roads in Kane County, Illinois. George N. Lamb. Eng. & Contracting, vol. 50, no. 6, Aug. 7, 1918, pp. 140-141, 1 figs. Laying out curves; standard cross sections for grading; the operations; cost of earth road grading.

The Necessity of Engineering Supervision in Construction and Maintenance of Earth Roads. H. Ross Mackensie. Eng. & Contracting, vol. 50, no. 6, Aug. 7, 1918, pp. 155-157. From paper before Regina Branch of Can. Soc. of Civ. Engrs.

Easement Curves

Easing and Super-Elevating the Highway Curve. Contract Rec., vol. 32, no. 32, Aug. 7, 1918, pp. 617-618. Table and diagram of super-elevations and offsets for easement curves, used by the highway engineers of King County, Wash., in construction of paved roads.

Frost Action

Impervious Bituminous Wall Suggested to Prevent Seepage Under Paving. Eng. News-Rec., vol. 81, no. 5, Aug. 1, 1918, pp. 226-228, 3 figs. Extensive study made of vertical movements of pavements with reference to frost action; distribution of moisture in clay and loam sub-grades and effect of walling off shown by charts.

Gravel Roads

Iowa Methods of Constructing Gravel Roads. Eng. & Contracting, vol. 50, no. 10, Sept. 4, 1918, pp. 247-248. From bulletin issued by Iowa Highway Commission.

Highways

Highway Carries Twelve Times as Much Local Freight as Railroad. Eng. News-Rec., vol. 81, no. 5, Aug. 1, 1918, pp. 224-226. Shipments by Baltimore road increase 480 per cent in year, saving railroads 39,923 ton miles.

Notes on Highway Design, J. L. Harrison. Eng. & Contracting, vol. 50, no. 10, Sept. 4, 1918, pp. 237-238. Preliminary investigation; population benefited; volume of traffic; grades; distance; curvature.

Macadam Pavements

Method and Cost of Reducing Excessive Crown on a Macadam Pavement. E. Earl Glass. Eng. & Contracting, vol. 50, no. 6, Aug. 7, 1918, pp. 144-145, 2 figs. Filling in sides of the road to reduce crown described.

Military Roads

Roads in [illegible] Section of American Forces. Repair, Widening and Resurfacing. Robert K. Tomlin, Jr. Eng. News-Rec., vol. 81, no. 8, Aug. 22, 1918, pp. 348-352, 8 figs. Heavy traffic by motor trucks and artillery on practice marches necessitates continuous maintenance.

Road Construction

Asphalt Resurfacing in Los Angeles, C. W. Geiger. Mun. Jl., vol. 45, no. 7, Aug. 17, 1918, pp. 123-125, 6 figs. Mixture for wearing surfaces and binder furnished by municipal asphalt plant. Surface heating method employed. All done by day labor.

Handling Materials on a Michigan Road Job. Municipal Jl., vol. 45, no. 10, Sept. 7, 1918, pp. 181-182, 6 figs. Gravel for concrete dredged from neighboring lake, transported, measured and mixed.

The "National" Pavement in New Haven. Mun. Jl., vol. 45, no. 8, Aug. 24, 1918, pp. 143-145. Methods used in resurfacing old macadam and brick pavements with a cover composed of about 18 per cent asphalt and 82 per cent pulverized earthy matter, 50 per cent of which passes through a 200-mesh sieve, and nothing being retained on a 10-mesh screen.

Road-Construction Machinery

The Use of Modern Machinery in County Road Construction, C. B. Scott. Good Roads, vol. 16, no. 9, Aug. 31, 1918, pp. 80 and 83. Various modern machines and devices; and new ways in which they are being used. Paper before North Carolina Good Roads Assn.

Sand-Clay Roads

Maintaining Sand-Clay Roads in North Carolina. Mun. & County Eng., vol. 55, no. 2, Aug. 1918, p. 49. Account of investigation regarding failure of roads.

Tar Surfaces

English and American Practice in the Construction of Tar Surfaces and Pavements, A. H. Blanchard. Better Roads & Streets, vol. 8, no. 6, June 1918, pp. 230-234 and 253, 11 figs. Paper before Fifth Can. Good Roads Congress. Also published in Eng. & Contracting, vol. 50, no. 6, Aug. 7, 1918, pp. 142-144.

War Conditions

Policy of U. S. Highways Council Regarding Highway and Street Work During the War. Eng. & Contracting, vol. 50, no. 10, Sept. 4, 1918, pp. 232. Text of regulations, effective Sept. 10, 1918.

Road Building in Michigan Under War Conditions, Frank F. Rogers. Good Roads, vol. 16, no. 10, Sept. 7, 1918, pp. 89-90 and 92. Paper before Mich. State Good Roads Assn.

Water, Action of

The Action of Water on the Road Subgrade and Its Relation to Road Drainage, J. L. Harrison. Mun. & County Eng., vol. 55 no. 2, Aug. 1918, pp. 50-52. Limitations of tile drainage; capillary attraction; heavy-clay soils; freezing of dry subgrades; cracking; use of Telford base; carrying capacity of subgrade.

See also Engineering Materials (Paving Blocks.)

SAFETY ENGINEERING

Acetylene

Report of the Department Committee on Cylinders for Dissolved Acetylene. Acetylene & Welding Jl., vol. 16, no. 177, June 1918, pp. 98-99. Results of experiments carried out at the Home Office Experimental Station, Eskmeals, Cumberland, with the object of ascertaining the result of igniting the acetylene in a pocket space formed in the porous material inside a cylinder, and the danger, if any, of such ignition. (Continuation of serial.)

Brick Making

Safety in Brick Making. Am. Industries (Accident Prevention Supp.), vol. 19, no. 1, Aug. 1918, 4 pp., 7 figs. Sketches of machines enclosed in standard guards.

Fires

Some Lessons from a Disastrous Carhouse Fire. Elec. Ry. Jl., vol. 52, no. 6, Aug. 10, 1918, pp. 239-241, 3 figs. Results of a fire caused by explosion of oil tank of a 44,000-volt lightning arrester.

Mine Rescue Stations

The Equipment and Organization of Mine Rescue Stations, A. J. Moorshead. Safety Eng., vol. 36, no. 1, July 1918, pp. 23-27. Prevention of accidents; necessary equipment and its care; first-aid supplies; exploring teams.

Scaffolding Construction

Safety in Scaffolding Construction. Building News, vol. 115, no. 3315, July 17, 1918, pp. 34-35. Reproduction of rules and regulations promulgated by the Department of Labor and Industry of the Pennsylvania Industrial Board.

Wood Alcohol

Wood Alcohol in War Time, Winifred Hathaway. Survey, vol. 40, no. 22, Aug. 31,

1918, pp. 609-611. Discusses unsuspected danger faced by thousands of workers in munition plants and elsewhere.

See also Hoisting and Conveying (Wire Ropes.)

SANITARY ENGINEERING

Air Checking of Sewer Pipe

Reducing Air Checking in Cooling Sewer Pipe. B. T. Sweely. Brick & Clay Rec., vol. 53, no. 4, Aug. 13, 1918, pp. 291-292. Procedure claimed to have reduced air checking 60 per cent. in middle-west plant.

Alum in Filters

The Selection of Alum for Filter Plants. Fire & Water Eng., vol. 64, no. 7, Aug. 14, 1918, p. 116. Extract of suggestions in annual report of Ontario Provincial Board of Health.

Sewage Disposal

Auto-Eductor Solves Sewage Tank Difficulty. Mun. Jl., vol. 45, no. 8, Aug. 24, 1918, pp. 145-146. Removal of large amount of greasy scum and sludge from septic tank that had resisted other pumping appliances.

Comparative Value of Activated Sludge and Sprinkling Filters, T. Chalkley Hatton. Contract Rec., vol. 32, no. 33, Aug. 14, 1918, pp. 638-641. Variation in standard effluent; area required for plants; loss of head and effect of temperature; clarification; odors; flies; disposal of sludge; cost of plants.

Design and Construction of the New Sewage Treatment Plant at Sedalia, Mo., R. E. McDonnell. Mun. & County Eng., vol. 55, no. 2, Aug. 1918, pp. 71-73. Intercepting and grit chamber; Imhoff settling tanks; sludge-drying beds; sprinkling filters.

Design and Construction of Water and Sewerage Works at the Hog Island Shipyard. W. H. Blood. Mun. & County Eng., vol. 55, no. 2, Aug. 1918, pp. 54-57. Difficulties met; purification plant; distribution system; hydrants; sewage pumping and treatment.

Design Details of Proposed Works for the Collection and Disposal of Sewage at Pottstown, Pa., C. E. Collins. Mun. & County Eng., vol. 55, no. 2, Aug. 1918, pp. 61-64. Pumping station; settling tanks; dosing tank; filter; sludge-drying beds; capacity, operation and care.

Miles Acid Process May Require Aeration of Effluent. F. W. Mohlman. Eng. News-Rec., vol. 81, no. 5, Aug. 1, 1918, pp. 235-236, 1 fig. Experiments show that sulphur dioxide in effluent deoxygenates several volumes of diluting water.

Novel Sewerage System and Sewage Plant at Mt. Horeb, Wis., W. G. Kirchoffer. Mun. & County Eng., vol. 55, no. 2, Aug. 1918, p. 61. Description of system made entirely of concrete.

Sewage Disposal. Edward Wilcox. Surveyor, vol. 54, no. 1386, Aug. 9, 1918, pp. 66-67. Presidential address, Assn. of Mgrs. of Sewage Disposal Works. (Concluded.)

Sewering an Army Cantonment. Mun. Jl., vol. 45, no. 8, Aug. 24, 1918, pp. 141-142. Construction work at Camp Bowie, Tex., done by the Gen. Construction Co., at a cost of $80,000.

Sprinkling Filter System and Auxiliaries Versus the Activated Sludge Process. T. Chalkley. Mun. & County Eng., vol. 55, no. 2, Aug. 1918, pp. 67-70. Comparison as to standard effluent, area, loss of head, temperature, clarification, odors and cost.

The Deoxygenating Effect of the Effluent from the Miles Acid Process of Sewage Treatment. F. W. Mohlman. Eng. & Contracting, vol. 50, no. 7, Aug. 14, 1918, pp. 166-167, 1 fig. Concludes that the Miles acid effluent contains unoxidized sulphur dioxide which is oxidized at the expense of the dissolved oxygen in the water in which the effluent is diluted and that it may be oxidized before dilution by aeration for a short time with relatively small quantities of air.

Water-Purification Plants

Design and Construction of the New Water Purification Plant and Pumping Station at Checotah, Okla., V. V. Long. Mun. & County Eng., vol. 55, no. 2, Aug. 1918, pp. 70-71.

Mechanical Rapid Sand Filtration Plant for Dorval, P. Q. Contract Rec., vol. 32, no. 32, Aug. 7, 1918, pp. 615-617, 1 fig. Details of construction.

STANDARDS AND STANDARDIZATION

Inductance

Standard of Mutual Induction (Etalon d'induction mutuelle). M. A. Guillet. Jl. de Physique, vol. 7, Mar. Apr. 1917, pp. 75-87, 1 fig. Formula determining standard; theory and operation of apparatus. Presented before French Phys. Soc. (Continuation of serial.)

Screw Standards

Gaging Screws. H. J. Bingham Powell. Am. Mach., vol. 48, no. 25, June 20, 1918, pp. 1045-1046. Attempt to show way to correlate the numerous existing standards and to secure their interchangeability.

See also Aeronautics (International Aircraft Standards); Paints and Finishes; Railroad Engineering, Steam (Locomotives); Testing and Measurements (Gages.)

STEAM ENGINEERING

Boiler Code

Table of Allowances. F. R. Burlingame. Boiler Maker, vol. 18, no. 8, Aug. 1918, pp. 218-219, 1 fig. Figured from formulæ given in the revision of the A.S.M.E. Boiler Code published in January.

Corrosion

Surface Defects of Condenser Tubes Causing Corrosion. W. R. Webster. Page's Eng. Weekly, vol. 33, no. 724, July 26, 1918, p. 42. Abstract of paper before Am. Soc. for Testing Materials.

What Is the Cure for Condenser Tube Corrosion? Hartley LeH. Smith. Elec. Ry. Jl., vol. 52, no. 7, Aug. 17, 1918, pp. 283-285. Writer believes longer life will be secured from condenser tubes by proper selection of materials and care in manufacture, rather than by modification of conditions directly under control of operator.

Water Softening to Correct Boiler Corrosion. William Henry Hobbs. Ry. Rev., vol. 63, no. 5, Aug. 3, 1918, pp. 167-170. Prevention of incrustation, pitting and corrosion; reference to experiments to determine the relative corrosibility of various salts and manner in which these tendencies can be corrected.

Engine Economy

Improving Engine Economy. M. A. Saller. Power Plant Eng., vol. 22, no. 15, Aug. 1, 1918, pp. 617-620, 6 figs. Increasing capacity and efficiency of steam engines by proper valve setting, eliminating leakage and maintaining speed regulation.

Exhaust Steam

Utilization of Exhaust Steam for Generating Electrical Energy in Collieries. (Considérations sur l'utilisation des vapeurs d'échappement dans les houillères en vue de la production d'énergie électrique). A. Barjon. L'Industrie Electrique. Year 27, no. 627, Aug. 10, 1918, pp. 287-293, 7 figs. Utilization of exhaust steam; turbo-generator groups; types of turbines. (Continuation of serial.)

Lubrication, Engine Cylinder

Problems of Steam Cylinder Lubrication. W. F. Osborne. Blast Furnace & Steel Plant, vol. 6, nos. 8 and 9, Aug. and Sept. 1918, pp. 338-341 and p. 389. Importance and difficulties of lubrication; features influencing method of lubricating, such as the cylinder, the valves, steam flow and steam exhaustion.

Pipe Lines

Relation Between Loss of Pressure and Pipe Size in Long Steam Lines. H. Eisert. Jl. Engrs. Club of Baltimore, vol. 7, no. 6, Dec. 1918, pp. 103-122, 2 figs. Technical study based on Weisbach's formula for determining flow resistance of a fluid through a conduit of uniform cross-section.

Pumping Engines

Historical Data of Steam Pumping Engines. A. O. Doane. Fire & Water Eng., vol. 44, no. 9, Aug. 28, 1918, pp. 148-149. Comparison of various types in capacity and cost.

Two Newcomen Atmospheric Pumping Engines. Cerald T. Newbould. Colliery Guardian, vol. 116, no. 3005, Aug. 2, 1918, pp. 230-231, 3 figs. One built in 1787 and the other in 1823 are still in operation. From paper before Midland Inst. of Min., Civ. and Mech. Engrs. Also published in Iron & Coal Trades Rev., vol. 97, no. 2631, Aug. 2, 1918, pp. 118-119, 8 figs.

Steam Plants, Statistics on

Notes on the Development of the Use of Steam Since 1876. Robert M. Anderson. Stevens Indicator, vol 35, no. 2, April 1918, pp. 97-107. Corliss engines, steam turbines, electric-power systems; statistics giving increase of various prime movers and electric motors during ten-year periods.

Turbine Theory

A New Theory of the Steam Turbine. Harold Medway Martin. Engineering, vol. 106, no. 2740, July 5, 1918, pp. 1-3, 1 chart. First of a series of articles; contains a steam chart based on Callender's tables and formulæ.

Turbines

Modern Steam Turbines. J. Humphrey. Iron & Coal Trades Rev., vol. 97, no. 2632, Aug. 9, 1918, pp. 147-148, 1 fig. A review of recent types.

New Turbine Plant at Hull. Tramway & Ry. World, vol. 44, no. 2, July 11, 1918, pp. 11-14, 8 figs. Installation of three-phase turbo-generating plant on scheme to augment existing high- and low-tension direct current system.

Volcanic Steam Generation

Power from Volcanic Steam. Jl. Royal Soc. of Arts, vol. 66, no. 3429, Aug. 9, 1918, p. 602. Brief notes on Southwestern Tuscany plant where electric energy is obtained from low-pressure alternating turbines operated with volcanic steam.

See also Air Machinery (Turbo Compressors); Engineering Materials (Boiler Plates); Marine Engineering (Turbo Electric Propulsion); Railroad Engineering, Steam (Locomotive Boilers, Locomotive Engines, Locomotive-Exhaust Nozzles); Testing and Measurements (Steam, Quality of.)

STEEL AND IRON

Blast-Furnace Operation

Blast-Furnace Bears. J. E. Stead. Proc. British Iron & Steel Inst., May 2-3, 1918, Paper no. 9, 42 pp., 5 figs. Discussion of variable character of bear (mass of metal found below the hearth level of a blast furnace after it has been blown out); evidence of the existence of kish, sulphides of manganese and iron, cyano-nitrite of iron, titanium dioxy nide, oxides, silicates, phosphides and carbide crystals, and unique specimens, in the composition of some bears; hypotheses explaining their genesis.

Conserving Manganese in Steel Production. A. N. Diehl. Blast Furnace & Steel Plant, vol. 6, no. 9, Sept. 1918, pp. 366-367. Discussion read before Am. Iron & Steel Inst.

Copper Tuyeres for Blast-Furnaces. A. K. Reese. Proc. British Iron & Steel Inst., May 3-2, 1918, Paper no. 6, 6 pp., 3 figs. Details of design and adaptation.

Fuel Economy in Blast-Furnaces. T. C. Hutchison. Proc. British Iron & Steel Inst., May 2-3, 1918, Paper no. 5, 14 pp., 6 figs. Report of work done at the Skinningrove Iron Co.'s plant, consisting of two 8-ft. hearths and three 10 ft. hearth furnaces, and inferred observations on the importance of effectually cleaning the ironstone at the belt, the conditions that secure long life of furnace lining, and fuel economy. Also published in Blast Furnace & Steel Plant, vol. 6, no. 9, Sept. 118, pp. 378-380, 3 figs.

Inquiry on Blast-Furnace Practice in the United Kingdom. Proc. British Iron & Steel Inst., May 2-3, Paper no. 2, 19 pp. Effect of the mechanical and chemical conditions of raw materials on furnace working; influence of dimensions of the bell relative to stock line; use of double bells; size and quality of firebricks; use of waste gas for calcining ironstone. Report of committee summarizing answers received from owners of blast furnaces.

Principal Changes in Blast Furnace Lines. J. G. West. Blast Furnace & Steel Plant, vol. 6, no. 8, Aug. 1918, pp. 323-329, 29 figs. Bronze cooling plates inserted in brickwork; development of wider hearths; use of high blast temperatures; discussion of theoretical lines. From paper before Am. Iron & Steel Inst. (Concluded.)

Briquetting Iron Ores

Present Knowledge and Practice in Briquetting Iron Ores. Guy Barrett and T. B. Rogerson. Automotive Eng., vol. 3, no. 7, Aug. 1918, pp. 310-311, 1 fig. Methods followed and machines used in this work, with special reference to conditions in United States, England and Continental Europe. (Third of series.)

The Briquetting of Pulverable Iron Ore and Blast-Furnace Slime. (Le briquetage des minerais de fer pulvérulents et des poussiers de hauts fourneaux). G. Barrett and T. B. Rogerson. Génie Civil, vol. 73, no. 4, July 27, 1918, pp. 70-73. Collection of practical data. From a report before Iron and Steel Inst. (To be continued.)

Cast Iron

The Fluidity of Molten Cast Iron. Matthew Riddell. Foundry, vol. 66, no. 313, Sept. 1918, pp. 408-411, 1 fig. From a paper before British Foundrymen's Assn.

Chemical Constitution of Steel

Iron, Carbon aand Phosphorus. J. E. Stead. Proc. British Iron & Steel Inst., May 2-3, 1918, Paper no. 19, 24 pp., 23 figs. Account of experiments performed in order to investigate the effect of introducing carbon, by cementation, into homogeneous solid solutions of iron and phosphorus and temperature ranges in which free phosphide of iron passes in and out of solid solution in iron.

Non-Metallic Inclusions: Their Constitution and Occurrence in Steel. A. McCance. Proc. British Iron & Steel Inst., May 2-3, 1918, Paper No. 14, 48 pp., 36 figs. Effect in strength of stressed material; position in relation to the ingot; etching reagents; influence of aluminum on sulphides; oxidation products of manganese sulphide; acid open-hearth slags and their reduction products; equilibrium conditions in liquid steel; results of analyses and examination of microphotographs of etchings.

Note on Inclusions in Steel and Ferrite Lines. Proc. British Iron & Steel Inst., May 2-3, 1918, Paper no. 13, 6 pp., 13 figs. Results of experiments which led the author to the conclusion that the phosphorus associated with non-metallic inclusions in steel leads to the formation of ferrite ghost lines.

Coke

The Importance of Coke Hardness. G. D. Cochrane. Proc. British Steel & Iron Inst., May 2-3, 1918, Paper no. 3, 11 pp., 3 figs. Results of experiments which led the author to establish as an axiom that the practical success of the working of a blast furnace is chiefly dependent on the mechanical condition of the coke used.

Cold-Working

The Effect of Cold Work on the Divorce of Pearlite. J. H. Whiteley. Proc. British Iron & Steel Inst., May 2-3, 1918, Paper no. 17, 9 pp., 14 figs. Investigation in the study of Eggertz color test for combined carbon consisting of experiments in which drillings of pearlitic steels were annealed in vacuo for about an hour at 650 deg. cent.; a small section of a hammered bar was heated in vacuo for periods of 15 min. at successive temperatures between 459 and 690 deg. cent., and finally a section of the hammered bar and a piece of the unstrained steel were heated together for 4 hr. at 600 deg. cent.

The Effects of Cold-Working on the Elastic Properties of Steel. J. O. Van Den Broek. Proc. British Iron & Steel Inst., May 2-3, 1918. Paper no. 18, 41 pp., 15 figs. Materials and apparatus; manner of conducting tests; measurements; discussion of data; effects of cold-stretching and cold-twisting; electric resistivity of cold-worked steel; effects on alloy steels; theory; microstructure; tests on steel balls; analysis of commercial process. Published also in Engineering, vol. 106, no. 2743, July 26, 1918, pp. 99-105, 15 figs.

Damascene Steel

Damascene Steel. N. Belaiew. Proc. British Iron & Steel Inst., May 2-3, Paper no. 20, 22 pp., 5 figs. History, external characteristics and three principal processes of manufacture; Anossoff's classification of patterns of damascene blades; author's analyses; explanation for ductility, malleability and elasticity of damascene alloys.

Electric Furnace Melting

Electric Cast Iron and Steel Manufacture (La production électrothermique des fontes et aciers), Jean Escard. Revue Générale des Sciences, year 29, no. 12, June 30, 1918, pp. 366-373, 4 figs. Héroult furnace; experiments of Sault Sainte-Marie; California New-Héroult furnaces; Trollhattan electric furnace; Keller process.

Electric Furnace Production of Cast Iron and Steel (La production électrothermique des fontes et aciers), J. Escard. Revue Générale des Sciences, year 29, no 13, July 15, 1918, pp. 401-413, 18 figs. Comparative study of five methods of manufacturing steel.

Electric Steel Production for Small Units, A. V. Farr. Blast Furnace & Steel Plant, vol. 6, no. 9, Sept. 1918, pp. 381-383, 6 figs. Description of cold-metal method predominating in electric-furnace units under 10 ton capacity; data on 6-ton Héroult furnace making high carbon chrome steel. Paper before Am. Drop Forge Assn.

Metallurgical Electric Furnaces. Engineering, vol. 106, no. 2743, July 26, 1918, pp. 86-87, 8 figs. Electric steel-refining furnaces; features of control. From discussion by Faraday Society at Manchester, Feb. 1918.

Electric Steel, Franklin D. Jones. Machy., vol. 24, no. 12, Aug. 1918, pp. 1104-1110, 11 figs. Advantages of electric furnace; types and methods of operation.

Electric Resistance of Steel

Concerning the Constitution of Martensite in Low Carbon Steel and Its Influence on the Electrical Resistance (Rorande martensitens Konstitution vid låg Kolhalt ach dess inflytande på elektriska ledningsmotståndet). C. Benedicks and E. Walldow. Bihang till Jern-Kontorets Annaler, vol. 19, no. 6, June 15, 1918.

Eutectic Alloys

Eutectic Alloys, Clifford W. Nash. Chem. Eng & Min. Rev., vol. 10, no. 114, March 1918, pp. 161-166, 9 figs. Study in the structure of iron-carbon eutectic and eutectoid. (Concluded.)

Ferro Alloys

Carbon-free Ferro Tungsten. A. F. Braid. Reactions, vol. 11, no. 2, Second Quarter 1918, pp. 28-29. Uses of ferrotungsten and tungsten powder.

The Manufacture of Ferro Alloys in Colorado. Robert M. Keeney. Eng. & Min. Jl., vol. 106, no. 9, Aug. 31, 1918, pp. 405-409. From paper before Colorado meeting of Am. Inst. of Min. Engrs., Sept. 1918.

Ingots

Defects in Steel Ingots, J. N. Kilby. Iron & Steel Inst. of Canada, vol. 1, no. 7, Aug. 1918, pp. 288-296, 13 figs. Previous conclusions upon influence of casting in relation to cracks in ingot or bar; composition of slags of different steel-making processes, their physical state, and relationship in ultimate product; basic open-hearth steel, with some reference to electric process. Abstract of papers before Sheffild Soc. of Engrs. and Staffordshire Iron & Steel Inst., coupled with further observations and results. Published also in Proc. British Iron & Steel Inst., May 2-3, 1918, Paper no. 12, 24 pp., 13 figs.

Magnetic Properties of Steel

Correlation of the Magnetic and Mechanical Properties of Steel, Chas. W. Burrows. Sci. Papers of the Bureau of Standards, no. 272, March 29, 1916, 208 pp., 42 figs. Relation of the magnetic to the other characteristics; magnetic behavior under influence of mechanical stresses greater and smaller than elastic limit; inhomogencities and flaws; bibliography.

Development of Magnetic Susceptibility in Manganese Steel by Prolonged Heat Treatment, Charles F. Brush. Proc. Am. Phil. Soc., vol. 57, no. 4, 1918, pp. 344-353, 3 figs. Experiments performed on 19 bars, each 6 in. long and ½ in. in diameter.

Rolling Mills

Plate Production Expedites Shipbuilding, A. M. Staehle. Blass Furnace & Steel Plant, vol. 6, no. 9, Sept. 1918, pp. 361-365, 8 figs. Rolling-mill capacities increased 20 per cent and material saved by efficient plate specifications; many new plate mills built; description of Liberty Mill of Carnegie Steel Co.

Practical Pointers on Wire Rod Rolls, W. S. Standiford. Blast Furnace & Steel Plant, vol. 6, no. 9, Sept. 1918, pp. 367-369, 3 figs. Consideration of design of passes and roll trains; draft influenced by form of pass, structure of metal and degree of heat.

Producing Special Steel to Suit Specific Purposes. Can. Machy., vol. 20, no. 2, July 11, 1918, pp. 33-34, 9 figs. New strip mill at Massillon, Ohio.

New Installation for Rolling Alloy Strips, Blast Furnace & Steel Plant, vol. 6, no. 8, Aug. 1918, pp. 319-321. Departure in strip-mill practice by the Nat. Pressed Steel Co., Massillon, O.

The Slick Wheel Mill. Iron Age, vol. 102, no. 9, Aug. 29, 1918, pp. 491-498, 17 figs. Commercial products formed directly from large rolled bars by rolling-forging process at Cambria Steel Works.

Scrap Steel

Discard Steel. Steel & Metal Digest, vol. 8, no. 8, Aug 1918, p. 474. Uses and properties of shell discard steel.

See also Chemical Technology (Analysis, Steel); Testing and Measurements (Steel Testing).

TESTING AND MEASUREMENTS

Balloon Fabrics

See Permeability, below.

Carbon Dioxide Recorder

CO_2 Recorders in the Boiler House, John B. C. Kershaw. Engineer, vol. 126, no. 3264, July 19, 1918, pp. 45-47, 10 figs. Boiler efficiencies and need for improvement; heat losses in the boiler plant and their control; seven types of automatic apparatus for recording CO_2 percentages described.

Clocks, Electric

Electrical Horology, H. R. Langman. Model Engr. & Elecn., vol. 39, no. 902, Aug. 8, pp. 72-77, 6 figs. Compilation of systems of electric clocks. (To be continued.)

Dynamometers

Commercial Dynamometers (IV), P. Field Foster. Mech. World, vol. 64, no. 1647, July 26, 1918, pp. 42-43, 4 figs. The rope-brake type invented by Lord Kelvin. (Continuation of serial.)

Elastic-Limit Recorder

An Improved Elastic Limit Recorder. Automotive Industries, vol. 39, no. 7, Aug. 15, 1918, p. 287, 1 fig. Attachment to a standard testing machine by means of which it is claimed one person can accurately determine the elastic limit of specimens both in tension and compression.

New Elastic Limit Recorder, J. L. Jones and C. H. Marshall. Iron Age, vol. 102, no. 7, Aug. 15, 1918, pp. 391-392, 2 figs. Sumner instrument enables tests to be made accurately and rapidly. From paper before Am. Soc. for Testing Materials, June 1918.

Electrical Measurements

A New Method of Measuring Alternating Currents and Electric Oscillations, I. Williams. Elecn., vol. 81, no. 12, July 19, 1918, pp. 253-255, 5 figs. Abstract of paper before Phys. Soc.

Fluid Gage

Coats Precision Fluid Gage. Am. Mach., vol. 49, no. 10, Sept. 5, 1918, p. 451, 1 fig. Data and description of a precision gage operating on the fluid principle, and used as a comparator, primarily, and not an actual measuring machine. Built by the Coats Machinery Co., Philadelphia, Pa.

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Industrial Gages (Les calibres industriels), Ch-Ed. Guillaume. Revue Générale de l'Electricité, vol. 4, no. 5, Aug. 3, 1918, pp. 141-145, 1 fig. Evolution of length standards; joint action of International Bureau of Weights and Measures and Technical Section of the Artillery; temperature of definition; coefficients of expansion of several metals; standards; official resolutions.

Gloves, Rubber

Lineman's Rubber Gloves Under Test, F. C. Perkins. Wireless Age, vol. 5, no. 12, Sept. 1918, pp. 1038-1041, 2 figs. Method used by the Duquesne Light Co., Pittsburgh.

Hardness of Metals

A Law Governing the Resistance to Penetration of Metal When Tested by Impact with a 10 mm. Steel Ball; and a New Hardness Scale in Energy Units, C. A. Edwards. Jl. Inst. Mech. Engrs., no. 5, June 1918, pp. 335-369, 9 figs. Experimental investigation from which author establishes as the law governing penetration resistance of plastic metals $d = C\ E^{0.25}$, where d = diameter of indent made by 10-mm. ball, C is a constant varying with hardness of metal, and E = total energy of impact.

Testing Hardness of Metals by the Boyelle-Morin Apparatus, C. J. Bowen Cooke. Jl. Inst. Mech. Engrs., no. 5, June 1918, pp. 331-333, 4 figs. Outfit and method of making a test.

Lubricants, Testing

Methods of Conducting Tests of Lubricants on Internal Combustion Engines, S. F. Lentz. Lubrication, vol. 5, no. 9, July 1918, pp. 4-9. Suggestions regarding extent to which local conditions should be considered in estimating importance of results obtained in tests.

The Testing of Lubricants, Raymond Francis Yates. Am. Mach., vol. 49, no. 7, Aug. 15, 1918, pp. 289-291, 3 figs. Explains various characteristics of lubricating oils and greases and how they may be tested with simple apparatus.

Meters, Electric

Demand Meters, J. A. Laubenstein. Gen. Elec. Rev., vol. 21, no. 8, Aug. 1918, pp. 573-576, 6 figs. Consideration of the actual measurement of "demand" and description of various types of meters designed for the purpose of determining the maximum demand rate of charge for power.

Effect of Daily Variations of Frequency on Reading of Induction Meters (Influence des variations journalièrs de la fréquence sur les indications des compteurs d'induction), M. A. Durand. Revue Générale de l'Electricité, vol. 4, no. 5, Aug. 3, 1918, pp. 136-140, 6 figs. Result of tests performed by Central Electrical Laboratory. From paper before French Society of Electricians.

Report of the Meter Committee. Elec. News, vol. 27, no. 13, July 1, 1918, pp. 45-48, 4 figs. Study of four methods for determining efficiently the power factor; account of recent changes in standard instruments Paper before Can. Elec. Assn.

Meters, Heat

Heat Meters (Les compteurs calorimétriques ou compteur de chaleur), R. Joëssel. Génie Civil, vol. 73, nos. 1 and 2, July 6 and 13, 1918, pp. 12-13 and 28-30, 3 figs. Résumé of work done to devise an instrument for measuring the amount of heat supplied to a fluid; applications and utility of this instrument. (Concluded.)

Moving Photomicrographs

How Moving Photomicrographs Are Taken. Iron Age, vol. 102, no. 6, Aug. 8, 1918, pp. 323-325, 10 figs. Apparatus for recording the gradual changes in a metal's structure when subjected to repeated bending stresses; possible applications.

Permeability

Determination of Permeability of Balloon Fabrics, J. D. Edwards. Aviation, vol. 5, no. 2, Aug. 15, 1918, pp. 103-106, 1 fig. Various methods for determining permeability to hydrogen; detailed description of method used at Bureau of Standards; discussion of phenomena of passage of gases through rubber by solution; data showing effect upon apparent permeability at different experimental conditions such as temperature, pressure, humidity of the gas, durations of test, etc.

Railroad Testing Laboratory

New Testing Laboratory, Southern Railway, Alexandria, Va. Ry. Rev., vol. 63, no. 5, Aug. 3, 1918, pp. 151-152, 3 figs. Brief description of laboratory and its equipment.

Refractories, Testing

Crushing Strength of Magnesia-Silica Mixtures at High Temperatures, O. L. Kowalke and O. A. Hougen. Iron & Steel Inst. of Canada, vol. 1, no. 7, Aug. 1918, pp. 300-304, 11 figs. Description of apparatus used; results of physical tests and microscopic examination.

Resonance Measurements

Resonance Measurements in Radio-Telegraphy with the Oscillating Audion, L. W. Austin. Jl. of Wash. Academy of Sci., vol. 8, no. 14, Aug. 19, 1918, pp. 498-500. Examples illustrating the procedure with the resonance click.

Specific Gravity Determination

Determining Specific Gravity of Viscous Tar, etc., at Different Temperatures, Renford Myhill. Gas Jl., vol. 143, no. 2882, Aug. 6, 1918, p. 254. Method used by writer.

Specific Heat

Calorimetric Determination of Curie's Point (Détermination calorimétrique du point de Curie). Jl. de Physique, vol. 7, March-April 1917, pp. 87-88. Method used by Weiss, Piccard and Carrard for measuring the mean specific heat C_m of ferromagnetic substances at temperatures between 16 deg. and 900 deg. cent.

Steam, Quality of

Testing the Quality of Steam, W. A. Taller. Mech. World, vol. 63, no. 1642, June 21, 1918, pp. 296-297, 1 fig. Effect of moisture in steam on turbine blades and on reciprocating-engine cylinders, also on lubrication; outline of two methods for determining percentage of moisture, by the throttling calorimeter and by weighing; formulæ for computations.

Steel Testing

Tests on Tie Bar from the Menai Suspension Bridge. Engineer, vol. 126, no. 3264, July 19, 1918, pp. 47-49, 3 figs. Report of the physical and metallurgical tests and the electrical resistance test.

Tanks, Measurements

Finding the Contents of a Horizontal Cylindrical Tank, Franz Szabo. Power, vol. 48, no. 8, Aug. 20, 1918, pp. 266-267, 1 fig. Gives alignment chart for the purpose.

Volumes of Cylindrical Tanks, M. W. Ward. Power, vol. 48, no 5, July 30, 1918, pp. 159-160, 1 chart. Ready method of finding contents of a horizontal cylindrical tank with contents at any depth.

Tar

See Specific Gravity Determination, above.

Vacuum Determination

Production and Measurement of High Vacua, J. E. Shrader and R. G. Sherwood. Phys. Rev., vol. 12, no. 1, July 1918, pp. 70-80, 7 figs. Attempt to modify operation of the mercury diffusion pump and the Knudsen molecular gage and tests of the two machines used in combination.

Viscosimeter

The Standardization of the Saybolt Universal Viscosimeter, W. H. Herschel. Jl. of Franklin Inst., vol. 186, no. 2, Aug. 1918, pp. 243-245. Equations between absolute viscosity and density obtained by using standard Saybolt instruments. From Technical Paper no. 112 of the Bureau of Standards.

See also Aeronautics (Instruments); Varia (Moisture Ratio).

THERMODYNAMICS

Some Recent Studies in Heat Transmission, A. J. Wood. Am. Soc. Refrig. Engrs., Jl., vol. 4, no. 5, March 1918, pp. 464-506, 8 figs. Work of thermal testing plant of Pennsylvania State College planned to include: Determination for various common materials of internal conduction (C) and combined coefficient (K) of convection and radiation as affected by velocity, humidity, difference of temperature and condition of surface; separation of this combined coefficient into its two factors, radiation and convection; deduction of laws which can be readily applied by heating and refrigerating engineers to building construction, including both simple and compound walls. Presented at annual meeting of Am. Soc. Refrig. Engrs.

TIMBER AND WOOD

Wood Grain

The Grain of Wood with Special Reference to the Direction to the Fibres, A. Koehler. Aerial Age, vol. 7, no. 22, Aug. 12, 1918, 12 figs. Influence of direction of grain on strength of timber; rules to determine direction and slope of fibers.

TRANSPORTATION

Marine Terminals

Marine Terminals for Inland River Cities Located on High Ground, H. McL. Harding. Int. Mar. Eng., vol. 23, no. 8, Aug. 1918, pp. 479-481, 7 figs. Principles governing construction of efficient river terminals; design and equipment; mechanical coördination between water and rail.

VARIA

Tractors Rough-Level Lands Before Sale to Settlers. Eng. News-Rec., vol. 81, no. 10, Sept. 5, 1918, pp. 438-439, 4 figs. Reclamation engineers get costs of putting acreage on as favorable conditions as units first entered upon.

Colored Photography

Dufay Colored Photography (El procedimiento versicolor Dufay para la fotografiá en colores). Boletin de la Sociedad de Fomento Fabril, year 35, no. 4, Apr. 1918, pp. 177-180, 6 figs. Successive operations in manufacture of films for colored photos.

Copper Statistics

The Future of Copper, W. F. Staunton. Min. & Oil Bul., vol. 4, no. 9, Aug. 1918, pp. 371-373, 3 figs. Chart showing world production for 28 years and considerations of the needs of industry.

Diamonds

Formation of Diamonds (La formation du diamant), Ch. A. Parsons. Revue Générale des Sciences, year 29, no. 11, June 15, 1918, pp. 327-333. Survey of systematic researches of the origin of diamonds and considerations on possibility of arriving at a definite conclusion in this question.

Engineering Societies

Centralized Activities of U. S. National Engineering Societies, Alfred D. Flinn. Can. Engr., vol. 35, no. 7, Aug. 15, 1918, pp. 151-154. Exposition of United States conditions to Canadian engineers.

Explosives

Science of Quarrying Rock with Explosives. Du Pont Mag., vol. 9, no. 2, Aug. 1918, pp. 4-8, 4 figs. Different ways of making blasts; suggestions and remarks.

Tunnel-Blasting at Chuquicamata, E. E. Baker. Western Eng., vol. 9, no. 9, Sept. 1918, pp. 366-372, 5 figs. Blasting for steam-shovel work in bench about 180 ft. high.

Filters

Filter Adjustments at Packard Mill at Rochester, Nevada, F. Dean Bradley. Eng. & Min. Jl., vol. 106, no. 5, Aug. 3, 1918, pp. 207-209, 3 figs. A mechanical sampler and a mixer for repulping the tails were added to the filter, the number of nozzles increased and a nozzle constructed for spraying wash solutions.

Moisture Ratio

Moisture Ratio, A. Smith. Aerial Age, vol. 48, no. 1228, July 12, 1918, pp. 48-49. Remarks on H. A. Noyes' article on Reporting Moisture Results. Science, vol. 47, no. 1212, p. 293, and Bul. no. 107, Bureau of Chemistry, Official Methods of Analysis, compiled by the Association of Official Agricultural Chemistry.

Public Utilities

Cost Versus Value of Service in Rate Making, John Bauer. Elec. World, vol. 72, no. 9, Aug. 31, 1918, pp. 388-389. Discussion of fundamental purposes and factors that must be considered in general system of public utility control; charging what the traffic will bear; popularity of cost rates.

Salvage

The Admiralty Salvage Section. Engineering, vol. 106, no. 2740, July 5, 1918, pp. 16-17, 2 figs. Description of some of the work of this section of British Navy.

Time Zones

Proposed New Boundaries for Standard Time Zones, Emerson W. Judd. Ry. Age, vol. 65, no. 5, Aug. 2, 1918, pp. 209-211, 1 fig. Elaborate and ingenious plan for relieving all large cities of the double time standard.

WOOD

(See Timber and Wood)

WOODWORKING MACHINES

Band Saw

Vertical Log Band Saw. Engineering, vol. 106, no. 2745, Aug. 9, 1918, p. 146, 1 fig. Description and principal data of a vertical log band saw made by A. Ransome & Co., Ltd.

Propeller-Shaping Machine

Aero-Propeller Shaping Machine. Engineer, vol. 126, no. 3264, July 19, 1918, p. 60, 2 figs. Description of a machine for shaping aero propellers made by A. Ransome & Co., Ltd., Newark-on-Trent.

See also Power Generation and Selection (Wood-Working Machinery.)

ACCESSIONS TO THE LIBRARY

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—— Report of the Committee of the Privy Council, 1915-16, 1916-17. *London, 1916-17.*

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Harrisburg (Pa.) Engineers' Commission. Report. 1916. *Harrisburg, 1916.* Gift of Charles Whiting Baker.

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Metallurgical Study of the Steel Base as Related to Galvanizing. By G. A. White. *Buffalo, n. d.* Gift of Matthews Northrup Works.

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—— List of inspected electrical appliances, April, 1918. *Chicago, 1918.* Gift of National Board of Fire Underwriters.

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Practical Treatise on Limes, Hydraulic Cements and Mortars. By Q. A. Gillmore. *New York, 1867.* Gift of John T. Whistler.

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Stone & Webster Engineering Corporation. Steam Power Stations, Ed. 2. *New York, n. d.*

—— Gas Plant Construction, Coal and Water Gas Generating Systems. *New York, n. d.* Gift of Stone & Webster Engineering Corporation.

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Cost of a House. A comparison between brick, wood, cement and hollow block construction. By J. P. B. Fiske.
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Map of Halifax to the Delaware. 1854-8.
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Carte de la Cote Orientale de L'Amerique Septentrionale du Detroit de Belle Isle a Boston. 1853.
Plan les Cotes de Terre Neuve. IIIe Feuille. 1784.

TRADE CATALOGUES.

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Bliss, E. W., Company. Brooklyn, N. Y.
General Catalogue, Ed. 14.

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Catalogue No. 85. Rex traveling water screens.

Cleveland Milling Machine Company. Cleveland, Ohio.
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Educational Exhibition Company. Providence, R. I.
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Mechanical graphs. 1918.

E. I. du Pont de Nemours & Co. Wilmington, Del.
Catalogue of Products, correct to May 15, 1918.

General Electric Company. Schenectady, N. Y.
Bulletin No. 45203. Type H circular coil form KDD transformers, oil insulated, self or water cooled. July, 1918.
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THE MEASUREMENT OF THREAD GAGES

Description of the Instruments and Methods Used by the Bureau of Standards for the Measurement of Plug and Ring Thread Gages

By H. L. VAN KEUREN,[1] WASHINGTON, D. C.

Many of the members of this Society will recall that through the Gage Committee it was recommended that there be a central place for the certification of all master gages. The Committee further recommended that inasmuch as Congress has provided the Bureau of Standards with a fund for the certification of gages, and, furthermore, inasmuch as the Bureau of Standards was organized and prepared to handle promptly the test of all master gages, the Bureau be designated as the official place for the certification and test of gages for the various departments of the Federal Government. It is of particular interest, therefore, that the Society should know the developments that have taken place along the lines recommended, and in this connection the present paper is prepared.

MEASUREMENT OF PLUG THREAD GAGES

There are five distinct operations in the measurement of a plug thread gage, namely:

1 The measurement of pitch or lead
2 The measurement of form and angle of thread
3 The measurement of core diameter
4 The measurement of full diameter
5 The measurement of effective diameter.

Measurement of Pitch

After trying various commercial machines for measuring pitch, the machine adopted for this purpose by the Bureau of Standards was of a design similar to that of the National Physical Laboratory of Great Britain. This machine, Fig. 1, is capable of making direct measurements of pitch, and, furthermore, is not limited to any one thread interval, but determinations of the lead between any two threads may be measured. About twelve of these machines have been constructed and are in use at the various branch laboratories of the Bureau of Standards. There are incorporated in these machines special micrometer screws designed and constructed by Dr. J. A. Anderson, who is associated with Mount Wilson Solar Observatory, Pasadena, Cal. These micrometer screws are provided with aluminum heads which are graduated directly to 0.0001 in. and the screws have straight-line calibration curves to within 0.00002 in. They are therefore very well suited for the purpose for which they are used.

The operation of the Bureau of Standards pitch-measuring machine may best be explained by referring to Fig. 1 as follows: A ball-pointed stylus *A* rests in the thread to be measured. This is carried at the end of a floating arm *B* which at the other end carries a lens *C*. The arm *B* is supported by a flexible, flat steel spring *D* and the movable support upon which the spring is carried is so adjusted that the spring *D* exerts a slight pressure on the floating arm *B* which tends to cause the stylus *A* to rest firmly against the flanks of the thread. When the stylus is resting evenly on both flanks of the thread the lens *C* is directly beneath the lamp *E* and the image of the straight filament in the lamp *E* is projected by the lens *C* downward to a prism *H*, thence under the machine to the prism *I*, from where it is reflected to the screen *S*. When the image of the filament coincides with a reference line on the screen *S*, the reading of the micrometer *M* is recorded.

The turning of the micrometer head *M* causes the carriage supporting the stylus, lens, lamp, prisms and screen to move with reference to the thread, which remains stationary. Upon moving the micrometer head an amount corresponding to one thread interval the stylus comes to a position in the next thread similar to the position in the preceding thread and the micrometer head is adjusted until the image of the filament coincides with the index line as before. The micrometer reading is again recorded. The difference between the two micrometer readings indicates directly the pitch interval passed over.

Similarly each thread interval may be measured and the pitch along the entire threaded portion may be investigated. The stylus, lens, lamp, and screen form merely a sensitive optical indicator which serves to enable the pitch to be measured with a micrometer head. It is interesting to note that during the course of movement of the stylus from one

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ANNUAL MEETING PAPERS

The thirty-ninth Annual Meeting of The American Society of Mechanical Engineers will be held in the Engineering Societies Building, New York, December 3 to 6.

The practice of previous years of having a topic of broad general interest for the leading session of the meeting will be adhered to by assigning one day for the discussion of subjects relating to Human Relations in Engineering and Industry.

Papers have been contributed by the Sub-Committees on Textiles, Industrial Buildings, Machine-Shop Practice and Gas Power. There will be a joint session with the American Society of Refrigerating Engineers, and at least two sessions for the presentation of miscellaneous technical papers.

Comprehensive abstracts of the papers to be presented are published in this number of The Journal and will be continued in the December issue. All the Annual Meeting papers appearing in The Journal are also being printed in unabridged pamphlet form for advance distribution, and members of the Society desiring a complete copy of any particular paper, previous to the meeting, may obtain it upon application to the Secretary.

Contributed discussion upon these papers is invited for presentation at the meeting and publication in The Journal and Transactions.

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[1] Chief of Gage Section, Bureau of Standards.

For presentation at the Annual Meeting, New York, December 3 to 6, 1918, of The American Society of Mechanical Engineers. The paper is here printed in abstract form and advance copies of the complete paper may be obtained by members gratis upon application. All papers are subject to revision.

thread to the next, it climbs up over the crest of the thread and down into the next groove. During this movement the image of the lamp filament is no longer confined to the screen but the image is again brought back to the index point when the correct position in the next thread is obtained.

The optical indicating apparatus forms a convenient means of standardizing the micrometer head M. When this is done a thread gage is inserted in the machine as if it were to be tested and flat-end standards or size blocks are inserted between the micrometer spindle and ball contact against which it rests, the carriage being kept stationary and the image of

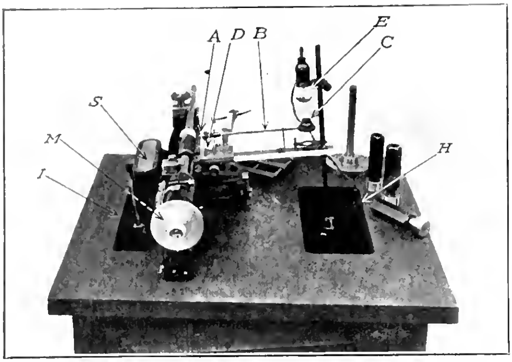

Fig. 1 Pitch-Measuring Machine Adopted by Bureau of Standards

the filament brought back to the same point with the stylus in the same thread of the thread gage at each observation.

Questions have been asked as to the result if a thread gage is not concentric with the centers. If any such indication is present the screw can be revolved 180 deg. and again tested, or it may be turned end for end in the centers of the machine. Experiments in which this procedure was taken with a large number of thread gages indicate that the difficulties of this nature are of little importance.

A still more recent development of the National Physical Laboratory is shown in a pitch-measuring machine similar in principle to the one just described, but which makes use of a mechanical indicator permitting the machine to be operated in strong daylight, whereas the optical indicator requires a subdued light or a shade around the ground glass. The micrometer-head arrangement in this machine permits the lead error to be read directly.

Measurement of Form and Angle of Thread

In the measurement of thread form or thread angle various methods such as those employing microscopic devices, conical test points, and other forms of angular test pieces used in connection with visual inspection, have been investigated and tried out, but practically all of these devices have been discarded in favor of the projection lantern. A general idea of the arrangement used at the Bureau of Standards for the projection lantern may be obtained from Fig. 2.

The operation of the projection lantern involves the placing of the thread to be examined in a beam of parallel light and, by means of a suitable lens system, the projection of the shadow of the thread on a distant screen. In the apparatus shown in Fig. 2, the light from a 10-ampere arc enclosed in housing L is emitted through the condensing lens A and directed toward the projecting lenses B and C. The screw is placed at the focus of the lenses B and C. The projection is then directed upward by a prism G to a mirror (not shown) which is supported about 10 ft. above the prism on the column K. The projection is then directed down by the mirror to the top of stage N which forms the screen and carries the standard angle M used in the examination of the thread form. As it is necessary that the parallel beam of light pass through the thread at the helix angle so that the shadow cast will be a true cross-section of the thread form, the lamp housing which carries the condensing lens A is pivoted about a point beneath the lens B. This insures that the beam of parallel light emerging from the lens A will always be directed at and fill the lens B.

Adjustments for Examinatien. The setting up of a thread gage for examination requires but a slight amount of adjustment. The stand E is provided with a motion for raising and lowering the thread, a motion for focusing the thread, and another motion for moving it along its axis in order that various portions of the thread may be brought into the center of the screen. The screw to be examined is supported by the spring centers which are carried on the stand E. For convenience in making observations it is raised until the center of the beam of light is passing the under side of the thread. The lamp L is then turned about the axis of its support until the parallel rays of light emerging from the lens A pass through the helix angle which occurs when the fringe pattern which is formed about the image of the screw due to imperfect focus, is symmetrical. The screw is then brought into focus by a slow-motion arrangement.

Measurement of Angle. The examination of the thread angle is conveniently made with a device shown on the table in Fig. 2. With this arrangement the standard angle M, known to be 60 deg., is supported by three columns on the revolving stage or screen N, which rests on a graduated cir-

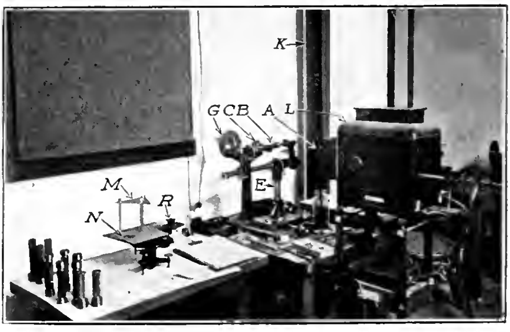

Fig. 2 Projection Lantern Used at the Bureau of Standards

cle or protractor head. In the protractor shown in Fig. 1 the graduated circle was obtained from a theodolite. During the examination of the thread angle, the opaque standard angle M is adjusted so that its shadow occupies the light space of the projected image which is cast on the surface below at N. The standard angle M is revolved so that one side exactly matches with the shadow of the thread as cast below and the reading of the graduated head is obtained through a magnifying glass. The gage is then shifted parallel to its axis by means of a slow-motion device on the stand E until the image of the other side of the thread approximately coincides with the other side of the standard angle. The standard angle is then revolved by a slow-motion screw operating the graduated circle until it again lines up with the other side of the thread, whereupon a reading of the graduated circle is again obtained.

The difference between the two readings shows directly the error of the included angle of thread if the standard angle M represents the correct thread angle.

Further application of the protractor arrangement is in the determination as to whether the thread is symmetrical about a line perpendicular to its axis. This may be verified by revolving the standard angle and matching it with the crest of the thread or by matching a straight edge which is placed perpendicular to a bisector of the standard angle with the crest of the thread.

Accuracy of the Method. It should be specially pointed out that the "shadow protractor" is an exceedingly effective device for the measurement of thread angles, much more so than any protractor, lying directly on the plane of the shadow, could be. This is because the eye is viewing two objects of similar character, namely, two shadows. When adjusting the gage for a reading, the shadows of thread and gage are made to approach and the protractor is angularly adjusted until only a faint, even thread of light remains between the two. Under these circumstances, an inaccuracy of but a few minutes is easily detected. Furthermore, the operation of the protractor is rapid. In case of particularly defective threads, exposures of the projection may be made on any photographic developing paper with an exposure time determined experimentally and a permanent record obtained of the condition of the thread.

Measurement of Core Diameter

The measurement of the core diameter of thread gages is in most cases a simple matter. It is mentioned at this point because the examination of the core diameter is generally included in the operation of investigating the thread angle and thread form while the gage is in the projection lantern previously described. It is the practice in most specifications to call for thread gages cleared or cut below the nominal flat required by the regular United States form at the root of the thread. This is done to facilitate lapping. In order to determine whether or not a gage is properly cleared when examining the projected shadow, it is only necessary to insert a suitable templet corresponding to the pitch of the screw being measured. If the projected shadow of the thread shows that it is clear below the templet form, it is passed as being correct. Fig. 3 shows a thread which has not been cleared sufficiently at the root.

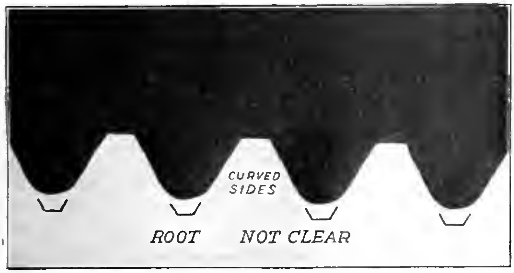

Fig. 3 Projected Shadow Showing Thread Not Cleared Sufficiently at Root

Measurement of Full Diameter

The measurement of the full diameter of plug thread gages is accomplished by the ordinary forms of flat-face micrometers or other suitable end-measuring instruments used in connection with properly authorized standards. These measurements are so simple and familiar to any one making gage inspections that no further comment will be made in this connection.

Measurement of Effective Diameter

Of the various methods which have been proposed for measuring effective diameters of male thread gages, the three-wire method is believed to be the most accurate and satisfactory. This method has been in common use for about 15 years. In measuring screws by the three-wire method, cylinders accurately ground and lapped to size and diameter are used. These wires or cylinders are inserted in the thread two on one side and one on the other. A measurement is then made directly over the tops of the wires by means of an outside micrometer or other suitable measuring device. From this measurement and from the size of the wire the effective diameter of the screw can be computed.

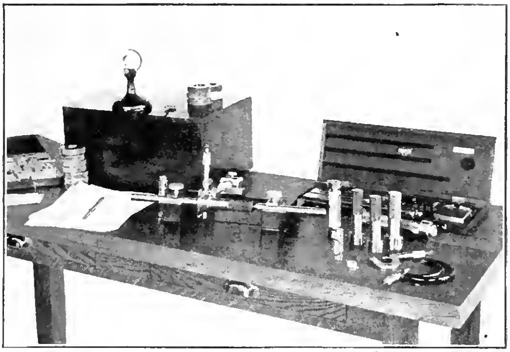

Fig. 4 Apparatus Used in Measuring Gages by the Three-Wire Method

Choice of Wires

In the choice of wires any size may be selected which will permit the wires to rest on the flanks of the thread and still project above the top of the thread. It is best, however, to choose wires of such a size that they touch the sides of the thread half-way down, or, in other words, at the mid-slope. In this case errors in the included angle of the thread have no effect on the measurement of an effective diameter. Moreover, the time spent in computations is greatly reduced. The best sizes of wire for various threads may be computed from the following approximate formula:

$$G = \frac{P}{2} \sec a$$

where G = diameter of wire, in.
P = pitch in in.
a = ½ included thread angle, deg.

For 60-deg. threads this formula reduces to

$$G = 0.5774 \times P$$

Standardization of Wires

Before the wires can be used to measure effective diameters of threads it is necessary to know accurately their diameters. The wires should be standardized in a way which approximates, as nearly as possible, the conditions under which they are used. In order to accomplish this purpose the wires are standardized with a micrometer caliper by measuring the

wire when placed over a standard reference disk, the diameter of which is accurately known. The object of measuring the wire over a cylinder is to approximate the condition of pressure which is exerted upon the wire when it is placed in the screw thread.

Computation of Effective Diameter

In the computation of the effective diameters of thread gages, if the exact conditions are recognized the formula is quite complicated and the resulting computations are very laborious. The formulæ for computing effective diameters as given in most engineering handbooks involve the use of best-size wire and do not take into account the complications introduced when considering the effects of the helix angle of the thread. These formulæ, as generally given, result in securing an answer which should check with the outside or full diameter of the screw being measured. The effective diameter is not mentioned in these formulæ and this often leads to confusion. Reference will therefore be made here to a simplified formula for 60-deg. threads which results in the direct computation of the effective diameter. This formula is as follows:

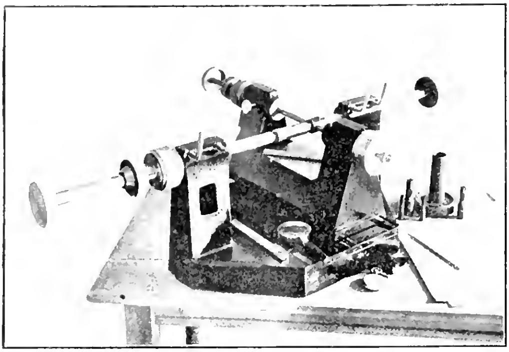

Fig. 5 Apparatus for Making Wire Measurements Using Two Wires

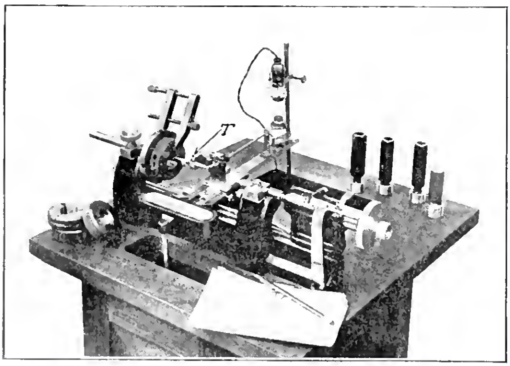

Fig. 6 Method of Measurement of Pitch or Lead of a Ring Thread Gage

$$E = M + \frac{0.8660}{N} - 3G$$

where E = effective diameter
M = measurement over the wires
N = number of threads per in.
G = diameter of wires.

In the use of this formula the term $\frac{0.8660}{N}$ may be computed for various pitches and the computations simplified. The general formula which may be used for any size of wire which will fit in the thread and which takes into account the helix angle of the thread for precision measurements, is as follows:

$$E = M + \frac{\cot a}{2N} - G\left(1 + \sqrt{\operatorname{cosec}^2 a + s^2 \cot a}\right)$$

where a = ½ the included angle of thread
G = diameter of the wires
s = tangent of the helix angle.

The above formula involves squares and square root of functions and therefore is awkward for making computations, and the following formula, which is an expanded approximation, but which is accurate to better than one hundred thousandth of an inch, is more convenient:

$$E = M + \frac{\cot a}{2N} - G\left(1 + \operatorname{cosec} a + \frac{s^2}{2}\cos a \cot a\right)$$

It should be noted that the error due to the first or simple formula rarely equals 0.0001 in., and then only when the helix angle is large.

Precautions in Making Three-Wire Measurements

It has been claimed that measurements of effective diameter made by the three-wire method result in values which are smaller than those secured by other means, such as by thread micrometers. This contention is probably justified in some cases and may be due to insufficient care in making measurements. It is important in making measurements that as little pressure as possible be applied on the wires with the measuring micrometers. Since the wires rest in a V-thread, a given pressure exerted on the top wire will have a magnified effect of distorting the wire where the contact is made on the sides of the thread. This will result in the measurement over the wires being less than it should be. Furthermore, if the wire is standardized under a light pressure and then used with a larger pressure, the diameter of the wire which is substituted in the formula for computing the effective diameter will be larger than it should be. This difference is multiplied by the factor 3 in the formula and the tendency is to make the result small. Excess pressure is often placed upon the wires during the measurement by use of ratchet or friction stops on micrometers, or by an unskilled operator, and sometimes on account of the arrangement of the wires and the screw thread when the measurements are taken. It is poor practice to support the screw being measured on two wires which are in turn supported on a horizontal surface, for if the screw is of large diameter the weight of the screw causes a distortion of the wires and interferes with the measurement.

One of the pieces of apparatus used in measuring gages by the three-wire method is shown in Fig. 4. This apparatus is known as a balanced micrometer. In operation the screw is supported between centers as shown, and the micrometer is supported on a counterbalanced arm which is in turn carried on a cylinder resting in a V-groove parallel to the centers. As originally designed, as shown in Fig. 4, the micrometer was constrained perpendicular to the axis of the thread being tested and two wires were used. The arm supporting the micrometer was overbalanced so that a slight upward pressure was given to the micrometer in order to hold a wire at the bottom of the thread and allow the operator to insert the top wire and make a reading with ease and rapidity. After using

this constrained micrometer for some time, it was found preferable to pivot the micrometer clamp on its supported arm so as to allow a slight movement in a vertical plane passed through the axis of the screw thread and then use three wires instead of two. For this arrangement two wires are carried at the bottom and one wire inserted at the top of the thread as before. This apparatus is very simple in construction and is recommended as being very convenient where a large number of gages are to be tested.

Another form of apparatus for making wire measurements using two wires is shown in Fig. 5. This instrument was specially designed and constructed for the Bureau of Standards. It embodies a precision bench micrometer accurate to within about two one hundred thousandths of an inch, supported on a heavy base and carried by steel balls. This support permits the micrometer uniform contact on the wires at either side of the thread. This machine has been found useful for threads of relatively large diameter. The instrument is of massive construction, and its rigidity, which is not common to ordinary measuring instruments, permits, when precautions are taken to avoid temperature changes, measurements which are accurate to within two or three one hundred thousandths of an inch.

TEST OF RING THREAD GAGES

The measurement of ring thread gages presents many problems owing to the difficulties with which observations may be made on the various elements. While there are various ways and means of obtaining the measurements required, it is not possible in most cases to work to the degree of accuracy that is obtainable in measuring plug thread gages. Very often the special apparatus required for such measurements is not available in commercial shops, and it then becomes necessary to judge the perfection of the ring thread by the way which it fits on a male check or checks. The various operations required for measurement are quite similar to those given for plug gages. The procedure generally embodies the following operations:

1 Measurement of pitch or lead
2 Measurement of angle and form of thread
3 Measurement of full diameter
4 Measurement of core diameter
5 Measurement of effective diameter.

Measurement of Pitch or Lead

The measurement of pitch or lead of a ring thread gage is accomplished as shown in Fig. 6. The same apparatus is employed for measuring ring threads as for measuring plug threads, with the exception that an extension stylus or attachment is provided to project into the ring and transfer the motion of the auxiliary stylus to the ball stylus used on the plug thread. This auxiliary device is shown at *T*, Fig. 6. Instead of being supported on centers, as is the case when a plug is tested, the ring is clamped on a faceplate and the operation then is exactly the same as previously explained for measuring the lead of the plug thread.

Measurement of Angle and Thread Form

The measurement of angle and thread form of ring threads is accomplished with the projection lantern in a similar manner to that employed in measuring angle and thread form of plug threads. In this instance, however, it is necessary to obtain first a cast of the thread to enable the projection to be made. The casts usually used are made of a composition of sulphur and graphite containing about 7 per cent by weight of graphite. The graphite is added to eliminate reflections which would be encountered on the surface of a plain sulphur cast in the process of projection. Then, in addition, the graphite has a tendency to reduce the shrinkage of the sulphur upon cooling. The procedure in making the cast is to clamp the ring in a vise, the jaws of which have been ground smooth, and pour melted sulphur into the ring, obtaining a cast which is a segment of a circle. The outfit required for this purpose and illustrations of the cast secured are shown in Fig. 7. The operation of pouring the casts with this method is very rapid. After the casts are poured they are immediately marked with a steel stylus with a number corresponding to the test number on the gage. The measurement of the angle is made as soon after making the cast as possible, inasmuch as experiment

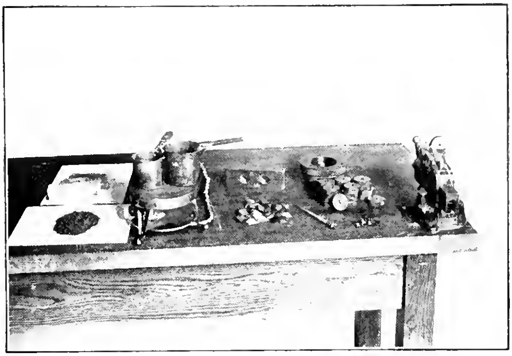

Fig. 7 Cast of Thread and Outfit Required for Making It

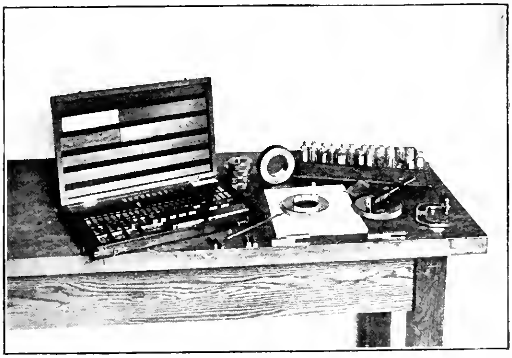

Fig. 8 Three-Ball Method of Measuring Effective Diameter of a Ring Thread Gage

shows that the cast warps but slightly during the first five or six hours, but that the warping is considerably greater if the cast is not measured at the end of 24 hours.

Measurement of Full Diameter

The measurement of full diameter is usually made part of the projection operation, as was the case of the measurement of the core diameter of plug gages. Here again it is only necessary to insert a templet in the thread to ascertain whether or not the thread has been properly cleared.

Measurement of Core Diameter

The measurement of core diameter is usually made with an

inside micrometer, Johansson inside set-up, or by the use of go and not-go plain check plugs for this diameter. This measurement of a plain inside diameter requires no further explanation.

Measurement of Effective Diameter

The method which is usually employed for measuring the effective diameter of a ring gage is by judging the fit of a gage on a plug thread check. This plug check is ordinarily ground off at the crest of the thread in order to make sure that the plug touches on the sides of the thread instead of at the crest. It is usually considered that when the ring fits snug on the plug the effective diameter of the ring is the same as that of the plug. This assumption, however, is not strictly true, inasmuch as there always is certain variation between the lead or pitch of the plug and the lead or pitch of the ring, and furthermore, variations of angle between the plug and ring are always present. Both of these variations necessitate the ring's having an effective diameter larger than the plug upon which it fits snugly. In most cases the amount actually required for fit, due to differences in pitch and angle, is appreciable, sometimes as much as several thousandths of an inch. In order to ascertain the effective diameter where check thread plugs are not available, the three-ball method of measurement has been adopted. In making these measurements the ring is laid on a flat surface with the axis of the thread perpendicular. Two balls are then placed in adjacent threads and a third ball is placed diametrically opposite. The distance between these balls is then taken by inserting size blocks together with a taper parallel, Fig. 8. The effective diameter can then be computed in a manner similar to that explained for male screw threads, as it is necessary to change only the sign of the different quantities of the formula as previously given for wire measurements. The formula as corrected for the change of sign is then as follows:

$$E = M - 0.8660 \times p + 3G$$

where E = effective diameter

M = measurement between balls

p = pitch in in.

G = diameter of balls.

This formula applies in cases where the balls used touch nearly at the mid-slope of the thread.

THE CONSERVATION OF HEAT LOSSES FROM PIPES AND BOILERS

By GLEN D. BAGLEY,[1] PITTSBURGH, PA.

The purpose of this paper is to present a more complete and detailed method of solving the problems involved in the calculation of the heat losses from bare and covered pipes and the economic problems encountered in the practical application of coverings. The factors in the economic calculations are: the cost of the heat, the cost of the covering, the size of the pipe, the temperature of the pipe, and the temperature of the atmosphere. It is necessary to consider all these factors together in order to obtain a correct result.

The data contained in the paper are a part of the results obtained in an investigation conducted for the Magnesia Association of America by the Mellon Institute of Industrial Research. The assistance received from the Association and from the Administrative Staff of the Institute has materially aided in the successful progress of the investigation, and credit is also due to Mr. G. F. Gray, who was originally in charge of the work, and to Mr. R. H. Heilman, who has assisted in securing the data.

It is generally recognized that the losses from bare pipes and boilers are considerable, but the real magnitude of these losses is little appreciated. The fact that the loss from 1000 sq. ft of exposed surface at 100 lb. per sq. in. steam pressure amounts to over 300 tons of coal annually is sufficient justification for serious consideration of the subject.

Heat Losses from Bare Surfaces

In a study of the conservation of losses, the first important fact to be considered is the actual value of the losses from bare surfaces. It is often considered that the loss from any bare surface is 3 B.t.u. per sq. ft. per hr. per deg. fahr. temperature difference between the surface and the surrounding air. While this value is correct for some special cases, it is by no means generally so. Most investigators have confined their measurements to one size of pipe at one temperature difference. Both the size of pipe and the temperature difference have an important effect on the value of this constant. Paulding in his book on Steam in Covered and Bare Pipes has worked out the theory of heat losses from bare pipes from the researches of the French physicist Péclet. The curves of Fig. 1 show the application of this theory to horizontal pipes. The solid curves indicate Paulding's values, while the dotted curves and the points give the results of various experimental tests.

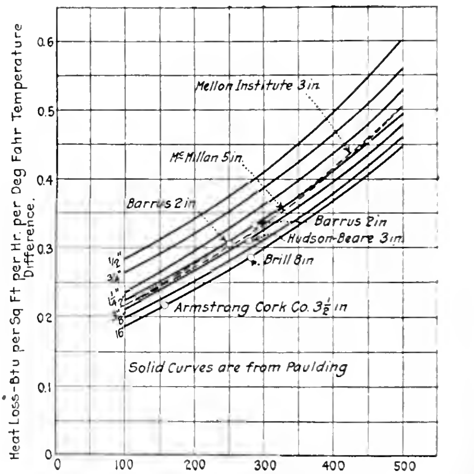

Fig. 1 Heat Loss from Bare Pipe

[1] Engineer for Mellon Institute of Industrial Research. Assoc-Mem.Am.Soc.M.E.

For presentation at the Annual Meeting of The American Society of Mechanical Engineers, New York, December 3 to 6, 1918. The paper is here printed in abstract form and advance copies of the complete paper may be obtained by members gratis upon application. All papers are subject to revision.

It seems that Paulding's curves give the best average values for use in calculating heat losses. They show that the constant may vary from 50 per cent below 3 B.t.u. per sq. ft. per hr. per deg. fahr. to values far above it. At 500 deg. temperature difference, which is often attained with superheated steam, the constant increases to double this value for the smallest size of pipe. In some chemical plants steam is used at temperatures of 1100 deg. fahr. The importance of using very thick insulation at these temperatures is easily judged from the rate at which the loss is increasing at 500 deg. fahr. It is to be noted that these values are all considerably higher than the values given in Kent for losses from bare surfaces.

Heat Loss from Insulated Pipes

The next important point in a consideration of the conservation of heat losses is the value of the loss after the pipes are insulated. In the apparatus used in determining these values at the Mellon Institute, the case of the heater, shown in cross-section in Fig. 2, consisted of three pieces of 3-in. pipe, the middle section being 3 ft. long and each end section $1\frac{1}{2}$ ft. long. The sections were connected by heat-insulating disks of asbestos board and each end section was provided with a hemispherical cap of cast iron. Inside of each section was an electric heater made by winding resistance wire on a frame of

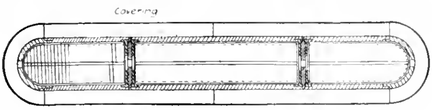

Fig. 2 Cross-Section of Heater with Covering Applied

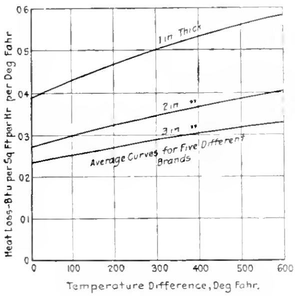

Fig. 3 Heat Loss Through 85 Per Cent Magnesia Coverings on 3-in. Pipe

asbestos boards. The wires were finely spaced and close to the inner surface of the pipe.

Results of tests made on five different makes of magnesia, in 1-in., 2-in., and 3-in. thicknesses, are shown in Fig. 3. These curves are all corrected for slight variations in thickness so that they are the true curves for the thickness given. Fig. 4 gives a comparison of the losses from a bare pipe with the losses through coverings 1 in., 2 in., and 3 in. thick. The contrast is very striking. The efficiency increases with the temperature as the loss from bare pipe increases much more rapidly in proportion than the loss from covered pipe.

Method of Conducting Tests

Two standard 3-ft. sections of pipe covering were applied as shown and the ends covered with plastic. This placed half of each section and a joint over the middle section of the heater, a condition exactly similar to actual practice. The currents in the different heaters were then adjusted until the temperatures shown by the thermocouples attached to the surface of the pipe were alike on both middle and end sections. The coverings were dried out for several days until conditions became constant, as shown by the readings which were taken every hour. The average of three consecutive constant readings was then used to calculate the conductivity. The power input was read on an accurate wattmeter and the temperature of the pipe by copper-constantan thermocouples peened into

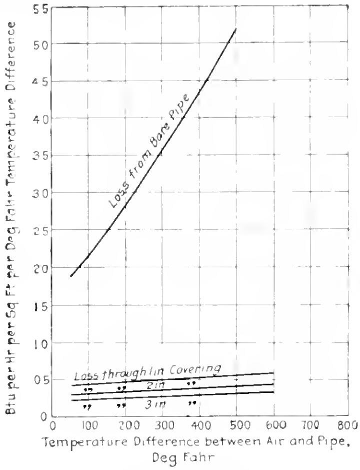

Fig. 4 Heat Losses from 3-in. Pipe with 85 Per Cent Magnesia Covering

the surface. Since the end sections of the pipe were adjusted to the same temperature as the middle, there could be no flow of heat in a direction parallel to the axis of the pipe. This obviated the necessity for any kind of end corrections in connection with the conductivity measurements. To obtain the conductivity of any covering in B.t.u. per sq. ft. per hr. per deg. fahr., it was only necessary to convert the power input to the middle section in kilowatt-hours to B.t.u. per hr. and divide by the area of the surface of the middle section in square feet, and by the temperature difference between the air and pipe. The temperature of the air was measured by thermometers suspended several feet from the pipe.

The temperature of the pipe was measured by copper-constantan thermocouples. It was found that the variation of individual samples from the standard curves of the American Chemical Society was so great that it was desirable to calibrate the thermocouples before use. This was done by the boiling-point method, which proved very satisfactory. A Siemens and Halske suspension-type millivoltmeter with a resistance of 889 ohms was used in connection with the thermocouples to measure the temperatures. This apparatus proved very satisfactory and made it possible to take a large number of readings quickly and accurately.

Calculation of Heat Losses Through Coverings

The theoretical calculation of losses through coverings on flat surfaces is quite simple, but the problem of curved surfaces is much more difficult. In this case the effect of the increased cross-section and surface area must be taken into account. Since the conductance is directly proportional to

the cross-sectional area and inversely proportional to the length of the path, it can be shown that the increment of heat loss is

$$H = \frac{2\pi K\,(T_1 - T_2)}{\log_e \frac{R_2}{R_1}} \dots\dots\dots [1]$$

where

H = heat loss in B.t.u. per hr. per ft. length of covering
T_1 = temperature of surface of pipe in deg. fahr.
T_2 = temperature of surface of insulation in deg. fahr.
R_1 = radius of pipe in in.
R_2 = outer radius of insulation in in.
K = conductivity of the insulating material in B.t.u. per sq. ft. of cross-section per in. thickness per deg. fahr. temperature difference per hr.

The loss through any pipe covering can be worked out by the use of this equation providing the value of K is known. K varies with the temperature and must be obtained from an

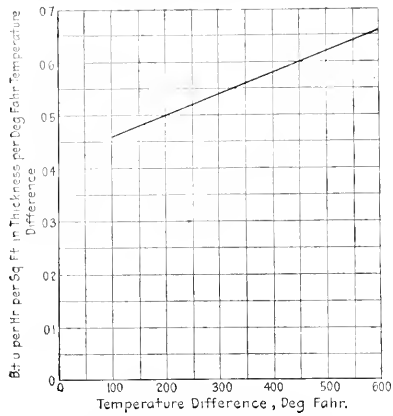

Fig. 5 Absolute Conductivity of Magnesia Plotted Against Temperature Difference at Surface of Insulation

experimental curve giving the value at different temperature differences above room temperature. The curve for K which was obtained during this research is given in Fig. 5. It should be emphasized that this kind of curve is the only fair basis for comparison of the heat-insulating value of the different kinds of coverings, as all variables due to small differences in thickness, to different sizes of pipes on which tests were made and to different surfaces or room conditions are eliminated. These curves take into account only the conduction through the material as they are based on temperature measurements at the inner and outer surfaces of the insulating material and not on the temperature at the outer surface of the canvas covering or in the air.

The difference in temperature between the outer surface of the insulating material and the temperature of the ambient air is a definite function of the heat transmitted per sq. ft. of the outer surface of the covering and of the kind of protective material used over the insulation. In Fig. 6 is given a curve showing this relation for the canvas covering as ordinarily used for this purpose. This curve was developed by L. B. McMillan at the University of Wisconsin and has been checked during this investigation. To use Formula [1] for a pipe covering in still air, an estimate of the heat loss per sq. ft. of the outer surface of the canvas covering must first be made. From the curve of Fig. 6 an estimate of the temperature beneath the canvas can then be made. Knowing this temperature and the temperature of the pipe, the term $(T_1 - T_2)$ of the formula is determined and the loss calculated. If this checks fairly well with the estimate of the loss from the outer surface, the calculation can be considered to give the proper value for the heat lost. If not, the estimated loss from the outer surface must be changed according to the indication of the calculation and the calculations repeated until the estimated and calculated losses check. This cumbersome process is necessary because of the complicated nature of the flow of heat through the compound insulation composed of the insulating material itself and the protective covering and the effect which the surface finish has on the radiation of heat from the outer surface of the covering.

In case it is desired to compute the loss per sq. ft. of pipe surface instead of per lineal ft. of covering, the formula becomes

$$H = \frac{K\,(T_1 - T_2)}{R_1 \log_e \frac{R_2}{R_1}} \dots\dots\dots [2]$$

Table 1 gives the value of the term $R_1 \log_e \frac{R_2}{R_1}$. The physical meaning of the figures in this table is the equivalent thickness on a flat surface of the given thickness on the given size of pipe. For example, a 3-in.-thick covering on a 3-in. pipe is equivalent to a covering 1.75 in. thick on a flat surface.

In connection with this work, an investigation was made to determine the distribution of temperature about a covering in still air. The results obtained show that no considerable error is made by assuming equal temperature distribution at the surface of the insulation in making the calculations.

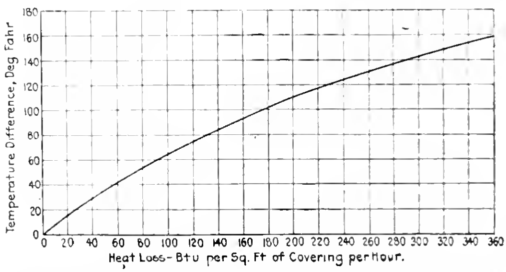

Fig. 6 Temperature Difference Between Inner Surface of Canvas Covering and Room for Different Heat Losses

Effect of Air Currents on Heat Losses

Some tests have been made and others are now in progress to determine the effect of wind velocity on the losses from bare and covered pipes. The apparatus used to determine this effect consisted of a 35-in. Sturtevant blower driven by an 8-hp. direct-current motor which furnished a blast of air for a wind tunnel. The apparatus used for testing pipe coverings was arranged inside of the tunnel so that the axis of the pipe coincided with the axis of the tunnel. This caused the air to travel parallel to the axis of the pipe and gave a condition similar to that encountered in locomotive practice.

The first test was made with a 3-in.-thick magnesia covering on the test pipe, a temperature difference of 460 deg. fahr. between the pipe and the wind, and a wind velocity of 30 m.p.h. Under this condition the loss was 0.430 B.t.u. per sq. ft. of pipe surface per deg. fahr. temperature difference

TABLE 1 EQUIVALENT THICKNESS ON A FLAT SURFACE OF VARIOUS-THICKNESS COVERINGS ON DIFFERENT-SIZED PIPES

Pipe Size, In.	Thickness of Covering, In.				
	1	2	3	4	5
3/4	0.560	0.823	0.897	1.130	1.240
1½	0.679	1.073	1.350	1.570	1.740
3	0.790	1.332	1.750	2.080	3.360
6	0.878	1.565	2.135	2.620	3.040
12	0.925	1.740	2.460	3.080	3.680
24	0.960	1.843	2.680	3.400	4.150

per hr. Under normal conditions of still air, the loss was 0.302 B.t.u. This shows an increase of about 40 per cent due to the wind velocity. From a theoretical consideration of the question, it can be shown that the maximum possible increase of loss due to wind will be reached when the temperature below the surface of the canvas covering on the magnesia is reduced to the temperature of the wind itself.

The curve of Fig. 6 shows the temperature beneath the canvas for any condition of loss in still air. When calculations are being made for exposed pipes, the loss should be calculated both by use of this curve as explained before and by using the temperature of the pipe and the temperature of the air for T_1 and T_2. By comparing the loss in still air and the maximum loss which may be caused by wind, an idea of the probable increase due to exposure can be obtained and extra thick insulation applied accordingly. Curves are being worked out to show the per cent increase in loss at various different velocities and different temperature differences.

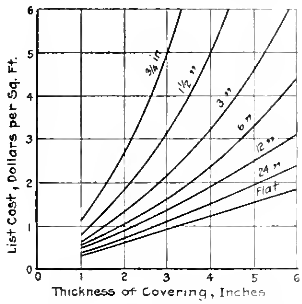

Fig. 7 Cost Curves for Different-Sized Pipes

Permanency of Insulating Qualities of Coverings

The last important point in considering pipe covering is the permanency of their insulation value. Tests were made on several old magnesia coverings. In the case of a 1-in.-thick covering which had been in service at the Armour Glue Works in Chicago for 8 years, the conductivity was found to be slightly lower than the average of the new 1-in. coverings tested, showing that no deterioration in service had taken place. Several sections were obtained which had been saturated with oil. Tests on these showed much lower insulation values than new coverings. The damage was permanent and shows that care should be used to protect coverings from oil while in service.

Initial Cost of Coverings

After considering the technical and theoretical side of heat losses from bare and covered surfaces, the next point is the economic side of the problem. In most cases the result desired is the maximum net saving of money for any given condition. If the covering cost were nothing, the proper thickness would be limited only by the requirements of space available, as each increased thickness would result in some slight increased saving in heat. In a practical case where the covering has a

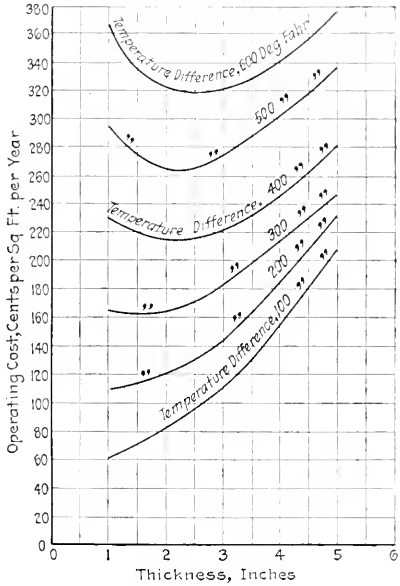

Fig. 8 Curves for ¾-in. Pipe—Steam Cost, 80 Cents per 1,000,000 B. T. U.

TABLE 2 THICKNESS OF 85 PER CENT MAGNESIA FOR MAXIMUM NET SAVING

(Thickness in Inches. S = Standard Thickness)

Coal at $2 per Ton						Coal at $4 per Ton					
Size Pipe, Inches	Hot Water, 175° F.	Steam, 5 Lb.	Steam, 100-200 Lb.	200 Lb. 150° F. Superheat	200 Lb. 300° F. Superheat	Size Pipe, Inches	Hot Water, 175° F.	Steam, 5 Lb.	Steam, 100-200 Lb.	200 Lb. 150° F. Superheat	200 Lb. 300° F. Superheat
3/4	S	S	S	S	S	3/4	S	S	S	1½	2
1½	S	S	S	S	2	1½	S	S	1½	2	2
3	S	S	S	1½	2	3	S	S	2	2	3
6	S	S	1½	2	2	6	S	S	2	3	3
12	S	S	2	2	3	12	S	S	3	3	4
24	S	S	2	3	3	24	S	S	3	4	4
Flat	7/8	1½	2	3	3½	Flat	2	2	3	4	4½
Coal at $6 per Ton						Coal at $8 per Ton					
3/4	S	S	1½	2	2	3/4	S	1½	1½	2	3
1½	S	S	1½	2	3	1½	S	1½	2	3	3
3	S	1½	2	3	3	3	1½	2	3	3	4
6	S	2	2	3	4	6	1½	2	3	4	4
12	1½	2	3	4	4	12	2	3	3	4	5
24	2	3	3	4	5	24	2	3	4	5	6
Flat	2½	3	4	5	5½	Flat	2½	3½	4½	5½	6½

inite cost, a point is soon reached where the increased cost of the covering would be greater than the additional saving in heat effected. The determining of this point is the thing in which the user of coverings is interested, as it is just at this point that the maximum net saving is accomplished.

In Fig. 7 a set of curves is given which show how the list prices of coverings vary with the thickness. By means of these curves the cost per sq. ft. of surface covered can be determined for any thickness desired. From this cost the annual fixed charges due to the covering can be calculated. After considerable investigation, it was decided that 20 per cent of the list price of the covering would be allowed as the cost of application, and 13 per cent of the total cost as the annual charges (6 per cent interest, 5 per cent depreciation and 2 per cent insurance and miscellaneous).

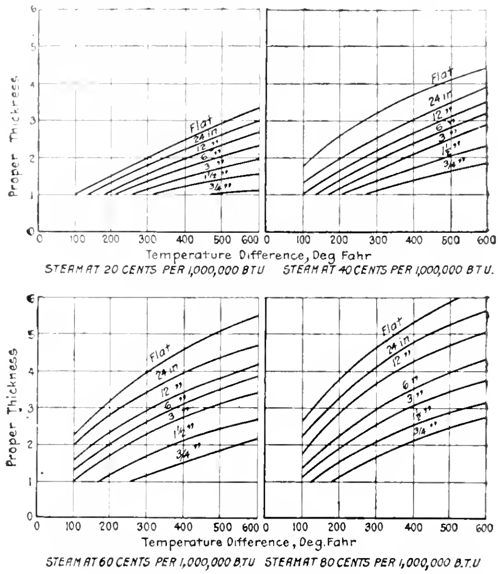

FIG. 9 THICKNESS OF 85 PER CENT MAGNESIA FOR MAXIMUM NET SAVING

OPERATING EXPENSES DUE TO HEAT LOSSES

The other cost to be charged to the operating expenses of the covering is the value of the heat losses through the different thicknesses of coverings. The previous work done on measuring the loss through 15 samples of magnesia furnished the necessary data for calculating the loss in heat units. After the heat loss was determined, it was necessary to convert the loss into dollars and cents. The assumptions used in making this conversion were that the cost of coal is 75 per cent of the cost of steam, that 1 lb. of coal as burned will evaporate 7 lb. of water from and at 212 deg. fahr., and that each pound of steam contains 1000 B.t.u. above the feedwater temperature. The value of the heat losses was calculated for seven sizes of pipes, five temperature differences between pipe and air, and four different costs of heat, both on the basis of a known cost per million B.t.u. and on a cost per ton of coal and the average conditions of steam generation given above. By making these calculations both ways, the results are applicable to plants where the steam costs are accurately known as well as to those where accurate records are not kept.

By combining the fixed cost and the heat losses per square foot per year, the total operating expenses were obtained. Once these are obtained, it is simply a matter of picking that thickness which gives the minimum annual operating expenses to obtain the proper covering to use. It is evident that the thickness which gives the minimum operating expense also

TABLE 3 COAL SAVED BY 85 PER CENT MAGNESIA COVERING 1 IN. THICK

Steam Pressure	Saturated 5 Lb.	Saturated 10 Lb.	Saturated 50 Lb.	Saturated 100 Lb.	Saturated 150 Lb.	Saturated 200 Lb.	200 Lb. Pressure with 100 Deg. Superheat
Steam temperature, deg. fahr.	228	240	298	338	366	388	488
B.t.u. loss per hr. per sq. ft. bare pipe...............	367	409	625	802	937	1058	1735
B.t.u. loss per hr. per sq. ft. of pipe covered with 85 per cent magnesia............	69	76	105	126	142	153	210
B.t.u. saved per hr. per sq. ft. by covering pipe with 85 per cent magnesia........	298	333	510	676	795	905	1525
Tons (2240 lb.) coal saved per 10,000 sq. ft. per year of 8760 hr. by pipe covered with 85 per cent magnesia.	1190	1330	2080	2700	3180	3620	5650
Cars of coal saved per year, as above, at 40 tons per car	30	36	52	68	80	90	140

Coal efficiency taken at 14,000 B.t.u. per lb. with boiler efficiency at 70 per cent.

TABLE 4 MONTHLY COAL SAVING, IN DOLLARS AND CENTS, BY THE USE OF 85 PER CENT MAGNESIA PIPE COVERING, STANDARD THICKNESS, PER 100 LINEAL FT. OF STEAM PIPES

Size of Pipe, Inches	5 Lb. Steam Pressure	10 Lb. Steam Pressure	50 Lb. Steam Pressure	100 Lb. Steam Pressure	150 Lb. Steam Pressure	200 Lb. Steam Pressure	200 Lb. Steam Pressure, 100° Superheat
½	1.44	1.58	2.20	3.28	3.66	4.11	6.80
¾	1.72	1.89	2.87	3.70	4.26	4.89	8.03
1	2.11	2.30	3.56	4.80	5.35	6.04	10.00
1¼	2.52	2 74	4.22	5.52	6.50	7.25	12.20
1½	2.86	3.10	4.73	6.14	7.29	8.17	13.70
2	3.53	3.74	5.86	7.63	8.93	10.11	16.80
2½	4.25	4.39	6.95	9.07	10.55	11.90	19.90
3	5.00	5.33	8.30	10.90	12.60	14.30	23.82
3½	5.72	6 22	9.60	12.40	14.40	16.32	27.23
4	6.50	7.06	10.60	14.05	16.40	18.40	30.85
4½	7.30	7.69	11 80	15.35	17.92	20.25	34.00
5	7.97	8 64	13.16	17.20	20.00	22.72	38.00
6	9.36	10.15	15.60	20.38	23.82	26.88	44.90
7	10 90	11.70	18.38	23.68	27.60	30.80	52.00
8	12 26	13.22	20 40	26.60	31.20	34.90	58.55
9	13.80	14.70	22.70	29.00	34.52	38.61	64.80
10	15.08	16.33	25.00	32.70	38.40	43.08	72.40
Flat surface, area 100 sq. ft., 1¼ in. thick...	5.26	5.67	8.80	11.50	13.48	15.12	25.44

These savings are based on pipes carrying steam for 24 hours per day and 30 days per month. Coal is figured at $5 per ton, delivered.

gives the maximum net saving, as the loss from bare pipe is a constant under given conditions and the net saving is the difference between the operating expense and the loss from bare pipe.

Selection of Coverings to Give Lowest Operating Expense

The way in which the covering which gave the lowest operating expense was chosen was to plot curves of the type shown in Fig. 8 for the total operating expense for five different thicknesses. By selecting the thickness corresponding to the lowest point on each curve, the proper thickness of covering to use for the temperature difference corresponding to that curve was obtained. One set of these curves was plotted for each size of pipe at each of four different steam costs. From this set the thickness curves given in Fig. 9 were derived and from these Table 2, showing the proper thickness in relation to coal cost per ton, was obtained by making the assumption previously explained. From these curves and tables, the proper thickness to use in order to obtain the maximum net saving under any condition may easily be determined.

The saving in coal tonnage and car capacity accomplished by applying 1-in.-thick coverings to 3-in. pipe is shown in Table 3. In Table 4 the saving is expressed in dollars and cents per hundred lineal ft. of pipe per month when covered with "standard" thickness coverings and where coal costs \$5 per ton. In this case the saving varies from \$1.44 for 100 ft. of ½-in. pipe at 5 lb. pressure to \$72.40 for 100 ft. of 10-in. pipe at 200 lb. pressure and a superheat of 100 deg. fahr.

Tests of Boilers With and Without Coverings

In order that the results of the laboratory tests might be checked on a larger scale, several practical tests were made. The first and most important of these was a boiler test made in a mine plant at Bruceton, Pa., where there were two boilers of 80 and 60 hp., locomotive type, having 675 sq. ft. of exposed surface. The tests covered a period of 24 hours. Conditions of load, etc., were practically the same during both tests. During the first test while the boilers were uncovered, 10,784 lb. of coal was burned to evaporate 58,000 lb. of water. In the second test, after the boilers had been covered with 2 in. of 85 per cent magnesia blocks and plastic, 9296 lb. of coal was burned to evaporate 59,500 lb. of water, or 1500 lb. more water evaporated with 1488 lb. less of coal burned. If calculated for an equal evaporation of water, the saving in coal would be 1700 lb. per day. The calculated saving based on the laboratory experiments was between 1400 and 1500 lb. per day. This saving amounts to 15 per cent of the coal burned due to covering the boiler alone, as the pipe lines were not included in the test. (The results of this test were reported in detail at the June meeting of the A.S.M.E. at Worcester.)

It is hoped that the data here presented will be of assistance to engineers and will help in the conservation of the resources of our country.

INDUSTRIAL POWER PROBLEMS

By W. F. UHL,[1] BOSTON, MASS.

THE two principal sources of power for industrial purposes at this time are steam and water-power plants owned and operated by the industry, the so-called isolated plant; or the purchased electric current from the public-service power companies, the so-called central plant or system.

The principal points which must be considered when provisions for a power supply for an industrial plant are to be made are reliability and cost. The relative importance of these two items is in the order stated and for many plants the last item is comparatively unimportant.

Conservation of fuel, which until recently received consideration only as a part of the cost of power, is now an important factor from a standpoint of reliability also. Within the last year it has become apparent that the important thing is to have power, no matter from what source; and within very wide limits, no matter at what cost.

Reliability

The proportionate cost of power to the total cost of the commodity produced for sale in most industrial plants is below 5 per cent; and, as already stated, reliability is of much greater importance than cost when considering the supply of power for such plants. An analysis of any power situation should therefore first consider the relative reliability of the various sources of power.

When considering reliability, our first thought is generally related to shutdowns. The loss due to complete failure of power supply, when translated into dollars per hour or other time interval, is one of the uncertain quantities which makes the question of reliability so difficult of solution. This loss is subject to determination if we make certain assumptions. For instance, if we have a plant that operates continuously, the loss due to a shutdown can be directly calculated in terms of average profit, plus idle-labor cost, plus spoiled stock in process, plus fixed charges. As most plants do not operate continuously, the time lost during shutdowns can generally be made up, at least to some extent, and the loss may be reduced to the cost of labor only if the nature of the industry is such that stock in process will not spoil.

Relative Reliability

Relative reliability is also somewhat indeterminate, but there are certain factors which have an important bearing on the subject. Ignoring the question of shortage of fuel, which it is hoped is only a temporary problem, and assuming equal reliability of plant, steam power is more reliable than water power, excepting certain noteworthy cases. The chief sources of unreliability of water powers are variability of streamflow, ice troubles and floods. In most cases water power must be supplemented to some extent by auxiliary steam or other source of power to make it equally as reliable as steam power alone.

Relative reliability as between the power obtained from the isolated plant and that obtained from a central plant or system depends upon the following principal factors: (1) Size of plant; (2) reserve capacity; (3) quality; (4) transmission.

Size of Plant. Unless the central plant is several times the size of an isolated plant of 500 kw. or greater capacity, it would be unusual to obtain greater reliability because of the factors which are generally considered as having a tendency

[1] Hydraulic Engineer. Mem.Am.Soc.M.E.

For presentation at the Annual Meeting, New York, December 3 to 6, 1918, of The American Society of Mechanical Engineers. The paper is here printed in abstract form and advance copies of the complete paper may be obtained by members gratis upon application. All papers are subject to revision.

to promote reliability merely on account of size. Such factors are design, quality of supervision, equipment, location, etc.

The average 1000-kw. isolated plant does not receive the attention in design, supervision, etc., that the average 10,000-kw. plant receives, but it would be a mistake to assume from this that all small plants are poorly designed or supervised or that there are no 10,000-kw. plants which are not poorly designed or supervised.

Reserve Capacity. An isolated plant can be said to be thoroughly reliable if it has an installation such that any one unit, as, for instance, prime mover, boiler, pump, etc., can be idle and the plant still carry the entire load. Such a plant might consist of two complete power units, each capable of

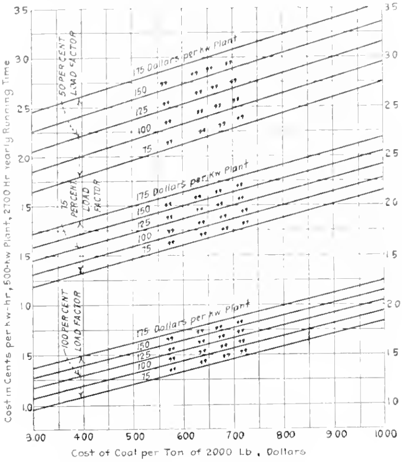

FIG. 1 APPROXIMATE COST OF STEAM POWER FROM 500-KW. ISOLATED PLANT RUNNING 2700 HR. YEARLY

carrying the entire load, and a spare boiler, or three power units, any two of which could carry the entire load if operated at some overload, and a spare boiler.

A central plant to have equal reliability as to reserve capacity must be able to carry its peak load at some overload on about 75 per cent of its rated capacity, depending to some extent on the number and size of units installed. If the isolated plant operates only nine or ten hours a day and is usually shut down over Sunday, it can get along with less reserve capacity than the central plant operating continuously, as there are more opportunities to make extensive examinations and repairs.

Quality. When speaking of quality of power, we refer to those characteristics which affect the speed and efficiency of the motors, such as speed variation and voltage regulation. These characteristics of power also affect both the quality and quantity of the product of many industries.

Speed variation is apt to be less in the average central plant, due to the larger amount of connected load and its diversity. Motors which are large compared with the total load and which carry a variable load are a source of poor speed regulation, whether connected to the isolated or central plant. Better voltage regulation is usually obtained from the isolated plant because of the absence of transmission lines.

Transmission. The one great weakness of central-plant power service is the necessary transmission. Even if the transmission is of the best and thoroughly protected by placing it in underground conduits or otherwise, it is always a source of possible trouble with which the isolated plant does not have to contend.

Under favorable conditions, this element of unreliability may be almost negligible, but more often, especially with long overhead transmission, it is the greatest source of shutdowns and poor voltage regulation in the present state of the art of power generation and use. It affects those industries most which are liable to have stock in process spoiled, due to shutdowns, or which produce a poorer grade of material on account of ununiformity.

SITUATIONS

It is possible to define a number of fairly common situations of power supply for industrial plants and to determine certain limits that it is well to keep in mind when making a comparison in which reliability, cost, conservation and policy are all considered.

An attempt is made in the following to outline a few such situations and in doing so only demands of power of 500 kw. or more are considered and these entirely in the form of electrical energy.

Situation A. An Industrial Plant Which Has No Water Power and No Demand for Exhaust Steam or Hot Water.

If a reliable central plant having several times the capacity required for the industry in question existed within reach it would ordinarily be policy to purchase power even at some increase in cost over what the power could be produced for in an isolated plant. It may be assumed that the money which must otherwise be invested in a power plant would bring addi-

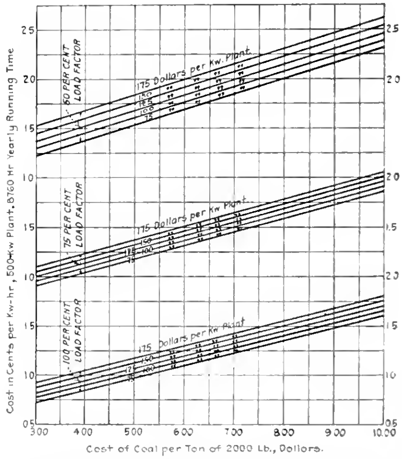

FIG. 2 APPROXIMATE COST OF STEAM POWER FROM 500-KW. ISOLATED PLANT RUNNING 8760 HR. YEARLY

tional profit to the industry if invested in manufacturing machinery, buildings or supplies. The management of the industry could be more specialized and conservation of fuel should also be a result.

The accompanying diagrams, Figs. 1 to 4, give the approximate cost of steam power from small isolated plants under various conditions and form a basis to determine the rate which

it would be policy to pay for purchased power, taking all things into consideration. The load factor in the diagrams is based on the number of hours the plant is in operation. [Additional diagram for plants up to 5000 kw. capacity are given in the complete paper, which is available in pamphlet form.—EDITOR.]

Situation B. An Industrial Plant Which Has a Water Power of Ample Capacity to Carry the Entire Load a Portion of the Time But Must Have Auxiliary Power in Some Form During Low-Water Periods and Has No Use for Exhaust Steam or Hot Water.

The cost of the auxiliary power other than cost of fuel and plant depends largely upon the following:

a Extreme-minimum stream flow, which determines the size of auxiliary plant required.

b Variation of stream flow throughout the year, which determines the number of times the auxiliary plant must be started.

c Pondage available, which determines the uniformity of demand on the auxiliary plant when in operation and the amount of banking of fires.

d Completeness of water-power development, which determines the proportion of the total load to be obtained from the auxiliary plant.

e Proximity of water power to auxiliary plant, which determines the cost of attendance.

Situation C. An Industrial Plant Which Has a Small Water Power, of Insufficient Capacity to Carry the Entire Load at Any Time, and Has No Use for Either Exhaust Steam or Hot Water.

Many industries were started at a time when steam power

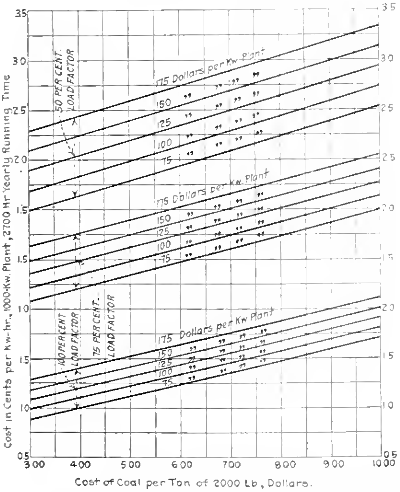

FIG. 3 APPROXIMATE COST OF STEAM POWER FROM 1000-KW. ISOLATED PLANT RUNNING 2700 HR. YEARLY

was inefficient and costly and when the demand for large and constant sources of power was not so important as at present. This naturally led them to locate where water power could be developed at small cost and which would serve all their purposes for the time being. Most of these industries which proved successful soon required larger and more constant sources of power than could be obtained from their local water power, and in many cases the water power soon became a very small portion of the total power required. Very few of these small water powers were abandoned where the industry itself prospered, although in many cases they would be found to operate at a loss if all proper charges were made against them. With others the use of water for condensing and manufacturing purposes required the maintenance of dams, ponds and other structures, which made it possible to consider a large portion or all of the fixed charges against such structures as properly chargeable to other parts of the industry than water power, thus again making the water power a profitable source of power.

Electrical transmission of power has made it possible to

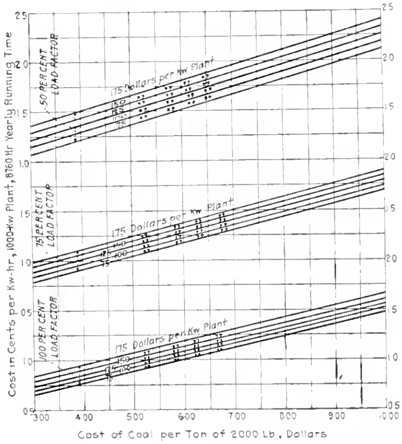

FIG. 4 APPROXIMATE COST OF STEAM POWER FROM 1000-KW. ISOLATED PLANT RUNNING 8760 HR. YEARLY

utilize many of these small water powers more fully, and in some industries where there often is necessity for overtime, night and Sunday work in some departments a small water power is valuable to carry such loads when it would otherwise have to be carried by a steam plant at inefficient part load and at considerable cost in attendance.

Such water powers may be the means of completing stock in process at a vital time, or of filling valuable orders, or keeping together at least a small part of an organization when other sources of power fail.

Unfortunately, measured in the light of improvement in the art of hydroelectric development in recent years, most of the existing small water powers and many larger ones are extremely inefficient. One of the greatest sources of fuel conservation exists in the redevelopment of water powers electrically and efficiently. Twenty to thirty per cent more power can frequently be obtained from the same amount of water and to this must be added the saving due to electrical transmission and the saving in wasted water on account of the more flexible use of the power.

It is evident from the foregoing that the value of these small water powers can no longer be determined from a purely investment standpoint, in which the cost of a certain number of kilowatt-hours produced by the water or by water and steam is compared with the cost of obtaining the same number of kilowatt-hours from a straight steam plant or from purchased power. The problem is more complex and must include power reliability and fuel conservation.

The cost of the power required by an industry other than

that obtained from its own water power in a situation of this kind is largely governed by the same limitations that have been mentioned under the previous situation. If such additional power is obtained from a steam plant, supplementary to the water power or to which the water power may be supple-

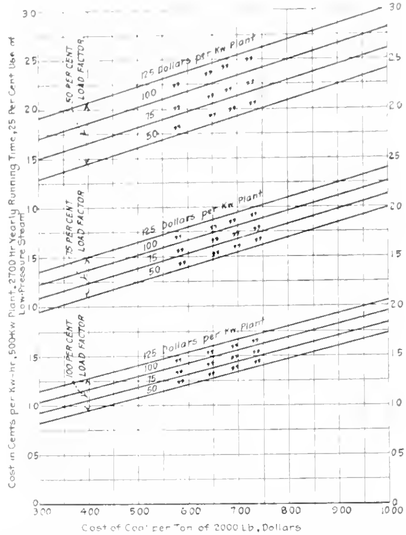

FIG. 5 APPROXIMATE COST OF STEAM POWER FROM 500-KW. PLANT RUNNING 2700 HR. YEARLY AND USING 25 PER CENT OF THE LOW-PRESSURE STEAM AVAILABLE

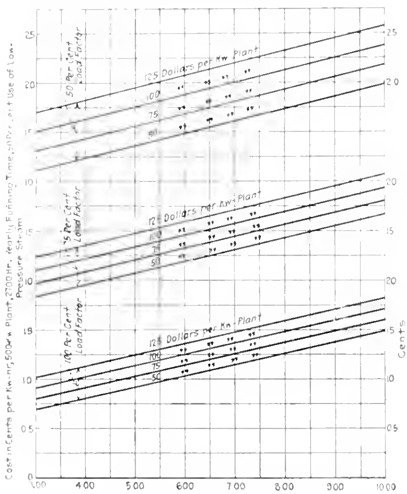

FIG. 6 APPROXIMATE COST OF STEAM POWER FROM 500-KW. PLANT RUNNING 2700 HR. YEARLY AND USING 50 PER CENT OF THE LOW-PRESSURE STEAM AVAILABLE

mentary, the size of the steam plant depends upon the extreme minimum water power available. The load factor on the steam plant depends upon the amount of water power available and to some extent upon the use made of it. Pondage, if wisely used, will decrease the size of the steam plant required and increase the load factor under which it operates.

There is a large field for fuel conservation in connection with water powers, attached to industries which operate for only 2700 to 3000 hr. annually. Either reciprocal relations should be worked out between such plants and central plants or the central plants should lease the water powers and furnish the lessor with the power required at a proper cost. The lessor could furnish the attendance at very small cost in most cases.

Situation D. An Industrial Plant Which Requires All or More than All of the Heat Which Can Be Made Available from a Steam-Power Plant in the Form of Either Low-Pressure Steam or Hot Water or Both.

Occasionally an industry is found where conditions are such, or the processes of manufacture can be arranged to be such, that the practicable supply of low-pressure steam can all be used. The demand need not necessarily be the same as the supply as long as it is always larger, as the additional supply can easily be obtained from the boilers by means of an automatic differential reducing valve connected in between the high- and low-pressure steam mains.

As nearly all industries require some high-pressure steam for certain processes, all steam is generally made at high pressure and the pressure reduced by means of reducing valves. It is evident that the steam-power cost in such a case may be comparable to the cost of water power obtained from a plant where there are no water charges, provided the first cost of the plant is about the same. It should be noted that the cost of the steam-producing part of the steam-power plant in such a case is not chargeable to power, as it would be required in any case.

Situation E. An Industrial Plant Which Can Use Only a Portion of the Heat Which Could Be Made Available if All Power Required Were Made By a Steam-Power Plant.

This is a common situation. Very often the total heat required for manufacturing purposes is in excess of that which could be made available from the prime movers, but either

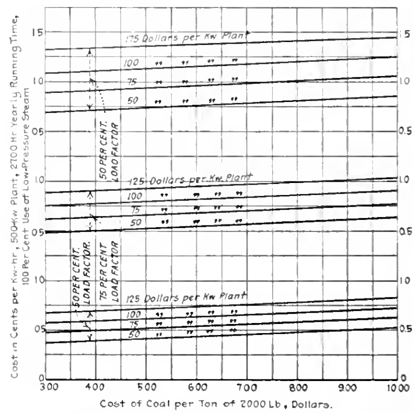

FIG. 7 APPROXIMATE COST OF STEAM POWER FROM 500-KW. PLANT RUNNING 2700 HR. YEARLY AND USING 100 PER CENT OF THE LOW-PRESSURE STEAM AVAILABLE

the demand or supply, or both, are variable and the situation cannot be developed to maximum efficiency. In other cases only a portion of the heat available is required, which may vary all the way from the plant which has use for exhaust steam only for a few months a year for building-heating purposes, which may be as low as 25 per cent of the total, to the

plant which would properly come under the preceding situation.

Many combinations of prime mover and accessories are possible to best develop a given set of conditions, among which are the following:

a Simple non-condensing engine or turbine, where the exhaust is used either entirely as low-pressure steam or partially for heating water.

b Compound condensing engine, where low-pressure steam is obtained from a receiver between the high- and low-pressure cylinders and where required hot water may be obtained from the condenser for purposes for which it may be suitable.

c Condensing steam turbine of the extraction or bleeder type, where a portion of the steam is extracted near the low-pressure end of the turbine. This low-pressure steam may be partially used to heat water or hot water may be obtained directly from the condenser. Where conditions warrant it, the condenser may be operated so that it will be really a heater rather than a condenser a great part of the time, heating water to suit the demand by varying the amount of condensing water at a sacrifice of vacuum on the turbine.

Figs. 5 to 10 are diagrams giving the approximate cost of steam power from plants of 500 kw. and 1000 kw. capacity operated under various conditions as to load factor and using 25, 50 and 100 per cent of the low-pressure steam available from the prime movers. When making comparisons between cost of power as given in these diagrams and those given in Figs. 1 to 4 for straight condensing steam plants, proper allowance should be made for the cost of that portion of the boiler plant which is not chargeable to making power.

There would be an opportunity for coal conservation as well as for financial gain in many situations of this kind, if the central plants would take over the isolated plants of such industries and tie them in with their distribution systems, operating them to the best advantage of all concerned. Efforts

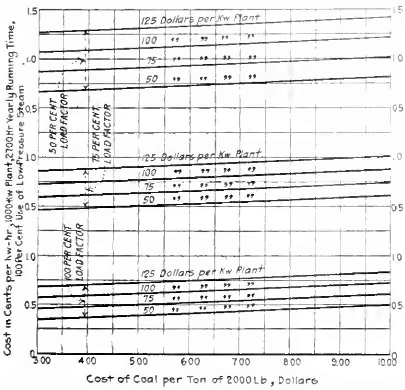

Fig. 8 Approximate Cost of Steam Power from 1000-Kw. Plant Running 2700 Hr. Yearly and Using 100 Per Cent of the Low-Pressure Steam Available

leading to such arrangements would seem to lead to better results than those which are aimed at shutting down isolated plants entirely. A common complaint coming from many industries is that they are burning nearly or quite as much coal since shutting down their steam-power plants and purchasing power as they did when running with steam.

In large industrial plants which cover much ground, the expense connected with the installation of low-pressure steam piping of sufficient size to carry the required amount of steam without excessive pressure drop and the loss of heat by radiation and condensation will sometimes be such that the use of low-pressure steam will not be warranted if it is to be supplied from a single steam plant. In such a case it is generally cheaper to use high-pressure steam for at least the

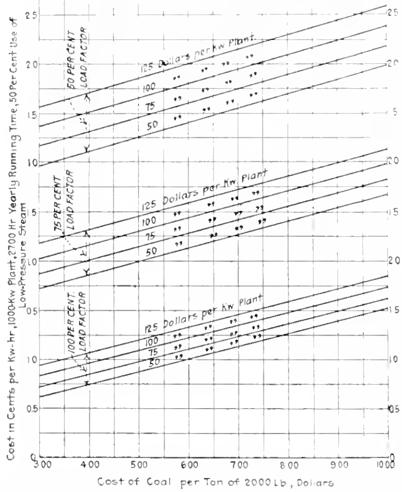

Fig. 9 Approximate Cost of Steam Power from 1000-Kw. Plant Running 2700 Hr. Yearly and Using 50 Per Cent of the Low-Pressure Steam Available

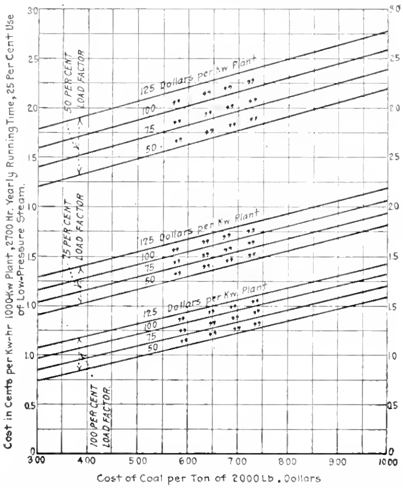

Fig. 10 Approximate Cost of Steam Power from 1000-Kw. Plant Running 2700 Hr. Yearly and Using 25 Per Cent of the Low-Pressure Steam Available

more remote parts of the industry and sometimes for all and obtain the power required from a plant operating as a straight condensing plant or by purchase from a central plant.

Situation F. An Industrial Plant Which Has a Water Power of Ample Capacity to Carry the Entire Load a Portion of the Time, But Must Have Auxiliary Power in Some Form During Low-Water Periods and Could Use All

Heat Which Would Be Available from a Steam-Power Plant.

To the cost of the water-power development must be added the cost of the necessary auxiliary plant to carry a portion of the load during low-water periods, ice troubles, backwater, etc. The cost of the power is then the total of the fixed charges, attendance and supplies for both the water power and auxiliary plant, plus the net cost of the power produced by the auxiliary plant. The size of the auxiliary plant and the extent of its output would depend upon the factors already discussed under Situation B. The only conservation of fuel would result from the difference in saving in the 10 to 20 per cent heat loss by radiation in producing the by-product steam power from the continuously operating steam plant and the auxiliary plant. The problem under this situation is generally to arrive at the cost of investment which would be warranted to develop a water power.

Situation G. An Industrial Plant Which Has a Water Power of Ample Capacity to Carry the Entire Load a Portion of the Time, But Must Have Auxiliary Power in Some Form During Low-Water Periods and Could Use Only a Portion of the Heat Which Would Be Available from a Steam-Power Plant.

This situation presents practically the same problem as the preceding one. The expenditure on water power which could be made to arrive at the same yearly cost of power as that made with a steam plant alone, would depend upon the extent of use of low-pressure steam and hot water and the auxiliary plant cost and power required from it.

In the case of large industries where the distribution of low-pressure steam is expensive, the auxiliary plant can sometimes be located near the point of greatest use of low-pressure steam and the balance of manufacturing and heating steam distributed at high pressure. Hot water can more easily be distributed over large areas than low-pressure steam. Very often the question of condensing-water supply and coal delivery will dictate the location of the auxiliary plant, with the result that all manufacturing and heating steam is distributed at high pressure.

Situation H. An Industrial Plant Which Has a Small Water Power, of Insufficient Capacity to Carry the Entire Load at Any Time, and Which Would Have Use for All Heat Made Available By a Steam-Power Plant at All Times.

Most small water powers operating under the above conditions would show a loss if all proper charges were made against them. The probability of making a water power of this kind pay for itself lies in its possible operation for overtime work and in carrying a part of the load in case of breakdown of the steam plant or in case of shortage of fuel.

A pond of some size and electrical development increase the possibilities of advantageous use of such small water powers under the above situation.

Conservation of fuel would result from the use of the water power for overtime work, if the steam plant could be completely shut down during such times.

Conclusions

Reliability of power supply is of much greater importance to the average industry than the cost of power. If the cost of power were doubled, it would be hardly noticed on the balance sheet of many industries, but shutdowns and speed drop or variation of speed may make a decided difference.

Cost and reliability being nearly equal, it would ordinarily be policy to purchase power where available. If the central plant from which the power is purchased is relatively large and has a fair load factor, this would tend toward fuel conservation.

Where an industry requires considerable heat for manufacturing and heating purposes, power can generally be made cheaper than it can be purchased, and fuel would also be saved by making rather than purchasing power in such a case.

Water power owned by an industry in many cases bears the same relation to it as does purchased power. If it is located at the industry it is often a form of reliability insurance to maintain a water power, even if there is no apparent saving due to its use.

Water powers that save coal should be maintained in any case, and there is a splendid opportunity to save fuel by redevelopment of inefficient water powers.

There exists a field for fuel conservation and financial gain for both central plant and industry, in the possibility of isolated-plant operation by the former.

In the case of water powers owned by industries running only eight to nine hours a day, the saving is of decided importance.

Under certain conditions the saving which would result from central-plant operation of isolated steam plants is also considerable.

FACTORY STAIRS AND STAIRWAYS

By G. L. H. ARNOLD,[1] NEW YORK, N. Y.

In the multi-story factory, the stairway is a detail worth much more than passing notice. Bear in mind that the people above the first floor are dependent on the stairs for egress; that four times daily the stairs are crowded by people in a hurry; that a large percentage of the minor accidents, many of the serious ones, and many panics happen on the stairs.

A poorly designed stairway may be an effective way to spread fires, smoke or false alarms and is sure to be a disturber of the heating system. A properly designed and located stairway affords not only a safe and convenient means of entrance and exit but also the handiest and most effective vantage point from which to fight fires on the upper floors.

In solving the stairway problem, consideration must be given

Fig. 1 Safety Steel Tread with Lead Plugs

to: (1) number; (2) location; (3) size; (4) type; (5) materials; (6) safety treads; (7) proportions; (8) landings; (9) handrails; (10) enclosures; (11) lighting; (12) wear.

1 Number

Where building codes are in force, the minimum number of stairways permitted is usually ample. Perhaps the most usual

[1] Mechanical Engineer, 37 Wall St., Mem.Am.Soc.M.E.

For presentation at the Annual Meeting, New York, December 3 to 6, 1918, of The American Society of Mechanical Engineers. The paper is here printed in abstract form and advance copies of the complete paper may be obtained by members gratis upon application. All papers are subject to revision.

code requirements are one stairway plus one for each 5,000 sq. ft. of lot area.

In cases where the code provision is insufficient, and where there is no code, it is essential to consider: (*a*) safety; (*b*) capacity; (*c*) convenience.

Safety. No building over two stories in height is safe with less than two stairways. A single stairway may, at a critical moment, be blocked by a temporary disarrangement of stock or fixtures on the floor, by repairs or by a fire.

Large floors require an increased number of stairs even if but few people occupy the floor. As the distance of the extreme point from the stairway increases, so do the chances of floor barricades. Furthermore, in case of panic, fire or other accident, the time required to walk or carry an injured or fainting person 100 ft. or more may be enough to produce serious results.

Two 4-ft. stairways for buildings having up to 20,000 sq. ft. of floor area, with one additional 4-ft. stair for each additional 10,000 sq. ft., is the least number that it is prudent to use.

If the building is liable to be used for purposes which may permit the occupants to be closely spaced, the number should be increased to two for the first 12,000 sq. ft. plus one for each additional 6,000 sq. ft.

At least one and preferably all of the stairways should be carried to the roof.

Capacity. In densely populated buildings the number of stairways must be increased to prevent dangerous overcrowding when all the occupants try to leave at once. In such cases, 20 in. in width for each one hundred persons, the Boston rule for theater exits, is high, and 10 to 14 in. would be ample.

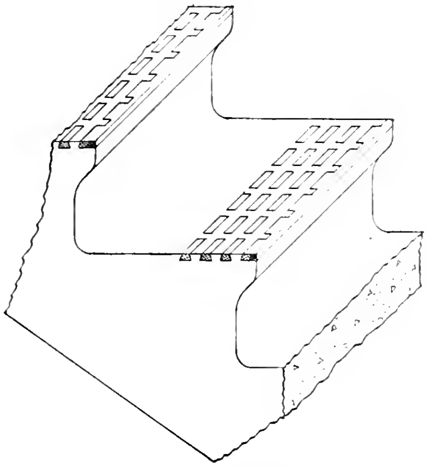

Fig. 2 Lead Safety Tread in Concrete Stairs

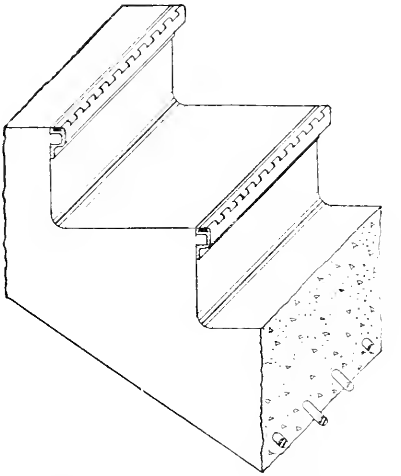

Fig. 4 Abrasive Safety Nosing for Concrete Stairs

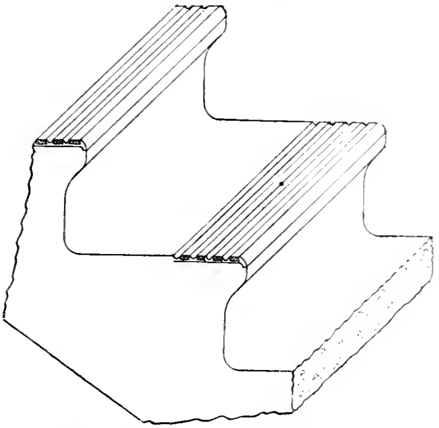

Fig. 3 Lead Safety Tread in Concrete Stairs

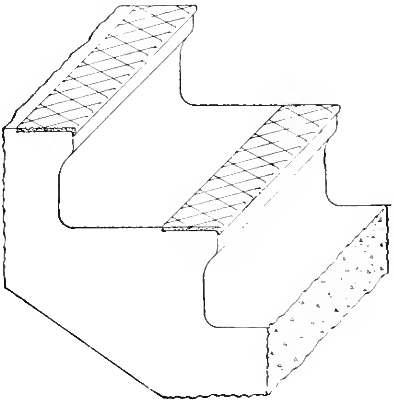

Fig. 5 Alundum or Carborundum Safety Tread

Convenience. Avoiding the disturbance of discipline and the loss of time caused by the passage of people through other departments, especial arrangements on one or more floors, the need of accommodating the building to the shape of the plot, the location of exits, and the advantageous subdivision of floors among different tenants or among different departments of the same tenant, may make it desirable to increase the number.

No question of convenience should be permitted to cause stairs to be so located that any occupant of a factory would be obliged to travel over 100 ft. to reach an exit.

2 Location

In the matter of location, many items should be considered. Every stairway should communicate directly with an exit from the building. The stairs should be distributed with a fair degree of uniformity and so placed as to reduce as much as possible the maximum distance to be traversed to reach an exit.

On each floor the landing should be so placed that lines of men going from shop to locker room, locker room to stairs, and shop to stairs, should not conflict.

It is also highly desirable to avoid obstructing the foreman's view of the room. When practicable, the separate tower or wing is the most satisfactory location. The locker and toilet rooms and the elevator can be in the tower, thus leaving the main building clear of obstructions and giving the foreman an unobstructed view of the room and permitting greater freedom in the floor layout.

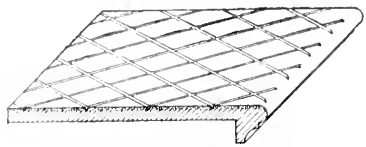

Fig. 6 Abrasive Safety Tread

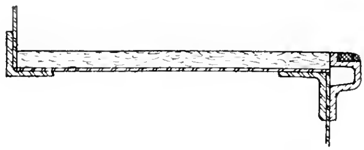

Fig. 7 Nosing for Cork Tread

3 Size

A clear width of 44 in. to 48 in. between handrails will allow the passage of two lines of people at once and the main stairs should never be less than this. If wider, the width should be in multiples of 22 in. to 24 in., the number of handrails being such that it is never less than 44 in. nor more than 48 in. between rails.

Where the number of employees is large, it is better to increase the number of 4-ft. stairs than to increase the width. Even when the number of employees in a building is large, only one floor, as a general thing, will be densely populated. This crowded floor is as likely to be at the top as at the bottom. Therefore, it is the usual practice to make factory stairways of constant width throughout their entire length.

Occasionally a factory building must be designed to accommodate dense population on two or more floors. In this case the employees from the upper floors coming down at the full capacity of the stairways will find the lower flights already taxed to the utmost and serious congestion will result. The remedy is increased widths for the lower flights.

Additional stairways from the lower crowded floors may not cure the trouble because, in the excitement of an emergency, when free and quick egress is most important, the occupants of the lower floors are likely to rush to the busiest stairway and leave their own special exit unused.

Special stairs, not used for general ingress and egress, may be as narrow as 20 in. in clear width; they may be steep, or, if not much used, they may have winders or be spiral.

4 Type

Except for special cases used by but few people for intra-department shortcuts, spiral stairs and winders should never be permitted in a factory. Straight runs alone are permissible. When the story height exceeds 9 ft., the flights should be cut and intermediate landings used. The landings should be rectangular and the flights should be not less than three risers nor more than 9 ft. high.

The intermediate landing is of little use if the flights are in line. A turn at the landing serves to limit a fall. A 180-deg. turn has the further advantage of reducing the floor space required. In fact, the stairway of minimum floor area (barring spirals) has a landing and a 180-deg. turn every 4 ft. in its height.

5 Materials

The factory stairs are usually of wood, cast iron, steel or steel with wood tread, steel with cast-iron tread, steel with stone tread, steel with concrete tread, or reinforced concrete.

The wooden stair in multi-story factories is not good practice. It is combustible and unsanitary. In buildings of mill construction, however, especially the smaller ones when not over four stories in height, sprinkled wood may be acceptable. The wood must be smooth, closely jointed, free from beads and not less than 2 in. thick, making a slow-burning construction. It is imperative that the wooden stairs be enclosed in a fireproof well.

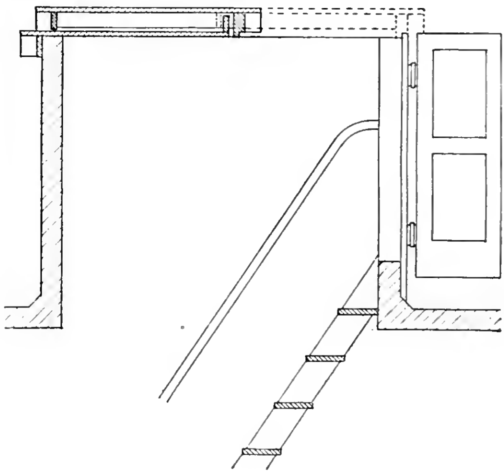

Fig. 8 Penthouse for Steep Stairs

The saving in cost, however, over a non-combustible stairway is not great enough to warrant the risk except in special cases. Cast iron and steel, while non-combustible, are not fireproof. Nevertheless, they are permissible when, as it always should be, the stairway is in a fireproof enclosure, since any fire hot enough to weaken the metals would render the stairway impassable.

Steel channels are more reliable for stringers and, except for short flights, cheaper than cast iron, and are more generally used. Risers are usually of angle and steel plate or pressed steel. Treads, while usually of cast iron, are frequently of checkered steel plate, wood, slate or concrete.

Cast iron and steel plate wear slippery and hence they are dangerous and should never be used without some sort of safety tread.

Wood, because of its inflammability, should not be used except as a safety tread over a solid sub-tread. Slate does not wear slippery but it is more expensive. It must be backed up by steel plate and replacements are expensive.

Concrete as a tread on steel stairs has no special advantage. The steel plate under tread is needed as it is for wood or slate, and to facilitate casting the steel is usually carried up to form a nosing. This is dangerous. The concrete is liable to crack off or wear below the top of the steel, leaving a lip over which, sooner or later, some one will trip and fall.

Reinforced concrete makes perhaps the most satisfactory stair if properly designed and built. There should be a good fillet between tread and riser for sanitary reasons, at least. There should be a nosing, which is not difficult to cast if made with a large fillet.

6 Safety Treads

Steel, cast iron, and concrete wear slippery and so become dangerous. Consequently, some form of safety tread must be used. Safety treads are made of: (*a*) lead; (*b*) abrasive material; (*c*) a combination of the two; (*d*) cork; (*e*) wood.

Lead Safety Tread. The lead safety tread is made by inserting plugs of lead in pockets in a steel frame, Figs. 1, 2, 3, the whole being fastened to the tread proper by screws. This of course wears more rapidly than cast iron or steel but does not become slippery and has no affinity for ice or snow. It is easily replaced when worn. The chief objections to it are that, owing to the grooves between the lead plugs, it is difficult to keep clean, and there is a chance for a heel to catch in the grooves.

Abrasive Safety Tread. The abrasive tread is made of alundum or carborundum cast into hard metal, leaving the grit projecting slightly above the surface of the metal, Figs. 5 and 6. The abrasive is also imbedded in the rounded nosing to prevent slipping on the edge of the step.

This type of safety tread is made to be used as the complete tread as well as the renewable safety tread bolted to a sub-tread. It is also made as a nosing, this form being especially useful on concrete stairs, Fig. 4.

This is probably the most durable tread in heavy traffic. It is, however, hard and noisy and, like the lead tread, it is difficult to keep entirely clean. There is also a chance that the grit may be too sharp: Instances are known where the shoe has been gripped so firmly as to cause a fall.

Combined Lead and Abrasive Safety Tread. A third type of safety tread is made of grains of abrasive in a lead matrix, the whole carried on a steel plate. It is made either grooved or flat, and with the anti-slip surface carried to the front edge.

The flat top is a great advantage as it makes it possible to keep the stairs clean. For outdoor use, it shares with the lead tread the advantage that snow or ice do not adhere. It also shares with the other type of abrasive tread the danger of too acute a grip.

With either of the above three types of tread, it is not necessary to cover the entire width of the tread. If the front edge of the step to a depth of 3 in. to 3½ in. is protected by a non-slipping surface, the remainder of the tread only needs to be brought up flush with the safety strip.

Cork Tread. Cork as a safety tread is not so well known nor so widely used as it deserves to be. It is impervious to almost all liquids and hence is easily kept in a really sanitary condition. It is noiseless, wears surprisingly well and is the pleasantest of all materials on which to walk.

Unfortunately, its lack of strength makes it necessary to use a metal or wood nosing. This is not dangerous, however, because owing to the elasticity of the cork, the nosing will wear ahead of it.

Where stairs are liable to rough usage, as by dragging heavy pieces up or down, the cork tile is sometimes used with a nosing having a lead or abrasive non-slip surface. See Fig. 7.

For use as a safety tread, the cork is compressed into tiles ½ in. thick by 9 to 12 in. sq. These are cemented to the sub-tread.

Wood Safety Tread. Except under the heaviest traffic, wood makes a splendid safety tread. Laid directly on top of a solid steel or concrete base and exposed only on the top and front edge, the fire risk is practically eliminated.

Wood offers one of the most satisfactory surfaces to step on. It is never slippery and it is cheap. The worst objection to it is from a sanitary viewpoint because it absorbs expectoration.

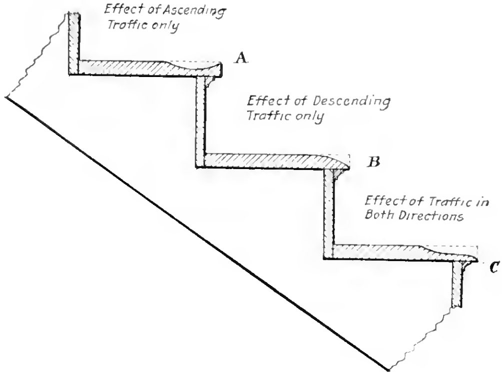

Fig. 9 Characteristic Effects of Wear on Steps

The wood should be either oak, maple or edge-grain yellow pine to wear well, the last-named being undoubtedly the longest-lived. Each tread should be made in three pieces. The rear strip will never need to be renewed and the center strip but rarely.

7 Proportions

Although the pitch of stairs must be kept within comparatively narrow limits for best results, still it is possible to make a safe and reasonably comfortable stair at almost any pitch if due regard is paid to relation of rise to length of run.

The natural length of steps decreases rapidly as the grade increases, even on a ramp where the surface offers equal foothold at all points.

Failure to take this fact into consideration results in a stair which is awkward and tiresome, with a pronounced tendency to produce stumbling and falls.

The length of the foot, or rather of the shoe, is not an important factor. For one thing, the actual length of the tread exceeds the run by the amount of the nosing. For another, practically all the work of ascending and descending stairs is done by the ball of the foot. In ascending the weight is borne on the ball of the foot in the middle of the step while the heel projects in the air. In descending, the toe projects, the weight being borne on the ball on, or just back from, the edge of the step, the heel barely touching the step.

For adults, making the length of the run plus twice the rise equal to 24 in. to 24½ in. can be relied upon to give satisfactory proportions.

By this rule, the rungs of a ladder should have a 12-in.

spacing, which is the recognized standard, and a 45-deg. stair would have an 8 in. rise and an 8 in. run, which a wide experience shows to be entirely satisfactory. A horizontal grating would have a 24 in. spacing, which, although a trifle short, is nevertheless within the bounds of practicability.

In factory practice, the tendency is to make the stairs steep in order to save room. Observation by several people over a period of years and under a wide variety of circumstances confirms the opinion that an 8-in. rise by an 8-in. run is the steepest stair practicable for general use and that $7\frac{1}{2}$-in. rise by 9 in. run is much better. Some building codes prescribe $7\frac{1}{2}$ in. as the maximum height of run. Although 7-in. rise by 10 in. run makes probably the easiest of all stairs, the improvement over $7\frac{1}{2}$ in. by 9 in. is not usually worth the extra floor space consumed.

Out-of-doors stairs or steps should be made with only 6 in. rise, if possible. In any case, the rise and run must be uniform throughout the entire length of the stairway. Otherwise, falls will be frequent.

8 Landings

All landings should be rectangular and at least as deep as the stairs are wide. The surface should be of the same material as the stair treads. Attempts to save room by cutting off corners or reducing the size of landings, or by the introduction of winders or straight steps invariably result in accidents, especially when the stairs are crowded and every one is in a hurry.

9 Handrails

Each line of people on the stairway should have a continuous, firmly supported handrail at a convenient height and of such size and shape as to be readily and securely grasped.

The material may be wood or metal. If of metal, the rail will usually be iron or occasionally brass pipe and of $1\frac{1}{2}$-in. or $1\frac{1}{4}$-in. iron-pipe size. The $1\frac{1}{4}$-in., although somewhat small, has the advantage that the fittings are more generally carried in stock. Large sizes are used but they are objectionable as they cannot be grasped securely in the frantic effort to recover from a misstep, especially by a person with small hands.

T-bars and special rolled, drawn or cast handrail sections, are frequently used but, except for the architectural effect, they have no advantage over the cheap and homely wrought-iron pipe.

If the rail is of wood, it should be of oak, ash or some other non-splintering hardwood; never yellow pine. It may be a round bar not less than $1\frac{3}{4}$ in. in diameter nor more than $2\frac{1}{4}$ in., or it may be one of the stock patterns carried by the mills.

In any case it must be strongly supported at a height of 31 to 33 in. above the front edge of the step. Around the landing, the height should be 36 in.

Open stairs require either a second rail at half height or a strong wire netting between stair and rail.

10 Enclosures

Notwithstanding the fire risk, the danger from things dropped or thrown, the chance for falls and the increased difficulty of heating, open stairways are frequently found in factories.

Every stairway should be enclosed in a fireproof well. In many cities a wire grill is permitted between stairs and elevators in the same well. A solid partition is more satisfactory and pays for the extra room and expense.

Choice of material will be governed by the same considerations as in the case of the other partitions.

The space under the bottom flight must be left open and kept clear unless filled up solid with non-combustible material.

If the stairs extend to the roof, the enclosure should be carried above the roof in the form of a bulkhead or penthouse high enough to allow a door 6 ft. 6 in. to 7 ft. in height.

If the roof flight is a ladder or a very steep stair, the penthouse may be replaced by a scuttle, or better, by a companion as shown in Fig. 8.

The door or scuttle should be hooked, latched or bolted in such a way that, at any time, it can be opened readily from the inside.

The roof of the stair well should be a skylight with a wire netting under the glass to catch pieces of glass in case of breakage.

At each story liberal wire-glass windows with metal frames should be provided so that the whole shaft shall be as light as may be in daylight. The better the illumination is, the fewer days in a year will artificial light be required.

All stairway openings should be closed with Underwriter automatic fire doors opening with the outgoing current. The outside doors need not be fire doors but should open out. Where there is much traffic, the fire doors may be supplemented by glazed double-acting doors.

The locks on all these doors should be such that under no circumstances can a person be locked in.

Care should be exercised to locate these doors so that they may be opened without risk of crowding some one off the landing and so that a stream of people descending cannot prevent them from being opened.

11 Lighting

In the artificial illumination of the shaft, brilliancy is not required but thorough distribution is. A light should be placed at each floor and each turn. The lighting should be in duplicate.

Since there is always a likelihood of a small group of employees being in the place at night after the stair lights are out, it is quite necessary to reduce to a minimum the distance one must grope in the dark. For this reason the electric lights should have double-acting switches at each end of each circuit and the emergency lights, whether gas, candle or lantern, should be so placed that each flight can be lighted on the spot.

12 Wear

Steps, subject to ascending traffic only, wear as shown in Fig. 9, at *A*. If the traffic is descending only, the wear is as at *B*. If subject to traffic in both directions, the wear will be as at *C*.

In any case, renewal of the front third of the tread will usually restore the worn step. At long intervals the middle third may have to be renewed if the traffic is very heavy.

Mr. F. A. Waldron, during the years 1896 to 1906, at the Yale & Towne Manufacturing Co., made extensive experiments on the wear of wooden treads constructed in three pieces. Hard maple, on account of its superiority for flooring, was taken as a basis of comparison. Mr. Waldron's method was to use the hard maple on every other step, putting the wood on trial on the alternate steps. Ordinary yellow pine proved to be very short-lived. Edge-grain yellow pine, on the other hand, proved to be by far the most durable, outwearing the maple two to one.

Where safety treads 3 in. or $3\frac{1}{2}$ in. wide are used, practically all the wear will come on the safety tread and only this will need renewal.

PROPERTIES OF AIRPLANE FABRICS

Methods Used by the Bureau of Standards in Developing a Cotton Fabric as a Substitute for Linen for Airplane Wing Coverings

By E. DEAN WALEN,[1] WASHINGTON, D. C.

THE early coverings of the wings of heavier-than-air machines consisted usually of a plain cotton fabric, coated with a beeswax compound or some sort of glue. Such a covering was not very strong and sagged materially when subjected to pressure or exposed to weather. It became necessary in the development of the planes to cover the wing surfaces with a material of high strength and low weight. Accordingly unbleached linen fabric, woven from yarns spun from flax, was used and found satisfactory, but the supply of linen in the present crisis would not suffice to meet the heavy demands and a search for substitutes was imperative.

Previous difficulties in experiments on cotton fabrics were four: (*a*) low strength per unit of weight; (*b*) low tearing resistance; (*c*) little shrinkage upon application of dope; (*d*) little tendency to retain what little shrinkage they had after doping.

In March 1917 the Bureau of Standards was able to issue instructions to various fine-goods cotton mills covering the construction of cotton fabrics for experimental purposes. In the early part of May 1917 a fabric had successfully passed the laboratory standards, and service tests in the field were started, with very satisfactory results, and the present Grade A cotton fabric was evolved.

In August 1917 a conference between the military authorities and representatives of the Bureau resulted in the Signal Corps Equipment Division's ordering the Bureau to supply necessary specifications for the purchase of 500,000 yd. of cotton airplane fabric.

Recently the standard fabrics were submitted to the English airplane authorities and the results of their tests were astonishingly successful. Since that time the English have adopted the standard Grade A fabric.

An interesting development in this connection was the fact that the Italians, working on the same problem at the same time, produced a fabric which had been used successfully on the battlefield and which differed but slightly from our own as far as thread count and yarn number are concerned.

Before suitable substitutes can be found, it is necessary to determine the requirements which a material must satisfy, together with the properties of the material being substituted. The following discussion treats of the methods of determining the properties of textile materials, from which may be determined their compliance with the requirements of airplane wing coverings.

Method of Covering Airplane Wings

It is thought advisable to discuss briefly the method of covering airplane wings in order that one may follow the discussion with more interest. The frame of an airplane wing is covered with a fabric according to one of the following methods: The fabric is sewed into a piece which is wide enough to cover, and is folded completely over and under, the wing frame. It is then tacked on the three open sides after being stretched just enough to take out the wrinkles. The raw edges of the fabric are then sewed together and the tacks removed. The other method consists in making a pocket of fabric and slipping it over the frame. The open end is then tacked and sewed the same as in the previous case. The system of threads in the fabric may have the following two relations to the major and minor axes of the wing: the warp running from the "leading-in" edge to the "trailing" edge, or parallel to the short or minor axis of the wing; or, it may be put on such that the warp is at 45 deg. to the axis of the wing.

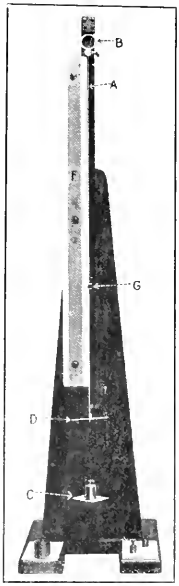

Fig. 1 Instrument for Measuring the Length of Yarn

The fabric is laced to the wing ribs at intervals of about six inches. After the fabric is on the frame, it is treated by means of a brush with a solution of cellulose acetate or nitrate with suitable stablizers, etc., which is termed "dope." The dope has the property of producing a tight drumhead-like wing covering, which is often attributed to the shrinking of the fabric. It also serves to fill in the interstices of the fabric, making a surface which has a coefficient of friction to air approximately equal to that of plate glass. The doped wing fabric may be considered as a rectangular membrane fixed at two sides and supported on the other two sides by the ribs of the frame, and that the wing is composed of many of these sections.

Determinations of the Properties of Undoped Fabrics

Moisture. The amount of moisture is found by drying the sample to a constant weight in a ventilated drying oven main-

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tained at a temperature of 110 deg. cent., and expressing the difference in weight from the conditioned weight in terms of the bone-dry weight. This is commonly termed "regain."

Weight. Pieces of 4 sq. in. are cut from various parts of the sample and weighed after exposure to the standard atmosphere, the results being expressed in terms of weight per unit of area.

Length of Yarn. The length of a yarn is considered to be that length when the yarn is straight and under no tension. The yarn is stressed in tension by equal increments of load and the stretch readings are taken at any particular load when the increments of elongation per unit of time are small. The stretch is plotted against the load. It has been found that after the fibers and the yarn have adjusted themselves the load-stretch curve follows a straight line. The straight-line portion of the curve is extended to intersect the zero-load coördinate, and this length taken to be the length of the yarn when straight and under no tension.

The apparatus is shown in Fig. 1. The yarn A is clamped at one end in the clamp B. The other end supports the weight pan C. The yarn is prevented from untwisting by the cross-arm D. The clip G is an index mark to read the changes in length on the scale F.

Crimp. The crimp of a yarn is the increased length of the yarn taken from the fabric over the length of the fabric. The difference is caused by the interlacings of the yarns. This length of the yarn removed from the fabric is determined in the manner outlined above.

Yarn Count. The yarn count is a term used to designate the size of the yarn and is expressed in terms of length per unit of weight. For instance, a No. 1 cotton yarn has 840 yd. to 1 lb. It may be considered as a very approximate index to the diameter of the yarn.

Thread Count. The thread count is the number of yarns per inch of width of the fabric, and its determination needs no discussion.

Twist of the Yarns. This term is perfectly obvious and needs no discussion. It is determined by counting the turns necessary to untwist the yarn, and the result is expressed in terms of twist per unit of length of the yarn before untwisting.

Tensibility Properties. The tensibility properties of a textile material may be defined as the behavior of the material when subjected to tensile stresses acting parallel to and at the center plane or line of the material. These may be divided into the following: (*a*) load-stretch relations; (*b*) tensile strength; (*c*) restitution and hysteresis.

The tensibility properties are determined in a testing machine of the inclination-balance type arranged to plot autographically the stretch against the load. A diagrammatic sketch of the apparatus is shown in Fig. 2. The inclination balance is represented by the pendulum arm A_1 and the sector arm A_2 which are rigidly connected and pivoted at the point B. The principle is one of balanced moments and its theory needs no discussion. The load applied at D is read on the scale C.

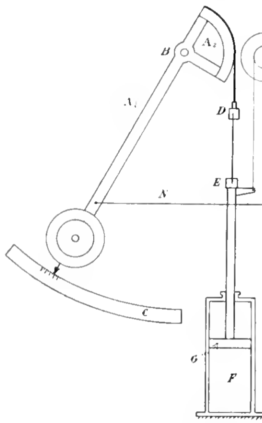

FIG. 2 INCLINATION-BALANCE MACHINE FOR TESTING TENSIBILITY PROPERTIES OF TEXTILE MATERIAL

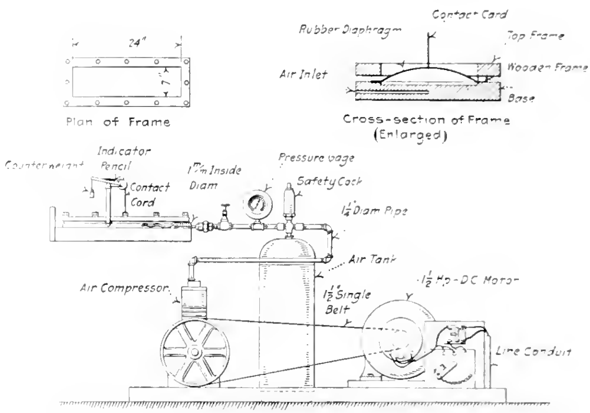

FIG. 3 APPARATUS FOR TESTING BURSTING STRENGTH OF CLOTH UNDER UNIFORMLY DISTRIBUTED PRESSURE

The fabric clamp E, which may be termed a pulling clamp, is operated up or down at will by hydraulic pressure acting on the bottom or the top of the piston G confined in the cylinder F. The motion of the balance arm revolves the drum K by means of the thin, narrow brass ribbon N. The motion of the pulling clamp moves the pen L along the vertical axis of the drum by the ribbon M and the magnifying pulley H. The pen is arranged to make a dot every second. [The paper discusses possible errors of the instrument, for which corrections were made.—EDITOR.]

The tensibility properties are determined in the following manner, which it will be noticed is a deviation from the usual method: Samples of fabric are cut 3 cm. wide by 25 cm. long. These are raveled to 2.5 cm. wide, and allowed to condition. They are then placed in the clamps of the testing machine with 20 cm. between clamps and stressed by reason of their being stretched at the rate of 13 cm. per min.

The tensile strength and load-stretch relations are taken directly from the chart.

The hysteresis and restitution properties are determined by stressing the fabric specimen to a certain load, and relieving the stress in the same manner as applying it. This may be repeated a number of times and the results taken as an index of the fatigue properties of the material.

Tearing Resistance, Tensibility Method. For this particular purpose the tearing resistance is determined in the following manner, which is a slight modification of the English method:

Specimens 25 cm. wide and 36 cm. long are clamped in the testing machine with 30 cm. between clamps. Slits are cut at the center and perpendicular to the line of pull, and the fabric is then stressed at the rate of 13 cm. per min., and the maximum load transmitted is recorded. The length of the slit is plotted against the load recorded.

The maximum length of slit which may be used with this size of sample is determined by the proximity of the zone of stress about the tearing point to the edge of the sample. The area of this zone is easily determined by drawing a series of lines parallel and perpendicular to the line of pull. These lines will be distorted in the zone of stress.

Resistance to Uniformly Distributed Pressure. The material is clamped over a rectangular container and subjected to air pressure. The apparatus is shown diagrammatically in Fig. 4.

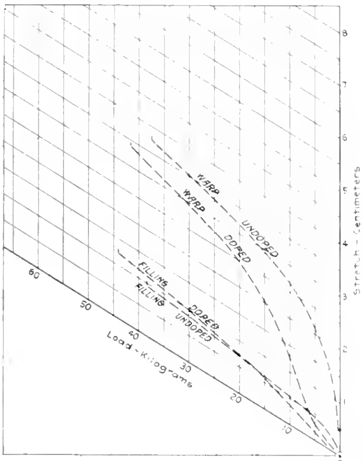

Fig. 4 Load-Stretch Relations of Standard English Grade A Airplane Linen

The deflection of the center point of the fabric is plotted against the unit pressure under the fabric by means of an ordinary steam indicator. The shape of the deflected surface is determined by measuring the vertical displacement of a series of rods placed at various points over the surface and free to move only in the vertical plane.

The rate of flow of air into the chamber under the fabric is very slow and is regulated by passing the air which is under a pressure of 10 kg. per sq. cm. through 110 cm. of 1-mm. tubing. A sheet of rubber dam is placed under the fabric to prevent air leakage. Considering these precautions, it is reasonable to assume that there is a very uniform distribution of pressure under the fabric. As there is practically a zero rate of flow of air into the indicator, it is reasonable to assume that there is no pressure drop in the connecting line.

In the surface formed by plotting the load-stretch and time relations of a fabric, there is a region where a change in the rate of load application produces only a slight change in the tensibility properties of the material. The rate of load application in this apparatus is adjusted by the definition of the pressure and dimensions of the capillary tube in such a manner that the variations in the load application produce only a very slight difference in the recorded tensibility properties of the material.

Bursting-Tear Test. The procedure is similar to that followed in the determination of the resistance to uniformly distributed pressure excepting that slits are cut in the fabric at various points and the pressure necessary to start the tear is recorded together with the deflection at the time of tear.

Determinations of Properties of Doped Fabrics

Preparation of Samples. In the tests made by the Bureau of Standards the fabrics were stretched and tacked on frames under a tension of 80 gr. per cm. of width and doped in a room maintained at approximately 65 deg. relative humidity at 21 deg. cent.

The frames were 30 cm. by 30 cm. inside dimensions for the preparation of specimens for the determination of tensibility

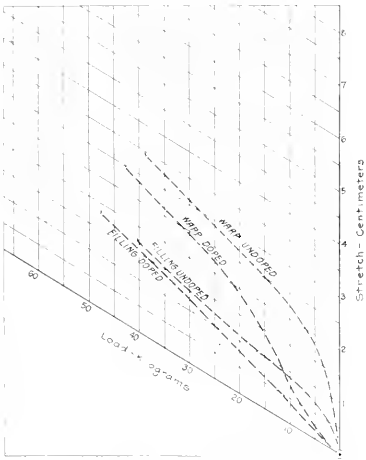

Fig. 5 Load-Stretch Relations of Standard A Grade Cotton Fabric

properties and 18 cm. by 61 cm. for determination of resistance to pressure.

The properties of doped fabrics were determined in the same manner as those of the undoped fabric, with the exception that the tensibility specimens were cut to 2.5 cm. width parallel to the line of threads.

Properties of Dope Films. Films of dope were made by painting the dope on glass plates and the films were subsequently peeled off and determinations made of tensibility and resistance to pressure.

Exposure Tests. The fabrics after tacking on frames and doping were placed on the roof and determinations made periodically of their physical properties.

Value of Tests

The determinations of weight, yarn size, crimp, thread count and twist are made primarily to explain difference in properties and more particularly to interpret properties in terms which readily adapt themselves to manufacturers' conditions. The effect of these values on properties will be indicated to give the reader a general conception of these effects.

The ability of a fabric to "take the dope" is influenced almost entirely by the relations between yarn number, twist, threads per inch, weight and weave, and they are practically the only measure of such a property. The functions of the dope are to produce a reasonably tight covering, to protect the

fibers from the influence of the atmospheric conditions and to produce a wind-tight surface. In order to perform these functions most advantageously it is necessary that one or two coats of dope penetrate the fabric enough to thoroughly protect the fibers and to serve as a necessary bond for the subsequent coats which should be more of the nature of a surface coating.

Crimp. The crimp of the yarn is the largest determining factor of the load-stretch relations of a fabric, particularly at the lower loads or under conditions of normal flight. This will be discussed under tensibility properties.

Tensibility Properties. The value of tensile strength as a measure of the quality of an ordinary textile material has long

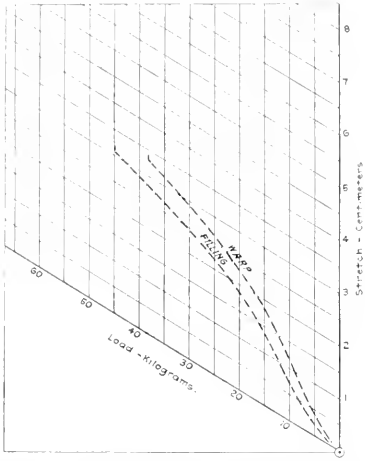

FIG. 6 LOAD-STRETCH DIAGRAM OF A 3/80'S UNMERCERIZED FABRIC DOPE

been realized, and it was largely the fact that this value was solely considered which misled investigators of cotton airplane fabrics.

An airplane-wing covering, for purposes of this discussion, may be considered as a flat, rectangular sheet supported on four sides, and subjected to pressure which may be considered as uniformly distributed over an area defined by the width of the rib spacing in one direction and relatively small distance in the other direction. The stress in the material of the section being considered is a function of the reciprocal of the radius of curvature plus a factor involving what is usually termed as an axial tension load. The curvature at any given pressure is determined by the load-stretch relations of the material, and although the load-stretch diagram does not consider the effect of axial loading, it does serve as a very valuable index to relative factors of safety of the various materials.

The wing covering must be airtight in order that the pressure may not build up on one fabric alone and that flight efficiencies may not be lowered. The material will remain wind-tight so long as the dope film is not ruptured or deteriorated.

The life of a fabric may be considered to be dependent upon the life of the dope. The dope may be caused to become deteriorated either by repeatedly exceeding its elastic limit or by exposing it to deteriorating rays of light. The latter condition may be reduced to a minimum by coating the material with pigmented varnish or dope which is opaque to the deteriorating portion of the spectrum. (This development may be attributed to an English investigator.)

The shape of the tensibility curves of the doped fabric serves as a valuable index as to whether the elastic limit of the dope will become exceeded under conditions of flight.

The ability of a fabric to shrink depends largely upon its load-stretch relations. The term shrinkage has been applied to refer to fabric tautness and leads to confusion as to the nature of the tightening. It has been observed that the fabrics having the least stretch at the low loads are tightest after doping, and that a plain-weave fabric is tighter than a fabric woven with fewer intersections and having less stretch. The fabric tautness is dependent largely upon the support which the fabric lends to the dope and the completeness with which the dope binds the yarns together in their crimped condition, and is dependent only slightly on film shrinkage.

The necessity of fabric tautness is believed to be largely dependent upon the psychology of the flyer, but, with the present dopes, fabric tightness is almost synonymous with life of the dope or fabric.

The relative recoverable stretch of an airplane-wing covering is quite readily indicated from an examination of the hysteresis loops of the load-stretch diagrams. It was not intended to convey the idea that all degrees of wing-covering looseness were equally desirable, and in the absence of exact data on the effect of fabric looseness on lift and drift, the allowable lack of recoverable stretch must be left to the judgment of the investigator.

The effect of the amplitude of the vibrations of a wing covering is, after a few flights, determined by the recoverable stretch of the material, and here again this phase of the in-

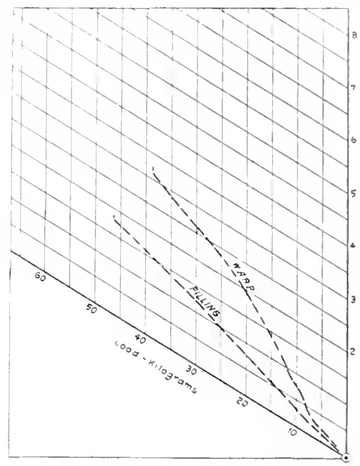

FIG. 7 LOAD-STRETCH DIAGRAM OF A 3/80'S MERCERIZED YARN

vestigation is not complete and the magnitude of this property must be left to the judgment of the investigator.

Tear Resistance, Tensibility Method. This method of determining tear resistance has been considered less applicable to wing-covering materials, as the value of the load-stretch relations is not fully realized, and has been superseded by the bursting-tear method.

The method may be used, however, in cases where the samples are too small for bursting tear and where such apparatus is not readily obtainable.

Resistance to Uniformly Distributed Pressure. As has been already pointed out, the stresses in an airplane-covering ma-

terial are a function of the curvature of the material at any pressure. It has been observed that the tensibility curve obtained by plotting calculated surface tension against stretch of the material during the application of pressure does not agree with the load-stretch diagram. The difference is probably due to the initial stress in the doped fabric and to the fact that the end and side effects of the tension strips are not present in the pressure test.

The test does not include the effect of tensions such as would result from wing deflections, but does serve as a more valuable index to factors of safety than the conventional tensile test. From the pressure-deflection curves it is easier to visualize the relative effect of wing deflection. The true conditions of flight are not duplicated, but the effect of the two systems of yarns are integrated and the results are less deceptive than those obtained from tensile tests.

Bursting-Tear Test. This test like the bursting test is a much better index to relative factors of safety than tension-tear tests. Questions of fabric reinforcement and balance of fabric are readily solved by a careful interpretation of the results obtained from such a test.

Results of Tests

Tensibility Properties. The load-stretch relations of a standard English Grade A airplane linen is shown in Fig. 4. It will be noted that the doped filling curve is practically a straight line. The doped warp curve shows a distinct yield point as indicated by the reversal of curvature.

Fig. 5 represents the load-stretch relations of a standard A grade cotton fabric, which, it will be observed, is very similar to the curve of the linen fabric.

The load-stretch diagram of a fabric may be divided into three parts according to the preponderating influences in these particular portions: (*a*) crimp; (*b*) crimp and yarn; (*c*) crimped-yarn characteristics. Referring to the warp load-stretch diagram of the cotton fabric, Fig. 5, the part of the curve extending to approximately 3 kg. is influenced almost entirely by crimp; the curve from 3 kg. to 10 kg. by yarn and crimp; the curve from this point on shows the characteristics of the yarn in its crimped condition.

This analysis suggests the particular part of the manufacturing process which should be varied to produce the desired shape of curve. The part of the curve below 10 kg. may be varied by changing the weave structure, stiffness of the yarn, and more particularly tension, on the yarns during weaving. The sum of the respective stretches of the warp and filling at this point is determined by the weave structure and the relative magnitudes of the respective stretches of the warp and filling are determined by loom tensions.

Fig. 6 represents the load-stretch diagram of a 3/80's unmercerized fabric doped. Both the warp and filling show a dope yield point between 5 and 10 kg. as is represented by the reversal of the curvature of the diagram.

The same construction of fabric made of mercerized yarn is represented by the load-stretch diagram, Fig. 7. The filling diagram does not show a reversal of curvature and the elastic limit of the dope will not be exceeded under normal conditions of flight.

Service tests on these two latter fabrics showed that the unmercerized fabric became somewhat mushy after a short period while the mercerized-yarn fabric stood up very well.

Similar tests on fabrics of various load-stretch diagrams showed that the fabrics whose dope-filling load-stretch diagrams were practically straight lines stood up exceptionally well.

The maintenance of the strength and the tautness of the cotton fabrics is dependent upon the completeness with which the dope protects the fabric and the completeness with which the dope is protected from deteriorating influences such as light and weather.

The dope penetration of the 3/80's fabric, 70 square, plain weave, is excessive. The dope penetration of the 2/60's standard fabric is slightly more than the standard linen fabric.

Excessive penetration of the dope reduces the tear resistance materially. If the standard 2/60's fabric is woven in a 2 by 2 basket the dope penetration is such as to cause an extremely low tear resistance. The small crimp in such a fabric makes it dope up very tightly.

Bursting Test. The curves, Fig. 8, represent the pressure-deflection properties of the center point of the fabric when subjected to air pressure, as previously described.

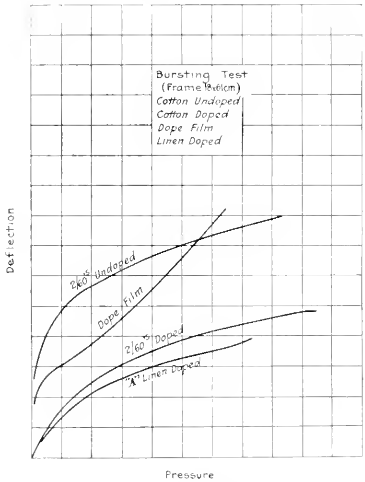

Fig. 8 Deflection of Center Point of Fabric When Subjected to Air Pressure

The deflection at any load of the fabric undoped is larger than that of the dope film. The deflection of the doped fabric is less than the deflection of either the fabric or the film. This further substantiates the theory that tautness is produced by the dope constraining the yarns in their crimped condition, and that in the standard fabrics the elastic limit of the dope is not exceeded.

It will be observed that the cotton fabric is capable of resisting more pressure than the linen, and it will have, therefore, a higher factor of safety. The fabric tautness is practically the same as that of the linen.

Tear Resistance. From an examination of the distortion of the lines about a tear, it is concluded that the tear resistance is a function of the strength of the individual yarns and the number being stressed. The number of yarns being stressed is dependent upon the load-stretch relations of the fabric and the weave structure.

[Other examples of tests are given in the complete paper.—Editor.]

Further experiments are being conducted to determine the properties of airplane fabrics, which have to do with the calculation of the exact performance of any fabric under any assumed condition of flight and which will include the effects of various rib spacings, wing deflections, vibrations, and the effects of various fabric structures.

MECHANICAL FEATURES OF THE VERTICAL-LIFT BRIDGE

By HORATIO P. VAN CLEVE,[1] NEW YORK, N. Y.

THE first important vertical-lift bridge was built in 1892 over the south branch of the Chicago River, at Halsted Street. Its span is 130 ft., it provides for city highway and electric railway traffic, and lifts 140 ft., affording vertical clearance for boats of 155 ft. This bridge is illustrated in Fig. 1.

The dead load is counterbalanced by a set of weights connected to the lift span by wire ropes which pass over grooved sheaves on the tops of the towers. The operating machinery is located under the roadway, at the base of one of the towers,

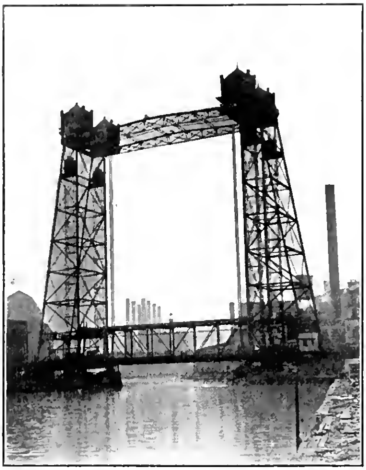

Fig. 1 Halsted Street Bridge Over South Branch of Chicago River, Chicago, Ill.
130 ft. span, 140 ft. lift. Design of J. A. L. Waddell, Kansas City, Mo

and the power is transmitted by a system of wire-rope drives running from the grooved drums in the machinery house to each end of the lift span, and to each counterweight. There are 16 ropes in all. Eight up-haul ropes, passing around a set of idlers at the bottom of the near tower, are carried to its top, where they divide into two groups. Four turn downward over another set of sheaves and attach to the near end of the lift span, and four, running horizontally to the top of the far tower, are there deflected downward and attach to the far end of the lift span. The eight down-haul ropes are connected in similar manner to the tops of the counterweights.

The towers, 217 ft. high, are steadied by well-braced lattice girders, which serve also as a support for the idler sheaves placed midway between towers to guide and steady the horizontal reaches of the operating ropes.

In the second structure of this type, of 229 ft. span and 40 ft. lift, built in 1909 across the Mississippi on the line of the Iowa Central Railroad near Keithsburg, Ill., several improvements were made on the operating mechanism of the Halsted St. bridge. Chief among these was the change in the location of the machinery from the pit below the tower to the top of the lift span. This shortened materially the length of operating ropes and reduced to a minimum the complications in their connection and arrangement; and it put the operator at once in reach of his machinery and in view of the river and approaching trains.

The scheme of operation, that used on nearly all succeeding lift spans, is as follows: The motor, in this case a gas engine, is connected by a train of gears to four spirally grooved operating drums, two over each top chord. Two operating ropes are fastened by rope clips to each of these drums, one for the upward movement of the span and the other for the downward, and are so wound on the grooves of the drum that the up-haul rope is wound on while the down-haul rope is paid off, and vice versa. An up-haul rope runs from each drum to the corresponding corner of the lift span, there over a double-grooved deflector sheave, and thence to the top of the tower, to which it is connected. The down-haul rope parallels the up-haul as far as the deflector sheave, and there, passing downward over the other groove in the latter, connects to the tower at a point in convenient reach of the deck.

Rotation of the drums in one direction winds on the up-haul ropes, causing an upward force at the deflector sheaves and thus, overcoming the friction of the tower sheave journals in their bearings, the unbalanced weight of suspending ropes and the inertia of the moving parts, lifts the span. All four of the operating drums are locked together by the connecting gearing,

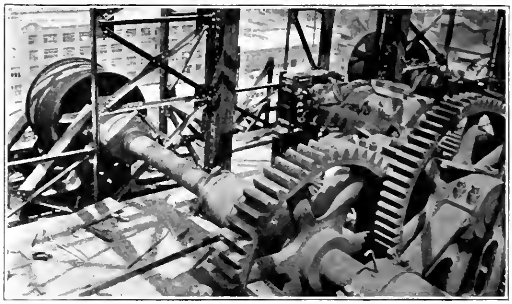

Fig. 2 Portion of the Operating Machinery, Bridge No. 458, Pennsylvania Lines
300-hp. railway-type motor, steel driving gears with 20-deg. involute-cut teeth, and operating drums.

thus insuring the synchronous rotation of the sheaves and keeping the span at all times parallel to its original position. Fig. 2 illustrates the general scheme of operation.

To keep the span in proper alignment between the towers, vertical tracks are provided on the four tower legs adjacent to it, and on these tracks bear the rollers which hold the span both in transverse and longitudinal alignment. Wedge-shaped steel castings at the foot of each tower engage close-fitting mating castings on the span when the latter is two feet above its seat. Automatic locks hold the bridge down when once seated. Each lock consists of two cams locked together by two segmental gears, and counterweighted to swing toward each other and grip a link hanging from the floor beam of the lift span. The cams are supported by a steel-casting anchor

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bolted to the piers, and the link, in descending, separates them and is in turn held by them when the end of the span is 1 in. above its final down position. Unlocking is accomplished by a foot-shaped bar, sliding vertically on the floor beam and connected by a wire rope to the lock lever in the operating house.

The counterweights of the Halsted St. bridge were made of cast iron, but considerable money has been saved on the Keithsburg bridge and on all later bridges by making them of concrete. Each weight is placed between two vertical steel members connected at the bottom by one or more laced struts and ending at the top in the equalizing devices to which the suspending ropes are attached.

A patented form of equalizer which makes the sixteen ropes receive their load from a single pin effects a very material saving in space over the types using straight horizontal bars and vertical links, and has the advantage of being less seriously affected in the event of failure of one of the ropes.

The third important bridge to be built was across the Willamette river at Hawthorne Ave., Portland, Ore. The lift span is 244 ft. long and lifts 116 ft. In this design, the machinery, located on the center of the span, is much more compact than in the Keithsburg bridge, all gears being mounted in the same frame instead of being supported on isolated bearings bolted to different parts of the steelwork. Operation is by two electric motors.

Electric power is far superior to any other for lift-bridge operation, as it makes possible niceties in control; direct-current motors are the most economical to use because of their high starting torque in proportion to their size.

While the Hawthorne Ave. bridge was under construction another lift bridge of entirely different character was being

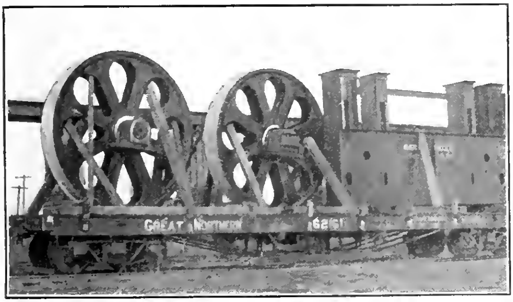

Fig. 3 Two 12-ft. Cast-Steel Sheaves and Supporting Girder, Missouri River Bridge at Mondak, Mont.

These sheaves weigh 7½ tons each and were built without any failures in casting.

designed. This was the 425-ft. span of the combined highway and railway bridge across the Missouri River at Kansas City. It consists of two decks, a fixed upper deck for highway and electric railway, and a lower deck for railway traffic, the hanger posts of the latter telescoping into the truss posts of the former as the lifting deck rises.

The live load coming on each lifting-deck hanger is carried by a pin into two saddle diaphrams in the upper deck truss. The dead load is carried into a pair of suspending ropes, which terminate in a counterweight after passing through the upper deck posts, over a deflector on the top chord, along the chord to the operating sheaves, and downward over another deflector. There are 15 panel points for each truss, and each point, except the two in the center, has one counterweight; the center points have two each, making 32 in all. There are two operating sheaves at each end of the bridge, and each pair is controlled by a motor and gear train near it. All suspending ropes pass over the four operating sheaves. The two sets of machinery, one at each end, are made to act together by means of two rope drives, one acting when the span is lifting, the other when it is lowered.

Each intermediate panel point of the lower deck is locked by a cam, and each end of the span is latched by a lock operated by a wire rope pulled by a segmental sheave in one of the machinery houses. All the hanger locks, 26 in number, and the two end locks, are operated by the same motor and gear train.

The Willamette river bridge of the Oregon-Washington Railroad and Navigation Co. is a combination of a simple lift

Fig. 4 Lift Span, Erected Position, Bridge No. 458, Pennsylvania Lines

The falsework is carried entirely on the piers and spread out from each of the latter in a fan shape upward to the panel points of the trusses.

span and the lifting deck just described. This lift span is 211 ft. long, weighs 3,420,000 lb. and lifts 89 ft., while the lifting deck below it can lift independently for 46 ft., and will then lift with the span for 89 ft. The advantage of this arrangement is that the highway traffic on the upper deck is not interrupted for ordinary river traffic, as the upper deck must lift for high-masted vessels only. There are five or six full operations daily and ten times that number of lower-deck lifts.

The large tower sheaves of this bridge are of 14 ft. pitch diameter, carry sixteen 2¼-in. ropes, and are made of cast-steel rim segments bolted to a center of rolled-steel plates and cast-steel hub. The sheave bearings are provided with a system of wedges which permits the replacement of the phosphor-bronze bushings.

The reason for making these large sheaves of built-up plates and castings was because of the difficulty of getting single steel castings of adequate size. However, considerable progress was made in three years in the manufacture of large steel castings. The two sheaves in Fig. 3, of 12 ft. pitch diameter and weighing 7½ tons each, were built without any failures in casting. They were used in the Missouri River bridge at Mondak, Mont.

In the bridge designed for the Vladicaucase Railway for a crossing of the Don River near Rostoff, Russia, the drums are close together instead of being at the opposite ends of the main drive as is the case with the Pennsylvania bridge illustrated in Fig. 2. The advantage in this arrangement is one of economy. A large gear reduction is made at the drums and there is only one line of shafting across the bridge. With the reduction used, the shaft is considerably smaller

than one of the two required in former layouts. The gear of one is also much smaller.

One of the heaviest bridges so far designed is that over the south branch of the Chicago River, near 19th Street, known

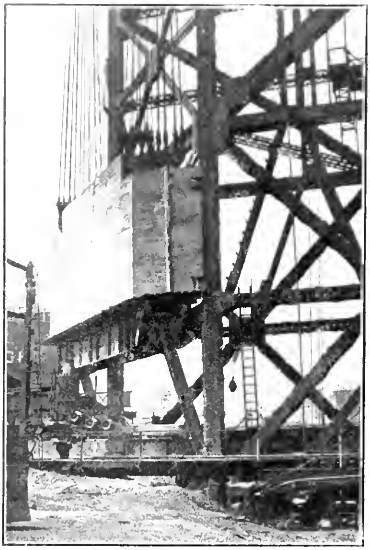

Fig. 5 Counterweight on Its Falsework, Bridge No. 458, Pennsylvania Lines

800 tons of concrete are supported on girders which deliver the load to two inclined struts bearing on 6-in. pins carried in saddle castings.

as bridge No. 458 of the Pennsylvania Lines. This bridge carries the double track of the Pennsylvania Lines and will be used by the Pennsylvania, the Chicago & Alton, and the Pere Marquette. There is no *closed season* on the river at this point and the Government required that the lift span should be erected 120 ft. above the river, the normal clearance for the span when lifted. As it was not possible to drive any piling into the river bed because of the resulting obstruction to river traffic, the falsework had to be carried entirely on the piers and spread out from each of the latter in a fan shape upward to the panel points of the trusses, as represented in Fig. 4. There were no connecting struts between the two sets of falsework and the upper end of the leaning members of each set had therefore to be tied back to the towers with steel bars and plates.

To erect the span with 120 ft. vertical clearance would have meant that these top chords of the falsework must in each case be attached to the tower legs half-way between two of the horizontal struts of the bracing, and as this was not considered advisable because of the resulting bending in the tower legs, it was necessary to erect the span high enough to allow these chords to come in line with the next higher struts. This placed it at 130 ft. clearance instead of the 120 ft. required. All connections were made in holes from which the rivets had for the time being been omitted.

On account of the shape of the falsework the erection of this span upon it would have developed an uplift in the shoes of the far tower legs too great to be safely carried by the anchor bolts, and it was therefore decided to build the concrete counterweights in such a way that their weight would be carried into these shoes. This was done (see Fig. 5) by supporting the 800 tons of concrete at each tower on girders which delivered the load to two inclined struts bearing on 6-in. pins carried in saddle castings riveted into the columns just above the bases.

There was nothing unusual in the erection of the towers, the derricks being stepped up from story to story according to practice common for similar structures. The heaviest pieces in them are the bottom sections of vertical legs next to the lift span which weigh 42 tons each. The four sheaves on the top of each tower weigh 31 tons each and are the largest of their kind so far built. They are of 15 ft. pitch diameter and each pair carries sixteen $2\frac{1}{4}$-in. plow-steel ropes, each weighing with its sockets about 2000 lb.

The span erection was carried on with two A-frame derricks shown in Fig. 4, the work progressing on the two sides simultaneously.

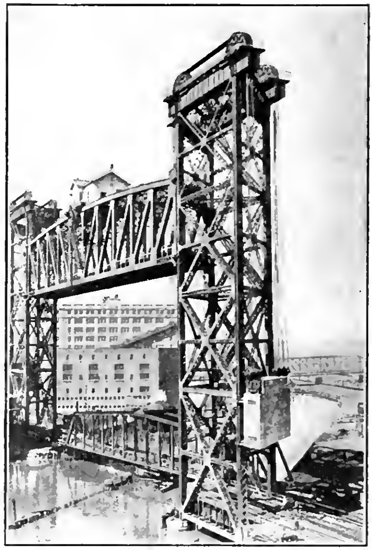

Fig. 6 Bridge No. 458, Pennsylvania Lines, After Removal of Falsework

The old swing span was kept in service until the upper structure was completed.

Only enough falsework to carry the end panel of the span was first set from the towers, and after the erection of these panels the derricks were moved from the towers to their first positions on the span, directly above the two sway frames nearest the ends. From here more falsework and more steel was erected and the derricks were again moved out. In Fig. 4 they are shown in their third and last positions as they stood to place the steel of the four center panels. To regulate the temporary camber to suit the erection of the last pieces of top chord, four hydraulic jacks were set beneath the bottom chord, immediately above the ends of the four last members of the falsework. Because of the eccentric loading on the towers there was bound to be some deflection of each tower toward the river, but calculations and measurements had been so carefully made that the two center pieces of bottom chord, 73 ft. 6 in. in length and weighing 36 tons each, when lowered into place fitted so exactly that the erection bolts could be entered without the use of drift pins. To get the last pieces of top chord in it was necessary to use the jacks.

Fig. 6 shows the bridge after the removal of the falsework and while the old swing span was still in service. This latter was partly under the new bridge, both open and closed, and as more than 300 trains use this crossing every day it was very important to take great care that nothing should be dropped from the span 100 ft. above. It is a matter for which the erecting contractor deserves congratulation that no accidents from this source occurred.

The new span is 272 ft. $9\frac{1}{2}$ in. long, lifts 112 ft., and weighs 1600 tons. At present it will be lifted at the rate of 15,000 times a year, for it lies near enough to the water to be in the way of every tug, but the great majority of these operations will require lifts of only a few feet. In a few years it is planned to raise the grade at this crossing, and the design of the bridge was carried out with this idea in view. Aside from raising the floor systems in the towers, lowering one story of tower bracings, and raising the base castings of the lift-span shoes, no change in this bridge will be necessary to accomplish this end. The span is operated by two 300-hp. series motors drawing their power from a 120-cell storage battery.

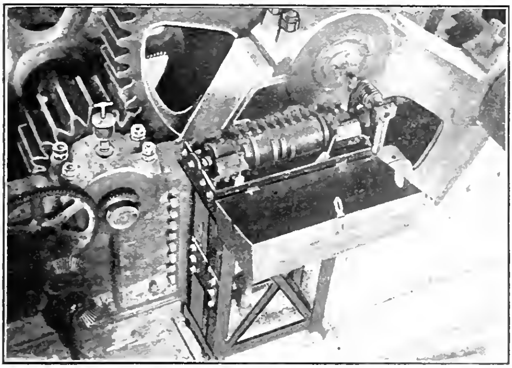

Fig. 7 Electrical Indicator and Limit Switch, Bridge No. 458, Pennsylvania Lines

Indicates by lights in the operator's house several points in the height traveled by the span, and cuts the controller circuit near each limit of travel.

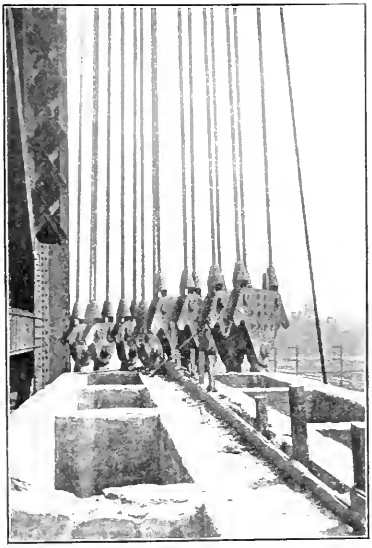

Fig. 8 Equalizer and Counterweight, Erected Position, Bridge No. 458, Pennsylvania Lines

When the span is lowered into place the parts of the equalizer become more closely packed together.

The electrical indicator and limit switch in Fig. 7, connected to the drive by worm-gear reduction, indicates by lights in the operator's house several points in the height traveled by the span, and cuts the controller circuit near each limit of travel, thereby breaking the main circuit, stopping the motors, and applying the solenoid brakes. Details of the equalizer and counterweight are shown in Fig. 8. Waddell & Harrington were the designers, represented in the field by the writer, and the Pennsylvania Steel Company were the contractors for fabrication and erection of superstructure.

DISCUSSION OF CERTAIN PROBLEMS IN REGARD TO MARINE DIESEL OIL ENGINES

By JOHN W. ANDERSON,[1] GROTON, CONN.

THE method of reversing used on the two-cycle engines is based on the fact that, in these engines, the spray and scavenger valves can be set right for running in the reverse direction by shifting the cams through a common angle. One camshaft running along the tops of the working cylinders operates all the valves; there is one cam for each spray and scavenger valve and the camshaft is shifted for reversing through an angle of 30 deg. The camshaft is shifted automatically by a slip coupling having a 30-deg. angle between the jaws, so that when the engine starts in the reverse direction, the crankshaft revolves 30 deg. before the camshaft starts, that is, when the timing becomes right for the new direction of rotation. The air starting valves are operated by two separate cams, one for ahead and one for astern, and the direction of rotation of the engine is determined by bringing into action the proper cam which in turn times the starting valve.

This automatic reversing mechanism fails to work satisfactorily when the engine is operated at low speeds, because then the engine does not turn exactly uniformly, and since the slip clutch is of the friction type, with jaws to limit the extreme travel to an angle of 30 deg., and since the camshaft and its parts have inertia of their own, this slip clutch fails to hold the camshaft in exact relation to the crankshaft. This upsets the timing of the valves, which in the case of the spray valve is important.

In the 1000-hp. engine installed in the single-screw submarine tender *Fulton* the shifting of the camshaft was made definite and positive by substituting, in place of the slip clutch, a sliding sleeve operated by a pneumatic cylinder under the control of the handling gear. The vertical shaft, which drives

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the camshaft from the crankshaft, is cut and the sliding sleeve connects the two parts; it slides on one of them on straight keys parallel to the longitudinal axis of the shaft, and on the other on spiral grooves, so that when the sleeve is moved along the axis of the vertical shaft the camshaft is twisted relatively to the crankshaft through the same angle of shifting used in the original design, namely, 30 deg.

To make the action still more positive, there is an automatic locking device on the pneumatic cylinder. It consists of a bar with two holes, connected to the lever operating the sleeve; corresponding to these holes there are two locking pins, one for each end of the pneumatic cylinder. The parts are so arranged that when the sleeve is in either extreme position, one of the locking pins fits into the proper hole in the locking bar and the parts are held securely in place.

When it is desired to reverse the engine, air is admitted by the handling gear to a piston on the locking pin holding the bar. This air pressure pulls the locking pin out, and when the pin is clear of the bar a port is uncovered leading to the pneumatic cylinder. The air pressure acting on the piston in the cylinder moves it to the other extreme position, setting the camshaft right for running in the opposite direction, and just as it reaches the extreme position it uncovers a port in the cylinder, admitting the air to the air starting valves on the working cylinders. Of course it is understood that when this gear reaches its new extreme position, the locking pin at that end of the cylinder registers with the hole in the bar and again locks the mechanism. The action is very simple and thoroughly foolproof and positive. This engine has been in service for some time now, and the reversing gear has amply lived up to expectations.

A similar method of reversing is used on the four-cycle engines, but unfortunately in this case it is necessary to have a separate camshaft for each kind of valve because of the different angles through which it is necessary to shift the cams in order to bring the timing right for the new direction of running. The engines are fitted with three camshafts, one for the spray valves, one for the inlet valves, and one for the exhaust valves. The air starting valves are operated by a single cam which is shifted by a separate mechanism to bring its timing right. The operation is pneumatic and the valves are controlled by plungers arranged radially around the single cam, in accordance with the proper sequence of cranks. All of the camshafts are shifted by means of a single pneumatic cylinder operating sliding sleeves similar to the one just described, except for the addition of a set of jaws on the camshaft which register with jaws in the sliding sleeve in its extreme positions and take the driving effort. The work of the spiral grooves is thus confined exclusively to shifting the camshaft. As in the two-cycle engines only a single cam is provided for each valve. This method of reversing has been applied to several engines and acts as satisfactorily in the case of the four-cycle engines as for the two-cycle.

The method of starting a Diesel engine which is almost universally used is by means of compressed air, and in most cases the air enters the working cylinders.

In starting, the air is ordinarily turned on for only a few seconds and in a few seconds more the engine can be brought right up to full power if desired. In fact, with a perfectly cold engine, the operation will be a great deal smoother under a moderate load immediately after starting than it will be at a very light load. This applies particularly at low speeds. For stationary engines which operate at full speed only, this condition is not encountered because the engine is brought up to full speed immediately after starting and the flywheel has inertia enough to keep the engine running smoothly even though ignitions are somewhat irregular.

In a marine engine the case is entirely different. Here it may be desired to start an engine slow ahead or astern, which, with a small, light, high-speed engine is difficult, unless a clutch between the engine and propeller permits the engine to be started up independently, warmed up, and then the clutch thrown in. The trouble in starting up when the engine is connected directly to the propeller is that in order to get the first ignition the fuel is turned well on, and when the first ignition does come there is enough energy in the combustion to overcome the inertia of the parts and drive the engine up to a much higher speed than is desired. With large, heavy engines this tendency is not nearly so marked and it is possible to get a slow, smooth start.

There are several ways to assist in getting a smooth start on a cold engine, and it is important to follow one of them in the case of large engines. One method is to heat the jacket water by turning steam in from an auxiliary boiler. In this way the cylinder walls can be warmed up to something approaching the working temperatures, and a smooth start is easily made. Another method, particularly useful in installations where very heavy fuels are used, is to start with a lighter fuel. By a lighter fuel is meant one that ignites readily and is more easily broken up so as to expose more surface to the heated air in the cylinder in the compression space, and thus give a quicker ignition. The solution to the problem of getting a good, smooth start consists essentially in having the temperature in the cylinders approximately the same as under working conditions and then injecting the fuel positively and regularly. Any method which does this will solve the problem.

Generally speaking, stationary engines and marine engines with clutches between the engine and propeller are fitted with starting valves on only half of the working cylinders. This means that while the engine is being turned over by starting air on part of the cylinders, the others are being warmed up by the compression, and even under very adverse conditions they soon reach such a temperature that ignition is obtained. In the case of reversing engines, the handling gear is sometimes modified to cause the starting air to be turned on and off the cylinders in groups.

The question of maneuvering is principally one of obtaining sufficient starting-air capacity, either by carrying a large number of flasks or—a much better way in the case of a large ship—by having an auxiliary compressor unit of good capacity. While the ship is maneuvering, the compressor unit is kept running all the time and pumps into the starting flasks. With such a provision an engine can be reversed repeatedly with only a very small starting-flask capacity.

In the case of small powers, it is much more convenient to use a clutch between the engine and propeller and employ a non-reversing engine which is kept running all the time.

The charge is often made against the Diesel engine that it is impossible to slow it down materially. This is true to a certain extent of the ordinary type of construction, but with the proper modifications any Diesel engine can be made to slow down and operate as readily at the lower speeds as at the higher. The solution of the problem consists in having a regular enough turning moment to keep the engine running fairly smoothly, and to obtain definite and regular ignitions in the cylinders. The case is much simpler for a large, heavy engine which has a big mass in the moving parts, and where there are a larger number of cylinders, say, at least six for a two-cycle engine and eight for a four-cycle engine, than it is for a small, light engine.

In the propulsion of a ship, the power drops off very rapidly as the revolutions are reduced, and therefore, at very low speeds, the power is so small that when divided up among all of the cylinders in the engine there is not enough fuel injected into each cylinder to give regular ignitions. This can be remedied in a large measure by cutting out half of the cylinders. The load per cylinder will then be more than doubled and the engine will run with very light loads at low revolutions.

Another method consists in the control of the spray-valve lift and timing by the operator. The control mechanism is so arranged that the timing and lift are changed at the same time. In some cases the valve is made to open at the same time under all settings and to close earlier, while in others it delays the time of opening by the same amount the time of closing is shortened. Both systems appear to work satisfactorily. When it is desired to slow the engine down, the fuel supply is reduced, the spray-valve lift reduced and the timing changed, and the spray-air pressure reduced somewhat. The combined effect of all these is to give regular ignitions in the cylinders, hence a smooth turning moment and good control over the engine. This method is much more preferable to cutting out some of the cylinders at reduced power, since it provides more impulses smaller in size and at closer intervals, which are all very vital points when running at very low speeds.

The advisability of fitting some sort of gear for controlling the timing and lift of the spray valve depends upon the type of engine and the place where it is going to be installed. Without such gear, an engine can be slowed down to about half speed without difficulty, hence for installations of small power in ships having a maximum speed of 10 knots or thereabouts it is unnecessary, because half speed means little more than steerageway. On the other hand, in the case of ships having a higher maximum speed such as 15 or 20 knots, it is very desirable to be able to slow the engine down to quarter speed or less, and then the installation of such a gear becomes almost a necessity. Under some circumstances, of course, it might be considered better to sacrifice maneuvering ability for the sake of simplification, but on engines of the size used on seagoing ships, the slight added complication due to this gear seems every bit worth while.

The question of lubrication is one that is dependent upon the type of engine. The gravity system is used successfully on large, open-frame, slow-speed engines, while on the small sizes, particularly where the crankcase is enclosed, a mechanical oiler is often used with leads to separate bearings or else a system of forced lubrication. There is one difficulty with the gravity lubrication and the mechanical oiler, and that is that there are many parts and pipes to consider, and each pipe or lead requires a certain amount of individual attention in order to see that the proper amount of oil is being supplied to that particular part. Furthermore, with these systems only just enough oil with a slight margin is provided to cover the necessary requirements of the bearing.

The big advantage of the forced-lubrication system is that a good surplus is supplied to each bearing at all times and distribution of the oil is secured by the proportions of the various passages, and hence requires no attention on the part of the operator other than to make sure that the main supply to the engine is kept up. Of course the various passages must be kept clear and open, but this is a matter that can be readily attended to during the overhauling period, and there is very little tendency for the oil to plug up the passages during operation.

There is one thing in connection with forced lubrication that is extremely important and requires constant watchfulness on the part of the operator, and that is the question of salt-water leaks into the lubricating oil. Any leak into the crankcase, no matter how small, forms an undesirable mixture with the lubricating oil, and at moderate temperatures creates a deposit which will quickly plug up the passages. If special precautions are taken against the leakage of the salt water into the oil, and the condition of the oil is watched carefully at all times, there is little chance for difficulty in this direction. From every other standpoint forced lubrication has the advantage over other methods. The proof of this is best shown by the increasing adoption of this system on engines of all types and sizes.

With an open-frame engine and using special precautions so that lubricating oil from the working cylinders does not drip into the crankcase, the oil does not become foul except after long service, but with the closed-crankcase trunk-piston engine the lubricating oil soon becomes fouled with finely divided carbon particles. After a time the oil turns very black and viscous and tends to clog the oil passages. This requires as much as 3000 hours' running in some cases, while in others this condition obtains in a few hundred hours. It is understood, of course, that oil is added from time to time to make up for the losses, but the system is not cleaned out and the whole supply replenished in all this time. As this condition of the oil is approached the danger of bearing troubles increases, and if it can be avoided the oil ought never to be allowed to get into such a condition.

Most of the carbon particles are removed by filtering, and the filtered product approaches the original in all its properties except that it is darker, due to the presence of the particles, which were not removed by filtering. The centrifugal process of clarifying is even better than filtering and removes a larger proportion of the carbon particles.

To attempt to filter or clarify the oil each time it is circulated through the engine would imply the addition of too much apparatus to take care of such a quantity of oil, and, fortunately, it is unnecessary. The best way is to drain out the system at regular intervals, depending upon the type of engine and the conditions of the service, and fill up with fresh oil. The fouled oil can be filtered at leisure and kept for future use.

The Diesel-engine industry is still so young that the question of how large an engine can be built is one that cannot readily be answered at this time. Practically all of the engines in service today are of small and moderate power as compared with certain steam plants, but, on the other hand, big strides have been made in the last few years in the development of large units.

In view of what has already been done and the experimental work that has been undertaken by so many firms, it is undoubtedly only a question of time when Diesel-engine power will be available for all except the very fastest liners and warships.

The vibration produced by an engine depends largely upon the number of cylinders and upon their arrangement. In commercial work, generally speaking, the speed is slow enough and the hull heavy enough so that the matter is not one of great importance; but in the case of a high-speed engine in a light hull, it is absolutely necessary that the engine be properly balanced.

For commercial work, many four-cylinder, four-cycle engines have been built, and these engines are very badly out of balance due to arranging the cranks all in one plane to get the best turning moment. But, as already stated, where these engines have been installed no serious difficulty has resulted,

due undoubtedly to the relatively low revolutions and the small size of the engine as compared with the hull.

If good balance is desired, it is necessary to use six or eight cylinders, which can be made to give the best turning moment and a good balance at the same time. The only thing that interferes with giving these engines a perfect balance is the air-compressor cylinders, but the reciprocating parts of these compressor cylinders are comparatively light, and hence do not cause any serious difficulty. In the case of crosshead engines it is oftentimes convenient to drive the compressors by beams and links from the crossheads. On a six-cylinder, four-cycle engine, for instance, there might be three compressors driven from three of the cranks, or on a six-cylinder, two-cycle engine three compressors would be driven from three of the crossheads and three scavenger pumps from the other three, so that a practically perfect balance would be obtained.

The usual method for the fuel system is to carry the main supply of fuel in the double bottom or in tanks in parts of the ship that are not ordinarily otherwise used, and then provide pumps for pumping it into gravity tanks placed well up in the engine room, so that the fuel can flow by gravity from the tanks to the engines. The tanks are made large enough to hold at least several hours' supply, and oftentimes a whole day's supply, so that the fuel has plenty of time to settle, and any sediment or water will collect at the bottom of the tank, where it may be drained off. It is very necessary that the fuel supply to the engine be perfectly clean. Very small particles of dirt or foreign matter will stick in the valves on the fuel pumps on the engine and cause no end of trouble. There is only one way to avoid getting this dirt into the engine, and that is to filter the fuel properly. The filter is sometimes placed between the gravity tank and the engine, and is sometimes combined with the gravity tank. In case the gravity tank is of small capacity, it is generally placed on the discharge side of the pump which pumps the fuel from the main tanks to the gravity tank.

The arrangement of the exhaust piping depends upon the type of the boat and the conditions of the installation. In the case of small boats, where the water line is more or less fixed and very little rough water is encountered, an underwater exhaust works out very satisfactorily, but in the case of large ships, the exhaust must be carried up a stack. In twin-screw boats it is essential that the exhaust from each engine be kept separate so that it can be watched by the operators. One of the simplest methods of detecting faulty operation in a Diesel engine is to watch the exhaust. The least sign of smoke is a sign of poor combustion and should be investigated at once.

Many varieties of muffler are used. The main idea of all of them is to break up the pulsations in the flow of the gases and give a steady flow. Where there is plenty of space and weight available, a big expansion chamber serves fairly well, but it is much better to reduce the size and use baffle plates. One of the best types is one in which the gases enter a cylindrical chamber tangentially at the circumference and escape at the center, or vice versa. Cooling the gases by turning the cooling water from the engine into the exhaust pipe helps too, but is not used except in some special cases. If there is very much sulphur in the fuel, water combines with the products of combustion and forms sulphuric acid, which will in time destroy the exhaust piping. If, however, the entire quantity of the cooling water passing through the engine is turned into the exhaust, the mixture is so dilute that there is little danger of trouble.

The piping itself must be jacketed or lagged, and due allowance must be made for expansion. Water jacketing is, in most cases, more satisfactory, but it adds to the complication and cost of the system, and for that reason is oftentimes avoided and the pipes are lagged.

The question of cooling the various parts of a Diesel engine is an important one, but as far as the fixed parts are concerned the problem is simple for all ordinary sizes of engines It is only necessary to provide for the proper flow of the cooling water, avoiding all pockets and dead areas. In the case of nearly all two-cycle engines and in four-cycle engines of quite moderate size, it is necessary in addition to cool the working piston, and herein lies a real problem. There is no exact dead line below which cooling is unnecessary and above which cooling is necessary, as a great deal depends upon the conditions of operation; that is, a high-speed engine designed to be driven at a heavy overload might require cooling, while the same engine driven at a lower speed and moderate power would operate perfectly satisfactorily with uncooled pistons. It is simply a question of carrying away the heat absorbed by the top of the piston. If it can be carried off fast enough through the cylinder walls to keep the center of the piston head from getting too hot, then the pistons do not need to be cooled, but if this is not so, then the extra heat must be absorbed by the circulation of a cooling medium through the piston. In general, it may be said that two-cycle engines developing 50 b.hp. or more per cylinder, and four-cycle engines developing 150 b.hp. or more per cylinder, are better off with cooled pistons.

The difficulties in the way of successfully cooling the piston are best shown by the variety of substances used and by the various devices employed to carry the substance to and from the piston. The simplest method is to employ a jet of air, but this is not very effective and can be used only where the cooling effect required is very slight. The other three substances employed to any extent are lubricating oil, fresh water and salt water. Lubricating oil has the distinct disadvantage that its specific heat is only about 0.4 of that of water, and hence about 2½ times as much must be circulated to carry off the same amount of heat within the same temperature limits. In addition, oil does not absorb heat from, or give heat to, a metallic surface as readily as does water. The one advantage of oil is that in case of any leakage inside of the crankcase, it mixes with the other lubricating oil and does not cause any damage.

In view of all this, it is readily understood why lubricating oil is used only in special cases where certain conditions make the advantages more than outweigh the disadvantages.

For commercial work it is safe to say that the choice lies between fresh and salt water. Fresh water requires an additional system, including tank, pump, cooler and piping, but it is not so corrosive, not so destructive to the packing in the joints of the system, not dangerous as regards deposits in the piston, and in case of leakage into the lubricating oil there is not the danger of damage to bearings. When salt water is used with proper precautions, most of the advantages of fresh water disappear; but it is a question as to how far these precautions can be successfully carried out under every-day working conditions. Both fresh and salt water will undoubtedly be used for some time to come until enough experience is gained with both systems to finally settle the matter either one way or the other, or it may be that fresh water will be used for high-grade installations, and salt water where first cost and simplicity are of prime importance.

To carry the liquid to and from the piston there are three general systems, but the details for any one system are varied greatly by the various engine builders or by the same builder

on different engines. One system is to combine the cooling with the lubrication system, but this, of course, is applicable only in case lubricating oil is used for cooling. The general scheme is to supply the oil to the main bearings, from whence it passes through the hollow crankshaft to the crankpin bearings and up the connecting rods to the wrist pins, thence through pipes or passages in the piston to the head and back again through a pipe or passage to some point near the bottom of the piston from where it can drain directly into the crankpit. A certain amount of oil leaks out at the bearings, and this serves to lubricate them.

A second system is to use jointed swinging pipes, and a third system, telescopic pipes. Both inlet and outlet pipes can be, and are generally, used so that any liquid desired can be employed for the cooling medium. The swinging pipes are suitable for slow-speed engines only, as at high speeds the inertia forces are very large and it is troublesome to take care of them properly. Moreover, the passage for the liquid must by the nature of the case have several bends and turns, and at high revolutions the inertia forces produce extremely high pressures, making it very difficult to keep the joints of the system tight.

There is one principle that must be followed in the design of swinging pipes for even moderate speeds, and that is to keep the bearings at the joints of the pipes entirely independent of the stuffing boxes, or, in other words, the piping for carrying the liquid, and the strength members for taking the inertia forces must each do its own work, although they are fastened together and are a part of each other. The great trouble with this system is to keep it tight at the joints, and it is only by careful designing along the lines stated that successful results can be obtained. In case water is used for a cooling medium, the lubrication of the bearings at the joints becomes important, but with forced lubrication there is generally enough oil flying around in the crankcase to take care of this if pockets, connected to the bearings, are provided for catching it.

Telescopic pipes are adaptable to both high- and low-speed engines. All parts are moving in line with the cylinder axis, and taking care of the inertia forces is much simpler than with the swinging links. Moreover, there are fewer turns in the passages for the cooling medium, and, as a general thing, air chambers can be placed so as to effectively care for the surges in the cooling liquids. An air chamber on the suction side is a necessity, but on the discharge side it may be dispensed with provided the discharge pipes are of generous size. It is good practice to put an open-end pipe discharging into a funnel, with proper provision against splashing, on the discharge line so that the cooling fluid coming from the piston can be actually seen by the operator. A certain amount of flexibility in the telescopic pipes is desirable, in order to remedy any slight looseness of the piston, or of the crosshead in its guide, or any slight misalignment. One method of accomplishing this is to provide a double pipe, one inside of the other. The inside pipe is fastened at one end to the piston or crosshead and at the other to the outside pipe. The outside pipe is guided in the part fixed to the engine frame. Here again the most troublesome part is the packing, but it is like packing the piston rod of an engine, and, as might be expected, the most satisfactory packing is of the labyrinth type, with provision for self-adjustment to the pipe so that it fits snugly under all conditions.

THE RELATIVE CORROSION OF CAST-IRON, WROUGHT-IRON AND STEEL PIPE IN HOUSE DRAINAGE SYSTEMS

By WM. PAUL GERHARD,[1] NEW YORK, N. Y.

A SPECIAL investigation was made in the summer of 1918 in New York City, with a view of bringing out facts regarding the deterioration by corrosion, and incidentally other characteristics, of cast-iron, wrought-iron and steel pipe as used in the drainage of buildings.

The plumbing of buildings comprises two distinct piping systems, namely, the *drainage* system (composed of sewer, drain, soil, waste and vent lines) and the *supply* system (composed of hot, cold and circulation pipes). The investigation was confined to the drainage and vent system.

The following kinds of pipes are used as materials for such drainage systems: standard or light and extra heavy cast-iron soil pipe (in 5-ft. lengths); light tarred cast-iron gas pipe (in 9-ft. lengths); standard-weight wrought-iron and steel pipe (in lengths of about 20 ft.), and finally extra heavy wrought-iron and steel pipe, both the steel and wrought iron being either black, asphalted or galvanized.

In the oldest plumbing installations standard cast-iron soil pipe was usually tar-coated or painted as a protection against corrosion. After about 1881 such pipe was not permitted to be used by municipal plumbing regulations, and extra heavy pipe took its place. Even this pipe was liable to have sand or blow holes, and its lead-calked joint was rarely permanent, as it was affected by extremes in temperatures.

These objections led to the introduction, in about 1881, of screw-jointed welded pipe with recessed drainage fittings, the late Mr. C. W. Durham, Mem.Am.Soc.C.E. having originated it. This system soon became the favorite one with the rapid growth of the skyscraper buildings in large cities. The earlier systems were of wrought iron, but since about 1890 steel pipe has also come into extended use.

In course of time severe corrosion occurred in some Durham drainage systems, and this led the manufacturers of cast-iron pipe to claim that both wrought-iron and steel pipe were not materials suitable for house drainage.

Great pains were taken in the investigation to distinguish between genuine wrought-iron and steel pipe, and the conclusion was reached that there was a vast difference in the corrosion of the two materials, and that steel pipe proved in actual service to be much inferior to the wrought-iron pipe.

The investigation involved the inspection of 78 buildings along both sides of Broadway, from Bowling Green (downtown) to 42nd Street. It included many modern office buildings and skyscrapers, also a few hotels and one large department store. The newer buildings, those less than 5 years old, were omitted from consideration, it being assumed that the corrosion of the pipes, if any, had not advanced suffi-

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For presentation at the Annual Meeting, December 3 to 6, 1918, of The American Society of Mechanical Engineers. The paper is here presented in abstract form, and advance copies of the complete paper may be obtained gratis by members upon application. All papers are subject to revision.

[illegible] to [illegible] much information of value. The roof vent pipes of the buildings were selected because these formed almost the only parts of the drainage system, of which the interior could be freely examined. An attempt, however, was made to gain information regarding the main drain lines in the cellars.

The oldest buildings were found to have cast-iron drainage systems, but in the later buildings, and chiefly in those over ten stories in height, the screw-jointed system prevailed, doubtless because of its important advantages over the former.

Samples from over 500 wrought-iron and steel roof vents were taken for analysis to determine the material. The method

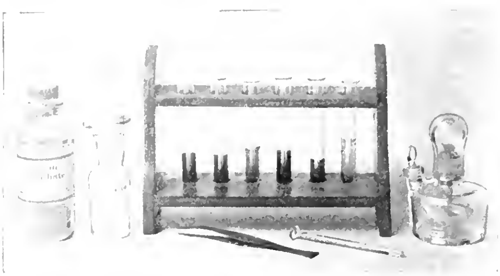

FIG. 1 MANGANESE TESTING OUTFIT

of testing was by the "manganese test." Small chips from the roof pipes were cut off by hammer and chisel, paint and galvanizing having first been removed with a file. The testing outfit used was a very simple one (see Fig. 1), and comprised a number of glass test tubes, with tube rack, a bottle of diluted nitric acid, a bottle of sodium bismuthate, an alcohol lamp, glass ladle and steel pincers. When the sample tested was steel, a decided pink color showed in the test tube, whereas if it was wrought iron, a brownish residue showed in the bottom of the tube. In numerous cases the chemical test was supplemented by a fracture test, showing the characteristic fibrous appear-

FIG. 2 CAST-IRON PIPE SHOWING TYPICAL CORROSION RESULTING IN EVEN POCKMARKING OR SHALLOW PITTING

ance of the break, if the material tested was wrought iron, and a bright crystalline appearance if the pipe was of steel. Doubtful cases were further investigated by referring larger samples from the roof pipes for microscopical examination to Prof. W. Campbell, of the Metallurgical Department, and for chemical analysis to Dr. Fales, of the Department of Chemistry, of Columbia University. Numerous photographs were also taken as a further record of conditions found.[1]

Two quite distinct forms of rusting or corrosion were observed, namely, pitting or pockmarking, and scaling or flaking. Both the wrought-iron and the cast-iron pipes were found to be evenly pitted to a comparatively shallow depth, thus reducing the pipe thickness but slightly (see Figs. 2 and 3). Many of the older steel pipes showed a characteristic and often aggravated form of scaling (see Fig. 4). When removed, the flakes often leave but a thin outer crust of the original metal; the scaling had a tendency to fall off by its own weight and to choke the vent pipes at angles or bends in the line.

While the genuine wrought-iron pipes made an excellent showing, the steel vents in service more than 20 years showed in nearly all cases a very bad deterioration.

As regards the drains and house sewers of welded pipe, a number of instances were recorded of pipes having become corroded, but only in a few cases could samples of the removed pipes be obtained for analysis. Assuming, however, the corrosive conditions to be no more severe in the drain pipes than in the roof vents, the drains would naturally last longer because of their larger sizes, which involve a greater wall thickness of the pipe. Concerning cast-iron drains, a few buildings still had the old light-weight pipes, and these were found without exception to be in bad shape, having leaky joints and sometimes holes, due either to corrosion or to the cutting of the pipes for the removal of stoppages, which were patched up with clamped bands. Where the house drains were of extra heavy cast iron, numerous instances of leaky joints were dis-

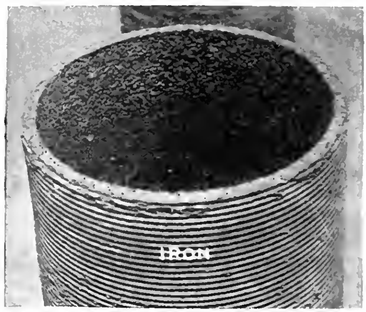

FIG. 3 WROUGHT-IRON PIPE SHOWING TYPICAL CORROSION RESULTING IN EVEN POCKMARKING OR SHALLOW PITTING

covered. This well-known defect of the calked joint in plumbers' pipe is particularly frequent where large volumes of hot waste water pass through the pipes, and also where steam exhaust, drip and boiler blow-off pipes are tapped into the house sewers. Municipal rules have for many years forbidden this practice, but it is still kept up, usually so after a building has been passed by the plumbing inspector.

The conclusions reached by the investigation may be summed up as follows:

1 Cast-iron pipe is a satisfactory material for house drainage purposes, many cast-iron roof vents showing up even more favorably as regards corrosion than had been anticipated, but the principal objectionable feature remains, i. e., the unsafety and unreliability of the calked joint, which can never be depended upon to be a permanently tight joint, because of expansion and contraction. A further objection to cast-iron drain and soil-pipe systems is that owing to the pipes being only five feet in length a much larger number of joints must be made, involving more labor in erecting and supporting the pipe stacks, and also the multiplied danger from leaky joints.

[1] Typical halftone illustrations appear in the complete paper.

2 The screw joint in welded pipe is much superior to the calked joint.
3 Steel pipe is much inferior to both cast-iron and wrought-iron pipe when exposed to corrosion. Galvanizing adds to the life of the pipe, but the coating does not adhere as well to steel pipes as to wrought-iron pipes. The rust resistance of the base metal is, however, of far greater importance than the preservative coating.
4 Ample evidence was obtained in this investigation to warrant the opinion that genuine wrought-iron pipe is a far more durable material for house drains and vents than steel pipe.
5 In recent years there has been a widespread substitution of the cheaper steel pipe where wrought-iron pipe was called for in the specifications. Then, again, engineers' and architects' specifications often make no discrimination between genuine wrought-iron and mild-steel pipe, and this is equally true of plumbing regulations.
6 Important municipal and governmental buildings, as well as those erected by private enterprise, all of which are expected to last from 50 to 100 years, should have all their important installations, and in particular those parts which are inaccessible after the building is completed, composed of materials having a corresponding duration of life.

In conclusion, one fact should be mentioned which may have contributed to the confusion as to wrought-iron and steel pipe, and that is that manufacturers and dealers have introduced the term *wrought pipe* for the purpose of designating steel pipe, when there appears to be no good reason why the material should not be called by its true name, viz., steel pipe.

This investigation as to the life of cast-iron, wrought-iron and steel pipe was in charge of the writer, and he personally inspected all buildings, witnessed all chemical tests, and

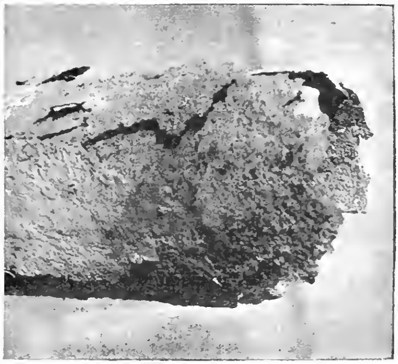

Fig. 4 Steel Pipe Showing Aggravated but Typical Corrosion Resulting in Flaking or Scaling

selected the typical vents which were photographed. The work was undertaken at the suggestion of the A. M. Byers Company, manufacturers of genuine wrought-iron pipe, of Pittsburgh, Pa.

WEIGHTS AND MEASURES OF LATIN AMERICA

By FREDERICK A. HALSEY,[1] NEW YORK, N. Y.

THE inquiry of which this paper is a report was conducted through a questionnaire of which about 500 copies were distributed throughout South and Central America and the West Indies. In order to secure representative and impartial distribution, outside agencies were enlisted in the work, the printed blanks being sent to their branches and correspondents by the National City Bank, the United Fruit Company, W. R. Grace and Company, and the Hill Publishing Company. Additional copies were sent out by the author to names taken from a commercial list obtained from the United Fruit Company and to United States consuls.

The questionnaire as drawn up in English will be found in the Appendix, together with the form letter which accompanied it. The actual printed forms sent out were translated into Spanish and Portuguese, in which languages most of the replies came back. The information given herein is not, however, limited to that obtained through the questionnaires as various citations in the text point out. In all cases, quotations without names attached are from the questionnaires.

Spanish and Portuguese Weights and Measures

As many readers are not acquainted with Spanish weights and measures, tables of the more common units and their relations are here given. The translation of the names is almost self-apparent, but the following are given:

Onza	Ounce	Pulgada	Inch
Libra	Pound	Pie	Foot
Tonelada	Ton	Vara	Yard
Cuartillo	Quart		

The Portuguese names are so similar that their meanings will be apparent.

SPANISH WEIGHTS AND MEASURES

Weight		
16 onzas	=	1 libra
25 libras	=	1 arroba
4 arrobas	=	1 quintal
20 quintales	=	1 tonelada
Dry Measure		
4 cuartillos	=	1 celemin
12 celemins	=	1 fanega
12 fanegas	=	1 cahiz
Liquid Measure		
4 cuartillos	=	1 azumbre
8 azumbres	=	1 cantara
16 cantaras	=	1 moyo
Length		
12 pulgadas	=	1 pie
3 pies	=	1 vara

Unification of English and Spanish Weights and Measures

With slight differences in the values of the units, this system is substantially identical with our own. With suitable foresight and effort the two might have been unified long ago.

[1] Commissioner, American Institute of Weights and Measures. Mem. Am.Soc.M.E.

Abstract of report prepared for the American Institute of Weights and Measures. For presentation at the Annual Meeting, New York, December 3 to 6, 1918, of The American Society of Mechanical Engineers. Advance copies of the complete paper may be obtained by members gratis upon application. All papers are subject to revision.

The chief difficulty in the adoption of the metric system in Latin America has been and is the psychological difficulty—that is, learning to think or vizualize values in strange units. In this sense the difficulty of adopting the English values of the units would have been nil for there would have been too little change in values to cause confusion of thought, while in names there would have been none.

Meanwhile the still greater difficulty in our own case—the physical difficulty due to the anchorage of units in standardized manufacture—was and is absent in Latin America where but little manufacturing is done. The difficulties in the way of adopting the English values of the units thus were and are trifling in comparison with those in the way of adopting the metric units. Moreover, the process would have been one of subtraction, two sets of values being reduced to one, and, internationally considered, several sets of values reduced to one, for the Spanish units have slight and annoying differences of value in different countries. The "adoption" of the metric system, on the other hand, has been one of addition, another set of units being added to those already existing.

The ease with which the English values of the units might have been adopted is shown by these reports of the progress they have made. With no trace of compulsion or even governmental recognition, they have come into large use by the operation of the forces of trade and commerce and by simple acceptance, whereas the metric units have nowhere made progress except by compulsion.

The remaining question is: Is it too late? Except for units for land measure, which, once established, should be let alone, I think not, for conditions have not materially changed in Latin America. It must be apparent there, as this inquiry makes it here, that the attempt to adopt the metric system is a failure. The weights and measures of Latin America are in a state of chaos, for which a remedy is sorely needed. Were they to dismiss the intruder and retain the old historic names with changes in values which are so slight as to be inappreciable for most purposes, Pan-Americanism in this important field would become an accomplished fact, and the unification of the weights and measures of North and South America with those of the British Empire would be within sight.

It is especially to be noted that until about the beginning of the present century there were few, if any, compulsory metric laws in Spanish America. The system had been "adopted" in many of those countries as the official system, and used chiefly for customs purposes and railway tariffs, but the people continued to use the old measures without molestation. The change in the intervening years is due to German influence and for German purposes. If, as seems probable, German influence in Spanish America is to suffer an eclipse, is it too much to hope that the future may see the unification of the weights and measures of North and South America and the British Empire on the foundation of the system which, in its basic and historic features, is common to all?

Meanwhile we have an important lesson to learn from Latin America. A glance through these reports will reveal the common practice of selling grain and other farm products at wholesale by *weight*, the arroba and the quintal being favorite units.

Our clumsy efforts to connect the bushel and pound through conversion factors are the cause of much confusion[1] which would disappear were we to copy this practice, and, incidentally, deprive the metricites of a false argument which is on all their lips. and which the unthinking know no better than to accept. The unit for this purpose should be the quintal of 100 lb.—a name which is preferable to hundredweight as it avoids confusion with the British hundredweight of 112 lb.

General Analysis of Results

The effort to learn the relative usage of the different systems has not been successful. When one return gives exclusive use of the metric system for a given purpose and another exclusive use of the Spanish system for the same purpose, discrimination is impossible. The thing here proven is that the claim that Latin America is metric is false, as are all arguments based upon it. In particular it should be noted that the order in which the units are herein named has no significance.

In but one of the countries investigated (Uruguay) can the metric system be said to be adopted for domestic trade, while there we find an authorized official exception in the case of real estate, as we find other exceptions in the cases of wearing apparel, industry, and navigation. Nevertheless, in twelve of these twenty countries, according to a report on The Metric System in Export Trade by the Director of the Bureau of Standards, the metric system is "obligatory."[1]

In ten of these countries (apart from the railroads and other fields under immediate government control) the metric system has made almost no impression. (Nicaragua, Guatemala, Spanish Honduras, Cuba, Panama, Colombia, Porto Rico,[2] San Salvador, Ecuador, and Costa Rica.

Of these ten countries, according to the above report, the metric system is "obligatory" in seven. In five of them (Cuba, Colombia, Porto Rico, Panama, and Spanish Honduras) the English units are used far more than the metric, having largely supplanted all others, although in three of them, according to this same report, the metric system is "obligatory." Not only has the English pound come into large use, but the arroba and quintal have been adjusted in value to make them equal to 25 and 100 English pounds, respectively. In substantially all of the countries investigated the English inch is used for mechanical purposes, as the English nautical units are used for navigation and sea shipments. That most derided of English units—the nautical mile—is used by all countries that sail the seas and they use no other. The kilometer is an unknown measure at sea.

In all countries the impression made is in direct relation to the severity of the laws, of which we have the climax in Uruguay, with Venezuela and Argentina not far behind. In all cases the movement was begun with mild laws under the impression that the adoption of the system was a simple and easy thing to bring about. Such laws failing, more drastic ones followed, but even these have been but partially effective. The greatest progress has been made in the field of domestic retail trade, in which weights and measures are under the immediate eye of officers of the law.

It is this field which comes under the observation of tourists. One may tour through, or, for that matter, live in a country for many years, in many walks of life, and experience but

[1] It should be noted that the adoption of the metric system would not do away with this confusion since wheat, corn, rye, etc., do not weigh the same per decaliter any more than they do per bushel. The sal of these and similar commodities by *weight* is the simple and sufficient method of abolishing all the confusion now experienced in this branch of trade.

[1] See The Metric System in Export Trade by the Director of the Bureau of Standards, page 17; Senate Document No. 241, Government Printing Office, 1916.

[2] Porto Rico is always claimed to be metric by the advocates of the metric system. But, according to Mr. Fred R. Drake, Chairman Executive Committee, American Metric Association, "The meter, liter and gram continue to prove most satisfactory in official and general use in the Philippine Islands, *Porto Rico* and other United States possessions."

little contact with weights and measures outside the field of retail trade, and we thus see why the reports of tourists are more favorable to the metric system than the facts justify, as we also see why the observations of tourists, in a comprehensive sense, have very limited value.

The further we get from the field of retail trade, the less is the system used. In this field the progress is chiefly with units of weight and capacity, the measure of length for the sale of drygoods being commonly the vara, while imported wearing apparel of all kinds is commonly sold by the units of the country of its origin, by the inch at least as much as the centimeter, and domestic products are frequently made to numbered sizes, of which the relation to any system of units is not apparent. They are not metric.

In primary or wholesale markets the old measures prevail, although these, in some cases, have been adjusted in value to make them even multiples of English basic units. We have here perfect examples of the simple process of unification of English and Spanish measures which, with proper encouragement, might by this time have become substantially universal.

Lumber and timber are almost universally sawn to the inch, although frequently mixed with the vara or the meter for length, and the square and cubic meter as sales units, prices being made at so much per square or cubic meter for one-inch boards.

In the mechanical trades tailors and seamstresses use all three systems, as do stone and brick masons, while carpenters commonly use the pulgada or inch. In machine shops both English and metric units are used, depending chiefly on the country of origin of the machines they have to repair. The inch is predominant.

In this connection we have the report of the Cleveland Twist Drill Company that shipments of their tools to South America are "95 per cent to 100 per cent English," and of the Detroit Twist Drill Company that "All of our South American customers use more English sizes than metric." Needless to say, English-sized twist drills are bought in order to make English-sized holes, for they will make no other.

In ship and boat building, also, the English units find large use, while in mining and smelting we find a miscellaneous mixture of all three systems.

The persistence of old units is most pronounced in the measurement of land. When units of measure are once anchored in titles to real estate, they are there to stay. Of this we have perfect examples in the use of the French arpent in Louisiana and the Spanish vara in Texas, in which states those units are today the common units of land measure. Another example is found in France, where, in some sections, the old units of land measure are still predominant.

When outlying districts are incorporated within city limits, parcels of land are much reduced in size and smaller units come in. This gives an opportunity for the introduction of the metric system, but with the result that, in the older portions of the town, the old units are used, while in the newer portions we find the new ones.

Similarly, initial surveys of the *hinterland* give an opportunity for the use of new units, but again with the result that the older portions of the country are measured in one set of units and the newer in another.

In Uruguay, where the laws are more severe and more rigidly enforced than in any other country, it has been found necessary to authorize the use of old units for the measurement of land (see Uruguay below), while in other countries the laws, in this application, are quietly ignored. This is the more significant because all transfers of real estate, as matters of public record, come before the eyes of officers of the law. In other countries, again, the purchase and sale are made in Spanish units and the day is then saved by inserting metric equivalents in the documents of record.

In marine measurements and sea shipments the English system is used everywhere, although mixed with metric units, especially for inland navigation.

Classified in another way, the most-used metric units are those of capacity. Next come those of weight, and, trailing far in the rear, those of length and their correlatives of area. This is in accordance with a law which long ago made itself apparent.

The Reason Why Compulsory Metric Laws Fail

A few words in explanation of the failure of even drastic laws for the adoption of the metric system are here appropriate. Such laws fail because established and harmless practice cannot, except in a technical sense, be made a crime. Fancy an American grocer arrested, haled to court, fined, and even sent to jail for selling sugar by the pound—a thing that has been done since the Pilgrim fathers landed at Plymouth Rock. And yet this is exactly what they do in Uruguay. Place a meter and a yardstick alongside. They differ in value by about 10 per cent. Is it conceivable that selling by one can be made a virtue and by the other a crime? Fancy an American jury convicting a merchant of a crime for selling drygoods by the yard! And yet this is precisely the meaning of compulsory laws.

It is a truism of law that excessive penalties cannot be enforced and so defeat themselves, and is it not clear that compulsory metric laws in any country in which the people have rights are unenforceable, and that the more drastic they are, the more unenforceable they become?

Theories Disproven

On its face, this Report sets forth a volume of facts regarding the weights and measures of Latin America, but, in addition to this, it disproves many theories.

The first theory is that it is an easy and simple matter for a country to change its system of weights and measures. Here we have the results of twenty attempts to bring about this change, most of which date from about the middle of the last century. In most of them the result has been grotesque failure, while in none has the attempt to retire old units been successful.

It is on this theory that the entire metric case is based. Once one has accepted the idea that a country may easily change its weights and measures, it is a short step to the conclusion that those who have tried it have succeeded, and then another short step to the conclusion that we can succeed. The question at issue is one not of belief but of fact. With 20 failures after, in most cases, more than half a century of effort, the fact is proven.

The second theory is that the adoption of the metric system does away with confusion of weights and measures. These reports show that the actual result is to increase and not eliminate confusion.

The third theory is that the metric system is in universal use, except in the United States, the British Empire and Russia. These reports show that in no country investigated is the system universal.

The fourth theory is that we must adopt the metric system if we are to succeed in selling goods to Spanish America. These reports show that if we are to change our weights and

me[illegible] order to conform to the practice of Spanish America, we should adopt the Spanish and not the metric system.

The fifth theory is that the "adoption" of the metric system leads to an important saving of time in primary education. Clearly, with a mixture of systems in use, children have more and not less to learn.

The sixth theory is that the adoption of the metric system leads to a saving of time in calculations. Clearly, with this mixture of systems in use, involving the constant necessity for conversions between them, the labor of calculations is increased and not reduced. For example, consider the purchase at wholesale by the meter and the sale at retail by the vara.

The seventh theory is that the persistence of old units in metric countries is a persistence of names but not of things — that the practice is nothing more than the use of old names for new units. One of the most recent formal statements of this theory is by Dr. William C. Wells, Chief Statistician of the Pan American Union, who says (*Bulletin* of the Pan-American Union, January 1917):

"It has been found somewhat difficult in countries adopting the metric scale to do away with the names of the most-used measures such as yards, quarts, pounds, miles, etc., or rather of the equivalents of those English words in the language of the country adopting the metric system. . . . It has been found very easy to substitute the thing, although sometimes difficult to substitute the word. . . . Scarcely a vestige of the old system is left in any country that adopted the metric system. Now and then in Latin-American countries one will hear the old words, but almost always with a meaning adapted to the new scale."

These replies are sprinkled with such expressions as these: "Same as in the United States." "English sizes." "For distance, the English mile." "English and metric system." "French and American indiscriminately." "Thickness of lumber is always in English inches." "Metric system infrequently." "The two standards are used indiscriminately." "The meter is used very little." "The artisans of the country use in their calculations the Spanish vara as their standard." "Our standard of weight is the quintal of 100 Spanish pounds." "The people continue to use the old Spanish measures." "At retail, vara; at wholesale, yard, meter." "While the metric system is legal it is not enforced." "In domestic business, only the Spanish system is used." "A few French articles are in metric sizes." "The cuadra is still commonly used, but is prohibited in the documents." "The English measures prevail." "Generally the English foot, exceptionally the meter." "The old Brazilian system is still commonly used." "Cloths are sold indiscriminately by meters, varas and yards." "Occasionally the metric ton." "The metric measurements are sometimes used."

Such expressions as the above, of which there are many more, cannot be thus explained.

Many of these reports *give values of the Spanish in terms of metric and English units* which show that the old names are not used for the new units, as for example:

From Costa Rica: Vara, 0.836 meter; libra, 460 grams; cuartillo, 1.165 liters; botella, 0.67 liter; manzana, 6988 square meters.

From Argentina: Vara, 0.866 meter; pie, 0.289 meter; libra, 0.4594 kilogram; tonelada, 918.8 kilograms.

From Nicaragua: Vara, 33 inches; libra, 16 onzas; fanega, 288 libras; manzana, 10,000 square varas.

Not one of all of these hundreds of sheets contains a single item to substantiate the theory advanced by Dr. Wells. No proof of it has ever been offered; it is clearly untenable and must be dismissed.

The eighth theory is that we will use metric equivalents for English sizes, or, as the metric party put it, "Whatever is manufactured must be actually the same size or weight as before. It is merely a matter of a new term of expression." Nothing to justify this theory can be found in these papers, no single example of this practice being found therein. Articles manufactured to the inch (wearing apparel, pipe, lumber, etc.) are uniformly sold by the units to which they were made.

The Result of a Great Series of Experiments

We have in this Report a composite picture of the result of many attempts to adopt the metric system, that result being uniformly the addition of that system to those previously prevailing, and it is this that we must contemplate as the result of the attempt to adopt it here. We must compare what we have with what we will get, not with what one may hope we will get. Moreover, it must be noted that had all these countries succeeded in this great experiment, it would have no significance for our guidance, because of the greater importance of our manufacturing industries. France adopted the system before the beginning of the manufacturing era, and Germany adopted it before the development of manufacturing in that country. Every one knows that the rise of Germany as a manufacturing nation began after the war of 1870. South American countries are not manufacturing countries. More manufacturing is done in the city of Philadelphia than in all South America.

We see, then, that in western Europe the system was adopted before the development of manufacturing and that manufacturing has developed with and in it, while in South America practically no manufacturing is carried on.

Great Britain and we are the first to be asked to change our manufacturing units, for which there is not a shadow of a precedent.

Seldom has an effort of such magnitude been made. We have here a record of twenty experiments on a national or, collectively, a continental, scale, and their net result is to demonstrate the wisdom of the conclusion arrived at by John Quincy Adams after four years of investigation and nearly a century ago:

"The substitution of an entire new system of weights and measures instead of one long established and in general use, is one of the most arduous exercises of legislative authority. There is, indeed, no difficulty in enacting and promulgating the law, but the difficulties of carrying it into execution are always great and have often proved insuperable.

"The legislator . . . finishes by increasing the diversities which it was his intention to abolish, and by loading his statute books only with the impotence of authority and the uniformity of confusion."

It is to protect our country from this "uniformity of confusion" that we are fighting.

The Results Are Not Surprising

Some who read this Report will, no doubt, be surprised at the condition disclosed in Spanish and Portuguese America, but there is no reason why any one should be surprised as no one has seen the first scintilla of proof to the contrary. Assertions and assumptions have been repeated so many times that, no doubt, in some cases, they have been accepted as true, but no proof has been presented and there is no proof. On the contrary, those who know weights and measures, who know the gigantic character of the task which confronts any nation

which sets out to change them, know that the inherent probabilities are all in favor of the condition set forth.

Do not confound legislation for the adoption of the metric system with its real adoption. All experience shows that while such legislation is fatally easy, the adoption of the system is impossible, the effect of the laws being to bring about nothing but the confusion and disorder that prevail throughout Latin America. Every success in the attempt to persuade some interest to introduce the system is but a step toward the confusion that prevails throughout Latin America. We have there twenty countries in which the experiment has been made with the uniform result of grotesque failure. Every expectation has been falsified and every prediction inverted. Shall we take warning, or shall we plunge headlong into this metric morass?

APPENDIX

Form of Letter Which Accompanied the Questionnaires

My Dear Sir:

The American Institute of Weights and Measures, which is composed of many of the leading engineers and manufacturers of this country, is engaged in an extended investigation of the subject of weights and measures, and it desires to obtain at first hand definite information regarding the units of weight and measure (Spanish, metric, and English) as applied to the trade, commerce and industry of South and Central America. With this in view, the accompanying list of questions has been drawn to which we ask you to kindly reply for your locality.

The thorough character of the investigation which this Institute is undertaking will, we hope, impress you with the importance of this questionnaire, since, when all the replies are assembled, they will constitute a mass of information which is not now in existence.

It is particularly desired that answers shall be forthcoming from the smaller towns of the interior as well as from the principal cities of Latin America AND FROM INDUSTRIES AS WELL AS COMMERCE in order that the usage of weights and measures among the people may be learned. To this end we ask you to kindly make inquiry among contractors, builders, manufacturers, and, if necessary, among artisans.

Please distinguish carefully, when necessary, between the metric and English tons, between the half-kilogram and the Spanish and English pounds, the Spanish and metric quintals, and the Spanish pulgada and the English inch. When two or more units are used for the same purpose, please name them in the order of their frequency. When one unit is chiefly used, please place after it the word "Chiefly" and similarly, when one of the units is used but seldom, kindly place after it the word "Infrequent."

Your reply, esteemed sir, will place us under lasting obligations which we trust we will at some future time have the pleasure and satisfaction of discharging. In the meantime, we beg to subscribe ourselves with every consideration of respect and esteem.

Most cordially yours,

American Institute of Weights and Measures,

.... *Commissioner.*

Questionnaire No. 1

What are the units of weight and measure commonly used with relation to the buying and selling at retail of the following products?

Groceries	Flour
Fruits	Tea and coffee
Milk, butter and cheese	Dry goods
Other farm products	Fuel
Hardware	Tobacco
Fish	Miscellaneous
Meat	

Questionnaire No. 2

What are the units of measure commonly used with relation to buying and selling articles of clothing, as follows?

Ready-made clothing	Shoes
Hats	Gloves
Collars	Corsets
Underwear and hosiery	Miscellaneous

Questionnaire No. 3

What are the units of measure commonly used with relation to the sale of lands and filing of papers and deeds, as follows?

In the farming districts
In the smaller towns
In the cities

Questionnaire No. 4

What are the units of weight and measure commonly used in the following industries?

Lumber and timber (length and thickness of boards and sizes of timbers)
By carpenters and other woodworkers
By tailors and seamstresses
By blacksmiths
In machine shops
In contracts for excavation of ground
In mines and for mineral products.
In smelting and for smelter products
Sizes of pipes for gas, water, sewers, etc.
In ship and boat building
Marine measurements (distances, maps, charts, tonnage, drafts, freight rates, etc.)
Miscellaneous

Questionnaire No. 5

What are the units of weight and measure commonly used with relation to the buying and selling of farm products at wholesale as follows?

Hay	Milk, butter and cheese
Grain	Garden products
Meat	Rubber
Root crops	Miscellaneous
Coffee	

Questionnaire No. 6

What are the units of weight and measure commonly used with relation to transportation tariffs?

Railway tariff for passengers and freight (load and distance)
Loads and rates for city transportation
Loads and rates for transportation by muleback across the mountains
Railway track gages and length of lines
Railway equipment (units used in the construction and repairing of locomotives, cars, etc.)

The Hill Publishing Company's questionnaire was considerably abbreviated from the above.

REPLIES TO THE QUESTIONNAIRES

In the complete report are summarized in great detail the replies to the questionnaires as received from the following countries: Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, Guatemala, Haiti, Mexico, Nicaragua, Panama, Peru, Porto Rico, San Salvador, Spanish Honduras, Uruguay, Venezuela. As typical of the replies, the summary of the replies from the largest country, Brazil, is here given:

BRAZIL

(Summary of thirty-seven returned questionnaires)

Groceries: Liter, kilogram, gallao, arroba, gram. *Fruits:* Kilogram, arroba, alqueire; conserves in ½-kilo cans. *Milk:* Liter, garrafa of ⅔ liter. *Butter and Cheese:* Kilogram, libra; butter in packages of ½, 1 and 7 pounds and ¼, ½, 1, and 3 kilograms. *Other Farm Products:* Cargueire, quarta, kilogram, metric pound, liter, arroba. *Hardware:* Inch, kilogram, meter, centimeter, millimeter, metric ton, liter (*sic*). "Use all measures." *Fish:* Kilogram. *Meat:* Kilogram, liter (*sic*); arroba. *Flour:* Liter, kilogram, alqueire. *Tea and Coffee:* Tea in cans of ¼, ½, 1 and 5 English pounds and by kilogram; coffee, kilogram.

Dry Goods: Meter, jarda, covado.

Fuel: Wood, cubic meter, carroca, cargneire; coal, metric ton, kilogram; oil, kilogram and liter.

Tobacco: Kilogram, meter, arroba; fine tobacco, onca.

Ready-Made Clothing: Centimeter, meter. *Hats:* Brazilian, English, Italian and Portuguese numbers, centimeter, inch, meter (*sic*). *Collars:* Centimeter, meter (*sic*). *Underwear and Hosiery:* Underwear, centimeter; hosiery, inch, centimeter, meter. *Shoes:* Centimeter, numbered sizes by no apparent system, English, Portuguese, meter (*sic*). *Gloves:* Letter sizes, numbered sizes by no apparent system, centimeter, inch. *Corsets:* Centimeter, meter (*sic*).

For the Measurement of Land: In the farm districts — meter, square meter, alqueire, hectare, legua, braca, are, palmo, pollegada (sic), paulista, front foot, tarefa. "For agricultural lands or open lands in general the division is almost universally into alqueires." "The old Brazilian legua is generally used." "The standard throughout the State is the alqueire." In the smaller towns — braca, alqueire, square meter, tarefa, vara, hectare, palmo, front meter, are, pollegada (*sic*). In cities — meter, square meter, braca, are, palmo, pollegada (*sic*), hectare.

Lumber and Timber: Palmo, foot, inch, pie, pollegada, meter and palmo for length, square foot, cubic meter, centimeter. "Thickness of lumber always in English inches. Width in English inch by the lumber company, and Portuguese inch by others. The lengths in feet by the lumber company and Portuguese inches by others."

By Carpenters and Other Woodworkers: Meter, inch, foot, palmo, pollegada, centimeter. *By Stone and Brick Masons:* Meter, cubic meter, square meter, pollegada, centimeter, palmo. *By Tailors and Seamstresses:* Meter, centimeter.

In Machine Shops: Meter, foot, inch, palmo, kilogram, metric ton, gram, liter (*sic*). "The metric system was established by law under the Empire as the only official system. The English system, especially for metal work, is very popular."

In Contracts for Excavation of Ground: Cubic meter, palmo, braca. *In Mines and for Mining Products:* Meter, cubic meter, metric ton, kilogram, gram, oitavo, carat. *In Smelting and for Smelter Products:* Cubic meter, metric ton, inch (*sic*), centimeter (*sic*), kilogram, gram. *Sizes of Pipe for Gas, Water, Sewers, Etc.:* Inch, centimeter, meter for length. "English system chiefly, metric system infrequently." For the measurement of earthen pipes, the internal diameter is usually given in inches. Metal tubing for gas and water is measured by weight, per kilogram. Diameters are usually measured in inches and lengths in meters." "The English measures prevail."

In Ship and Boat Building: Meter, yard, foot, inch. "Generally the English foot; exceptionally the meter." *Marine Measurements:* Marine mile, foot for harbor charts, meter; freight by metric ton, cubic meter, kilogram; depths in meters or feet; knot, league. "English mile for distance; English foot for drafts." "English system." "The nautical mile is most commonly employed; Lloyd's registry is used in calculating tonnage." "Distances, English mile; tonnage, English ton; draft, English foot."

Hay at Wholesale: Arroba, kilogram. *Grain at Wholesale:* Liter, kilogram, prato, cargueiro quarta, alqueire, arroba. *Meat at Wholesale:* Kilogram, arroba. *Root Crops at Wholesale:* Kilogram, arroba, amarrado, metric ton. *Coffee at Wholesale:* Kilogram, arroba. *Milk at Wholesale:* Liter. *Butter and Cheese at Wholesale:* Kilogram, libra, jaca, arroba. *Garden Products at Wholesale:* Liter, kilogram. *Rubber at Wholesale:* Kilogram, arroba.

Railway Tariff for Passengers and Freight (Load and Distance): Kilometer, metric ton, cubic meter. *Loads and Rates for City Transportation:* Kilometer, tonelada, cubic meter, arroba, metric ton, kilogram. *Railway Track Gages and Length of Lines:* Meter, kilometer, centimeter. *Railway Equipment (units used in the construction and repairing of locomotives, coaches, etc.):* Inch, foot, kilogram, meter. "Weight, kilo; measure, English inch."

"The official system of weights and measures, etc., is the metric system. However, the old Brazilian system is still commonly used." According to the Report to the International High Commission on the Metric System in Export Trade, the metric system is "obligatory" in Brazil.

Brazil "adopted" the metric system in 1862.

VALVES AND FITTINGS FOR HIGH HYDRAULIC PRESSURES

Their Design and Maintenance in Operation for Pressures of from 1000 to 8000 Lb. per Sq. In.

BY WM. W. GAYLORD,[1] TORRINGTON, CONN.

With the greater use of hydraulic machines of various sorts as the result of the large manufacture of munitions, a greater interest is to be expected in the design of valves and fittings for such machines. This paper gives the results of my experience, and I have written it largely in the hope that others may be led to publish the results of theirs.

A few years ago when the problem was presented to me of designing a new hydraulic system for a working pressure of 5000 lb. per sq. in., with the probability that this would be increased to 7500 lb. per sq. in., I found there had been very little published on the design of valves and fittings for this pressure, and that the designing formulæ given in standard handbooks were either incorrect or unsatisfactory. The formula most generally given was that of Lamé, based on the maximum-stress theory, which, while correct for cast iron, is not satisfactory for steel. Lanza, in his Applied Mechanics, gives a modification of the Grashof formula based on the maximum-strain theory which I had used before with fair results for steel fittings on lower pressures. I had, however, noticed some unaccountable failures when applied to pipe and fittings using a working pressure of 4000 to 4500 lb. per sq. in.

While studying these failures my attention was called to the maximum-shear theory proposed by Guest, and this seemed to explain most of them. About this time the results of the experiments of Cook and Robertson were published in *Engineering*, December 15, 1911, and after considerable study I became convinced that these offered the best basis for design.

The form in which they give the formula for fiber stress, based on the maximum-shear theory, is

$$\frac{P}{f} = \frac{K^2 - 1}{2K^2}$$

where P is the internal pressure in pounds per square inch, f the fiber stress, and K the ratio of external to internal diameter. This is the equivalent of the usual formula

$$f = P\frac{2}{1 - \dfrac{d_0^2}{d_1^2}}$$

where d_0 is the internal diameter, and d_1 the external diameter.

The results of their experiments show that if a factor of 1.2 were introduced the equation would more nearly represent the actual results, so the formula suggested by them becomes

$$\frac{P}{f} = 1.2\frac{K^2 - 1}{2K^2}$$

By substituting $\dfrac{r + t}{r}$ for K in this formula, the thickness t of cylinder wall of a cylinder of inside radius r becomes

$$t = -r \pm \sqrt{\frac{Pr^2}{0.6f - P} + r^2}$$

From this formula it is apparent that a material having a working fiber stress of 12,500 lb. per sq. in. or less would not be safe however thick the pipe wall. This, of course, eliminates

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For presentation at the Annual Meeting, New York, December 3 to 6, 1918, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. The paper is here printed in abstract form and advance copies of the complete paper may be obtained by members gratis upon application. All papers are subject to revision.

bronze, cast iron and semi-steel as materials for making these fittings. After careful consideration of the materials available it was found that cold-drawn seamless steel pipe annealed to give 45,000 lb. per sq. in. elastic limit, and steel castings for fittings giving 30,000 to 35,000 lb. per sq. in. elastic limit, could be obtained, and it was decided to use these.

As the system had no accumulator and therefore was not subjected to severe shocks, a working fiber stress of 0.6 of the elastic limit was used.

The largest pipe in the system was to take the discharge of five pumps, each of 60 gal. per min. capacity, making a maximum flow of 300 gal. per min., but most of the time only three pumps or 180 gal. would be used. In view of this a maximum velocity of 20 ft. per sec. or a usual velocity of 12 ft. per sec. was allowed which required a pipe of 2¾ in. inside diameter. From the above formula the thickness required for a pipe of 2¾ in. inside diameter is

$$t = -1.375 \pm \sqrt{\frac{7500 \times \overline{1.375}^2 \times 2}{0.6 \times 27000 - 7500} + \overline{1.375}^2}$$

$$= -1.375 \pm \sqrt{\frac{28360}{17400} + 1.891} = -1.375 \pm 1.876$$

$$= 0.51 \text{ in.}$$

and for a fitting

$$t = -1.375 \pm \sqrt{\frac{7500 \times \overline{1.375}^2}{.6 \times 19500 - 7500} + \overline{1.375}^2}$$

$$= -1.375 \pm \sqrt{\frac{28360}{8400} + 1.891} = 0.925 \text{ in.}$$

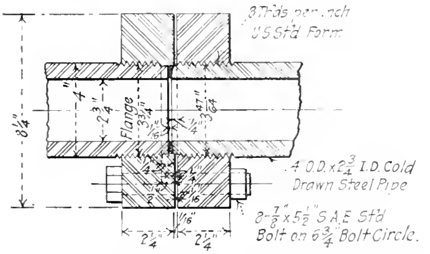

Fig. 1 Typical Flanged Joint for 7500 Lb. per Sq. In.

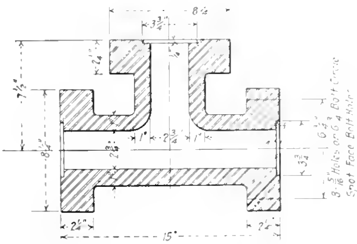

Fig. 2 Typical Flanged Fitting for 7500 Lb. per Sq. In.

A pipe having 4 in. outside and 2¾ in. inside diameters was chosen, as this was a commercial size and allowed the necessary thickness of metal for threading to use in a joint of the type shown in Fig. 1. The fittings were made with a 1 in. wall thickness, the tee shown in Fig. 2 being an example of the type used.

The bolting of the flange was figured by assuming that the full pressure was applied to the area of a circle of the outside diameter of the gasket. In the joint in Fig. 1 this would make a total load on the bolts of $(1.875)^2 \times 3.142 \times 7500 =$ 83,150 lb., which would require eight 1⅜-in. bolts if U. S. standard bolts were used, allowing a working fiber stress of 10,000 lb. per sq. in. This would have taken a flange about 11 in. in diameter and would have made the piping very hard to install in the limited space available, so it was decided to use bolts made to the S. A. E. or, as it was then known, the A. L. A. M. standard. Using a working stress of 22,500 lb. per sq. in., this allowed the use of eight ⅞-in. bolts in an 8¼-in. flange. This is open to the objection that a careless mechanic may replace these special bolts with standard bolts and thus cause the failure of the joint, but there has been no trouble from this cause.

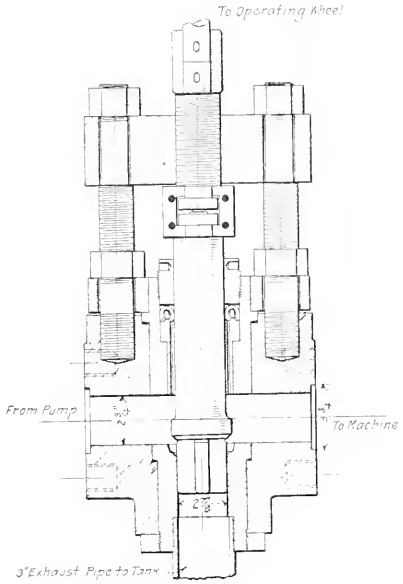

Fig. 3 Operating Valve for 7500 Lb. per Sq. In.

When the piping was installed, some of the gaskets were of soft copper and the rest of red fiber, but experience has shown red fiber to be more satisfactory as the copper soon hardens and a slight water hammer will often start the joints leaking, while the red fiber does not give this trouble.

The system was to supply three machines from a group of five pumps, and the piping was to be so arranged that the large machine, which was to use pressures up to 7500 lb. per sq. in., could be operated with any or all of the pumps while the other two machines were to be operated with one or two pumps each, but the connections were to be so made that any pump could be connected to any machine. This was done by using a manifold tee on the discharge of each pump with a valve connecting to each pipe line.

The valves originally put in were of two types: one a wedge gate valve with cast-steel body and hard bronze wedge, the other a stop valve of the balanced type having cast-steel body and bronze plunger. The gate valves proved impracticable as the bodies could not be made sufficiently rigid to prevent distortion of the seat and the starting of a leak which would

grow very rapidly because of the cutting action of the water. The other valves were more satisfactory and could be kept fairly tight by frequently dressing the seat and plug; but it was found more satisfactory to use blank flanges and pipe spools in place of the valves to make necessary changes in connections.

The machines were in effect single-acting presses in which the ram was returned by an auxiliary low-pressure system. The main operating valve therefore became a bypass valve which was closed to drive the ram forward and opened to allow the ram to stop and be returned. The valve in Fig. 3 was chosen for this place and was first made without the loose connection shown in the stem, but it was found very hard to open it after it had been shut tight, so the connection was added and this difficulty overcome. Experience had shown that the rather difficult to build, it has proved very satisfactory.

On a smaller press having three double-acting cylinders designed to operate in regular sequence, a multiple valve of the semi-balanced spring-closed type was used, having the individual valves opened by bell-crank levers moved by face cams mounted on a common shaft. The cams were so arranged that rotation in one direction would cause the cylinders to operate in the proper order. The valve was so designed that when open the area through the seat was greater than around the stem.

In designing valves and fittings for service on accumulator systems I have found that it is usually the severity of the water hammer rather than the actual pressure that determines the strength required and that in laying out such a system all possible care should be used to avoid trouble from this source.

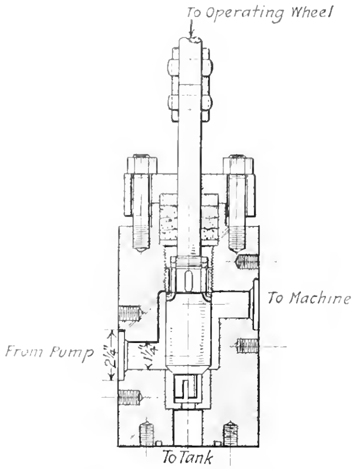

FIG. 4 OPERATING VALVE FOR 5000 LB. PER SQ. IN.

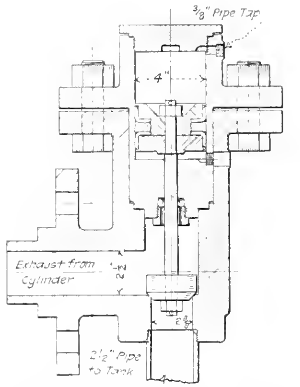

FIG. 5 CAST-STEEL EXHAUST VALVE USED TO REPLACE VALVE IN FIG. 6

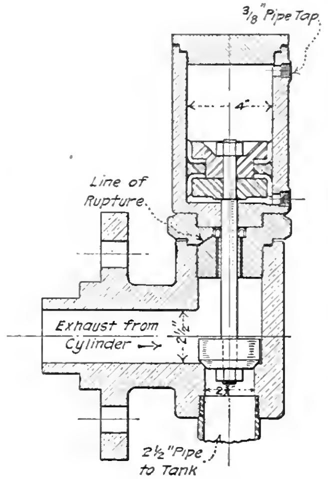

FIG. 6 EXHAUST VALVE FOR 5000 LB. PER SQ. IN.

form of seat used with the beveled recess for the plug would last much longer than if the valve had a flat seat.

This system has been in use five years, often with a working pressure of 8000 lb. per sq. in. for short periods, with no failures, and with the exception of the valves mentioned has given good satisfaction.

On two similar systems more recently installed for operating pressures of from 4000 to 5000 lb. per sq. in. the same type of pipe and fittings has also been used with success. The operating valves furnished for these systems were made as shown in Fig. 4 and proved unsatisfactory, as the water pressure on top of the plug held the valve closed so that it was almost impossible to open it. These were replaced by valves similar to Fig. 3, which are working satisfactorily.

These machines had an exhaust valve as shown in Fig. 6 which returned the water direct from the main cylinder to the tank on the return stroke of the ram. These gave much trouble by the intermediate piece between the valve body and operating cylinder breaking through as indicated. This in two cases blew the operating cylinder entirely off the valve body. Two of the valve bodies also failed by splitting. In view of this and the fact that a leakage through the U-leather packing might also blow the operating cylinder off, it was decided to redesign this valve, using a cast-steel body and cylinder arranged to eliminate these faults. Fig. 5 shows this valve, and although it is

However, as the severity of water hammer in a new system can never be exactly determined before it is in operation, I have used the designing formula given in the first part of this paper, with a working fiber stress of one-third to one-half the elastic limit of the materials employed, depending on the probable severity of shock from this cause. This I have attempted to check by figuring the rise of pressure to be expected due to the inertia of the moving parts of the accumulator if all operating valves should be closed at the same time. This is done by assuming the ram of the accumulator to be coming down with a maximum velocity and figuring the force necessary to cause a negative acceleration sufficient to stop it in an assumed minimum time of closing the valves. This at best can only be a rough check but has proved sufficient in several cases. The piping should be so supported and anchored that water hammer will not cause any considerable whip, as this is the usual cause of broken fittings and leaking joints.

The valve most used to control single-cylinder machines like draw benches on an accumulator system is a combined throttle and reversing valve, while the valves for multi-cylinder machines are too numerous and complex to describe in this paper; but the principles used in their design are the same as for the valve already described, except that greater care must be exercised to prevent too rapid opening and closing and consequent destructive water hammer.

ENGINEERING SURVEY

A Review of Progress and Attainment in Mechanical Engineering and Related Fields, Including Abstracts of Articles in Current Technical Periodicals

Italy to Have Aerial Laws

THE Italian Government has just completed the draft of a series of laws covering aerial navigation. First of all, the law fixes the technical names to be used in designating the more important aspects of aerial navigation. All aircraft, whether airplanes or dirigibles, will be known under the general name of aeromobiles. Aeriat ports will be the name applied to the regular places for landing and departing, while refuge ports will be the name applied to those landing places where the aerial craft can put in in case of accident.

The law provides that regular aerial ports are to be equipped with very much the same facilities as are to be found in any great seaport for the landing, unloading, repairing and taking on of cargoes.

Special articles provide for what an aeromobile must do if obliged to land in other than a regular or refnge aerial port.

Special provisions govern the zones of altitudes in which the aeromobiles must navigate to prevent collisions and other accidents.

For reasons of national defence, there is an article prohibiting aeromobiles from flying over forts and other military and naval defences. The proposed laws would prohibit transportation by aeromobiles of inflammable matter, explosives and other kinds of merchandise that might endanger the aircraft and other property in case of accident.

Other articles provide that all aeromobiles must be registered in the national registry of aircraft; that each aeromobile must have a government certificate of its navigability: that there mnst be officers of recognized competency aboard, and that each aircraft must carry certain official documents.

The proposed code, in all probability, will be made law at the coming session of Parliament. (*The Evening Sun*, New York, Oct. 4, 1918, p. 20)

New German Textile Substitutes

In THE JOURNAL for July (p. 581) reference was made to a German textile substitute, a wood-pulp fiber called "cellulon." Further information regarding this and other substitutes is given below.

Paper yarn, which has been used in the manufacture of sacks, carpets, beltings, and like articles not washable and of a coarse fabric, has not yet been found suitable for clothing. From cellulon, however, a yarn is obtained somewhat better than paper yarn, but still not fitted for anything but coarse fabrics.

Another product, "Stapelfaser," seems to promise better results. In the manufacture of paper yarn the cellulose fiber is cut off when the paper is cut into strips for the spinning machines. Efforts are now being made to secure longer fibers from cellulose. In the manufacture of Stapelfaser the cellulose treated with certain chemicals is dissolved to a jelly-like mass, which is pressed through very fine strainers, thus producing fine fibers. These fibers are then twined together into coarser threads. The thread is rolled up and cut into pieces from 4 to 5 cm. (= 1.57 in. to 1.97 in.), which are put through a drying process, during which the fibers part from each other, leaving sufficiently long and fine threads. This method of manufacture is somewhat similar to the one used in the manufacture of artificial silk.

Stapelfaser is claimed to replace cotton and wool, except that it is not as washable. It may be washed, but when wet must not be pulled. As soon as dry it is just as good as before. However, if, when weaving, a small portion of wool or cotton is inserted, a full washable fabric is obtained.

The above facts are from the *Frankfurter Zeitung*, which journal, however, claims that the textile question is not yet fully solved. It states that the production of clothes from Stapelfaser has already been started at several factories in Germany, but that the products have been taken by the military authorities for the needs of the army. Even if the method is technically finished, production is dependent upon the supply of raw materials and mainly chemicals. Both the raw materials and the chemicals necessary are available in Germany, but not in sufficient quantities.

The Textile-Industrie A. B., in Barmen, has succeeded in obtaining a product from cellulose yarn which, without any dressing, can replace leather and from which shoes are said to have been successfully made. (*Commerce Reports*, no. 233, Sept. 23, 1918, p. 1114)

War Department Committee on Education and Special Training

The Committee on Education and Special Training of the War Department has issued a special bulletin on programs in engineering which is intended to indicate how existing courses at schools may be modified by eliminations and condensations so as to meet the needs of the present emergency.

A significant feature of the programs is the inclusion of the subject of war issues in two terms. The approved course in mechanical engineering is as follows:

MECHANICAL ENGINEERING

	Hours per week
1ST TERM	
Mathematics	12
Drawing and Descriptive Geometry	9
Chemistry	12
War Issues and English Composition	9
2D TERM	
Mechanism	9
Mathematics	12
Chemistry	12
War Issues and English Composition	9
3D TERM	
Mechanism and M. E. Drawing	10
Mathematics	12
Physics	14
Shopwork	4
Surveying, Map Reading and Topographical Drawing	7
4TH TERM	
Applied Mechanics	12
Mathematics	12
M. E. Drawing	5
Physics	14
Shopwork	4
5TH TERM	
Heat Engineering and Eng. Lab.	15
Electrical Engineering	10
Applied Mechanics	12
Machine Drawing	6
Shopwork	4
6TH TERM	
Heat Engineering and Eng. Lab.	15
Hydraulics	11
Applied Mechanics	10
Electrical Eng. Lab.	7
Shopwork	4
7TH TERM	
Materials of Engineering and Testing Materials Lab.	12
Mechanism of Machines	5
Machine Design	10
Applied Mechanics	10
Refrigeration	2
Engineering Lab.	4
Shopwork	4
8TH TERM	
Power-Plant Design	5
Industrial Plants, including Heating and Ventilation	16
Mechanics of Engineering	7
Engineering Lab.	10
Gas Motors or Heat Treatment	5
Shopwork	4

Shipyards and Shipways

When the present Shipping Board began its work, in August 1917, there were only 61 shipyards in the United States. There were 37 steel shipyards with 162 ways. About three-quarters of their capacity had been preëmpted by the naval-construction program, while private orders overflowed the remaining ways. In the 24 wood shipyards there were only 73 ways.

The largest shipyards in the world in September 1918 are those of the United States. The Clyde River, in Scotland, historically famous as the greatest of all shipbuilding localities, is already surpassed by two shipbuilding districts on the Atlantic coast and by two on the Pacific coast—by Delaware River and Newark Bay in the East and by Oakland Harbor and Puget Sound in the West. One yard, Hog Island, on the Delaware, is equipped to produce more tonnage annually than the output of all the shipyards of the United Kingdom in any pre-war year. It has 50 ways.

There are now 203 shipyards in the United States. The list comprises 77 steel, 117 wood, 2 composite and 7 concrete shipyards. Of these, 155 are completed, 35 more than half completed, and only 13 less than half completed. The great plant at Hog Island is 95 per cent completed—built in one year on a site formerly a swampy marsh.

Every month of the past year has added to the number of American shipways, until today the impressive total is 1020—more than double the total of shipways in all the rest of the world. Of the 927 shipways that are for the Emergency Fleet Corporation of the Shipping Board, 810 are listed today as completed, and only 117 are to be added. There are 410 completed ways for the construction of steel ships, 400 completed ways for the construction of wood, composite and concrete ships. (*Shipping Facts*, issued by U. S. Shipping Board)

Fourth National Exposition of Chemical Industries

The Fourth National Exposition of Chemical Industries, Grand Central Palace, New York, September 23 to 28, 1918, was signalized by the gathering of a notable body of men engaged in the various industrial applications of chemistry. Various addresses were made comprising a series of symposiums devoted to the consideration of the development of the chemical industries in the United States, notably since July 1914.

Tons of machinery and material were exhibited, transported in spite of present war difficulties, which tangibly attested America's approach to chemical leadership. The achievements in the production of dyestuffs and explosives and acids; the independence of the potash industry, of vital importance to the United States; the wonderfully encouraging and typically American progress of the ceramic industries; the new achievements in metals and alloys in which we have long held high rank; and the growing importance of organic chemistry in the arts and industries, were abundantly evidenced by the varieties of new devices and methods exhibited.

The Chemical Warfare Service of the United States Army displayed the developments in chemical warfare. Originals and photographs of various types of masks were shown. The new American type was also displayed, and its future use in mines was clearly indicated. Offensive gas warfare was represented by specimens of shells and grenades of many sorts. They are designed for the various different types—sneeze, mustard, lethal, phosphorus (for incendiary work and to produce white smoke) and others. An oval form of shell was shown that may fall into any position without becoming a "dud"—a shell that fails to explode.

Copies of rules and general orders relating to chemists and engineers in essential industries and providing for the allocation of enlisted men were distributed by the chemical-warfare exhibit.

New York Section of American Society of Refrigerating Engineers

At the meeting of the New York Section of the American Society of Refrigerating Engineers, held on September 18 at Machinery Club, New York, Charles N. Neeson gave an informal talk on his experience with electrically operated high-speed refrigerating machines. He stated that these machines are started much quicker and easier when the bypass as well as the suction and discharge valves are closed, especially when the back pressure is high. It is necessary to shut the discharge valves when starting on account of leakage through other valves. With the introduction of the high-speed ammonia compressor, the selection of proper valves giving large clearance to the compressors is essential for the successful operation of the machines. In the plant of Mr. Neeson's company, with 18 cans per ton of ice, 35 kw-hr. per ton was achieved, and for the summer conditions, 22 kw-hr. per ton. With a cooling-tower plant 32 kw-hr. per ton was had, and for summer conditions, 12 cans per ton, 60 kw-hr. per ton of ice. The compressors have center ports and the indicator diagrams showed a 5-lb. drop in the suction pressure, with 20 lb. excess above the head pressure at the end of compression. There was about 25 per cent reëxpansion with the high head pressure.

F. L. Fairbanks said that on the whole the tendency was to give high-speed compressors too little total valve area. There is a tendency on the part of the operator to make plate and feather valves give from two to four years' service, whereas a feather or a plate valve should be changed every six months to avoid serious recesses in the valve seats. In reference to the effect of inertia of the reciprocating parts, Mr. Fairbanks said that with his 1000-ton compressor, which has a 24-in. shaft, 28 ft. long, running at 45 r.p.m., the machine could be run with the caps and quarter-boxes out of the bearing, but at 50 r.p.m. the 150-ton shaft was lifted off the bottom bearings owing to the inertia of the pistons and other reciprocating parts.

The meeting manifested an anxious interest in the question of flywheel effect for high-speed compressors, and particularly for the compound type driven with synchronous motors. Experience seems to show that where there are a number of these machines in one plant, any one running singly gives no trouble in the way of regulation, but when two or more of appreciably different capacities are in parallel, considerable trouble is experienced in regulation. (From account of the meeting given in *Power*, October 1, 1918)

Western Society of Engineers

A meeting of the Western Society of Engineers was held in Chicago on September 23, under the auspices of the hydraulic, sanitary and municipal section. W. G. Edens, President of the Illinois Highway Improvement Association, in a paper on Illinois roads, explained the need for improved highways and, referring to the proposed $60,000,000 bond issue to be voted on November 5, he laid stress on the part engineers can play in promoting this program for after-the-war work, as under the terms of the proposed issue the bonds are not to be sold until after the war.

REVIEW OF ENGINEERING PERIODICALS

SUBJECTS OF THIS MONTH'S ABSTRACTS

For Articles on Subjects Relating to the War, see Engineering Materials, Machine Parts, Marine Engineering, Refrigeration, Testing

Engineering Materials

The Effect of Cold Work on Copper, W. E. Alkins. An investigation to determine whether any quantitative relationship exists between the amount of cold work done upon the metal and the magnitude of the change in its properties.

In particular, an account is given of an inquiry into the change in tensile strength of copper in the form of wire as it is progressively hardened by cold drawing in the ordinary way.

Copper was chosen as the experimental material for three reasons: (1) It appeared to afford an example of a simple metallic system which is supposed to undergo no definite thermal change between its melting point and the ordinary temperature (though an allotropic modification of copper with the transition point at about 70 deg. cent. is claimed to exist by Cohen); (2) copper shows the hardening by plastic deformation very well; and finally, in this particular instance, it was most readily obtainable by the author in the required form and of superior purity, in particular, 99.92 copper with the remainder consisting of oxygen with a smaller amount of arsenic.

The author gives a brief discussion of the previous work by Thomas Bolton, A. P. Trotter and D. R. Pye. Of these Trotter concluded that there was a linear relation between the tensile strength and the diameter, and suggested that the tensile strength might be expressed by a formula of the type

$$T = a - bD$$

where T is tensile strength in tons per sq. in., D diameter in inches, and a and b are constants.

The method of carrying out the tests and taking the various measurements is described briefly and the results given in the form of tables and curves. The results of tensile tests give a smooth curve for the tensile strength against diameter of sectional area, but at the same time show conclusively that the effect of a certain amount of cold work at any stage is intimately connected with the previous history of the metal.

From this point of view the curve of Fig. 1 is of interest. This curve showing the variation of tensile strength with sectional area consists of two rectilinear portions, AV, CD, connected by a smooth curve BEC. This curved portion shows only a point of inflection at E, and not a maximum and minimum.

The portion AB corresponds to the equation:

$$T = 31.6 - 67A$$

where T = tensile strength in tons per sq. in;
A = cross-sectional area in sq. in.

The upper rectilinear branch CD corresponds to the equation:

$$T = 30.83 - 82.66A$$

The curved portion BEC agrees very closely with the expression:

$$T = 23.2 - \sqrt{A - 0.107}$$

but while the form of this portion is of the first importance,

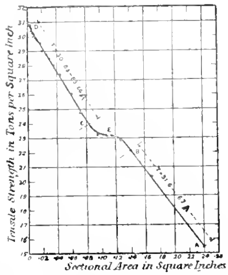

Fig. 1 Curve Showing Variation of Tensile Strength with Sectional Area

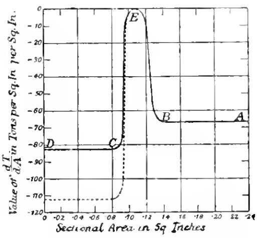

Fig. 2 Curve of Differential of Curve of Fig. 1 with Respect to Cross-Sectional Area

the corresponding mathematical function is only of secondary interest.

Significance of the Curve of Fig. 1. Differentiating the curve of Fig. 1 with respect to area (A), we have:

Over the portion AB, $\frac{dT}{dA} = -67$; from B to E the value of $\frac{dT}{dA}$ changes from -67 at B to 0 at E; from E to C the value of $\frac{dT}{dA}$ diminishes from 0 at E to -82.66 at C, and over

the branch CD, $-\frac{dT}{dA} = 82.66$ (*cf.* Fig. 2, which is lettered to correspond with Fig. 1).

Thus, from A to B the tensile strength increases at the rate of 67 tons per sq. in. for a reduction in area of 1 sq. in., while from C to D the rate of increase is 82.66 tons per sq. in. per sq. in.; the rate diminishes from B to 0 at E, and increases again from E to C; the curve shows no discontinuity, and at no stage is there a simultaneous diminution in sectional area and in tensile strength. From the foregoing considerations it appears that in the drawing of copper the phenomena which present themselves are not of that simple nature which the amorphous theory would lead one to expect.

The variation of several other physical properties of the metal was investigated and such properties as density, elongation, scleroscope hardness, and so on, were all found to change in a way similar to tensile strength. The following tentative explanation of the above results has been suggested: When copper is subjected to cold work by drawing through dies the first change which occurs is allotropic in nature. After this change is complete, that is, presumably when the whole of the metal has undergone transformation, a second change sets in which may be regarded either as allotropic or as explicable on the lines of the amorphous theory, and of the two possibilities the latter appears to be the more probable. (Paper read before the Institute of Metals on September 10, 1918, abstracted through *Engineering,* vol. 106, no. 2770, September 13, 1918, pp. 282-285, 4 figs., *eA*)

THE INFLUENCE OF SOME ELEMENTS ON THE TENACITY OF BASIC STEEL, Andrew McWilliam. The writer proposes a new formula for calculating the maximum load from the composition of steel. The first formula given for basic steel was

$$\text{Maximum load in lb. per sq. in. of original section} = 38{,}000 + 800\text{C} + 100\text{Mn} + 1000\text{P}$$

in which the carbon, manganese and phosphorus are expressed in units of 0.01 per cent. It was found, however, that under certain conditions this formula did not give correct results. Thus, around 0.2 per cent carbon the results were correct, but at 0.5 per cent carbon they were too low. It was thought then that as the carbon would be present in the form of pearlite to which the added strength was due, the more pearlite present the greater effect the carbon would have per unit on the tenacity of the mass. Further, as the manganese influenced the nature of the carbon, its influence would increase with increasing proportions of pearlite. Another calculation was made with the result that the maximum load in pounds per square inch of original section is expressed by the following formula:

$$\text{Maximum Load} = 38{,}000 + [800 + 4\ (\text{C} - 20)]\ \text{C} + 120\text{Si} + [100 + 2\ (\text{C} - 20)]\ \text{Mn} + 1000\text{P}$$

This formula has stood the test of trial quite well and even with the higher-silicon shell steels has given good results.

To check the correctness of this formula the writer compares the results derived by this means with those obtained experimentally by Arnold and shows that the two are in close agreement. (Paper before the September 1918 Meeting of the *Iron and Steel Institute,* abstracted through advance copy, 13 pp., 3 figs., 5 tables, *eA*)

Internal-Combustion Engineering

DIESEL ENGINES FOR MOTOR VEHICLES. Notwithstanding the great amount of work devoted to this purpose no one has succeeded in developing a Diesel-engine drive for motor vehicles.

This is due to the fact that no small high-speed multiple-cylinder Diesel engines have yet been constructed, and this again is mainly due to the difficulty of building a reliable small pump that would deliver air at about 100 atmos. pressure and would be easy to operate notwithstanding its many valves and regulating devices.

Austrian Patent No. 72356 describes an attempt to inject the fuel into the combustion chamber at variable pressure, but with a constant position of the needle valve.

With such an arrangement it was found that it is quite feasible to introduce into the cylinder the exact predetermined amount of fuel and to regulate it at will. The experimental installation consists of a three-cylinder, two-stroke-cycle engine with cranks at 120 deg. To use the engine for motor-car driving it is necessary to provide two steel flasks filled with air at 70 atmos. pressure. One of the flasks serves to start the engine, while the other delivers air for fuel injection. When the engine is running it makes its own compressed air. The flasks hold 1400 liters of free air each and can easily be carried on the car. For purposes of starting the air pressure is reduced to 10 atmos. (the original article does not state whether gage or absolute pressure is referred to).

The fuel injection occurs during 25 deg. of the crank rotation. In the experimental engine exhaust slots are provided along the entire circumference of the cylinder, but the scavenging air enters only through its own valve in the cylinder head. It is the view of the inventor that slots for the admission of scavenging air should be avoided, because at great speed a thorough scavenging by means of slots cannot be secured, and, further, if slots are used both for the scavenging air and for the exhaust, unequal expansion of the cylinder walls is apt to occur.

The scavenging valve opens after the piston has uncovered half the height of the exhaust slots and therefore permitted a complete expansion of the gases of combustion to occur. The scavenging air enters the cylinder at a pressure of 0.34 atmos. and an excess of 50 per cent of scavenging air is provided. The air valve remains open at exactly 90 deg., or one-fourth of the crank revolution. The exhaust slots remain open for 110 deg. The scavenging air is produced by the engine itself, an expansion piston being added to the working piston for this purpose. The air of combustion is compressed in the cylinder at 35 atmos. and is thereby raised to 580 deg. cent.

For the sake of safety the engine is driven by kerosene and for its injection into the cylinder an air pressure of from 40 to 70 atmos. is needed. This is obtained by means of an air compressor driven by the engine. The fuel flows to the pump automatically. The pump is driven from the engine at a speed reduction of 1:10 corresponding to the air-compressor drive. The fuel pump takes up the fuel by suction and forces it into the air container, having a capacity of about 1 liter, in which there is air compressed to from 40 to 60 atmos., but the fuel pump has absolutely nothing to do with the engine governing. The overfilling of the container is prevented by a simple governing device which acts on the suction valve of the fuel pump by the pressure in the air container.

The working cylinders are made of steel and form a unit with the scavenging air cylinders located underneath. The use of steel results in a considerable saving in weight, as well as a better cooling than would be the case with cast iron.

The air compressor is so large that the supply of starting air can be replaced in any case within a quarter of an hour after starting. The compressed air which forces the fuel into

the cylinder either does not reach the combustion chamber at all, or else in very small amounts. In this way but very little injection air is used and, therefore, the air compressor can be quite small and can be run at the low speed of 120 r.p.m., which materially increases the reliability of operation. While in an ordinary Diesel engine 8 cu. m. of injection air would be consumed, the new injection method permits using the same amount of air as of fuel, or at most 0.088 cu. m. The air compressor is single-acting two-stage and compresses in the first stage to 8.4 atmos. and in the second stage to 70 atmos.

The fuel valve has a needle in constant position. The fuel goes into an annular distributing chamber and is given a rotary motion in its helical passages. From this chamber it enters the combustion space through the fine holes in the nozzle, which is shaped like an injector. By the injector action of the fuel jets a strong turbulent motion of the air is created in the combustion chamber which leads to a good mixture of the fuel with the compressed air in the cylinder. Since no injection air is allowed to enter the cylinder, the undesirable cooling of the mixture is avoided. It is claimed that extensive tests have been made with the new system of fuel injection in order to determine whether the fuel chamber is necessary for governing the engine. These tests have also shown that the atomization of the fuel is perfect and that no drops are formed from the fuel present in the nozzle. In order to determine the quality of atomization the fuel was allowed to discharge into the atmosphere and the kerosene mist was ignited for experimental purposes. It was found that when the nozzle was kept open for some time the length of the flame varied with various air pressures from 1.5 to 2.5 m.

In the original article a diagram is given showing that the amount of fuel ejected is proportional to the air pressure, though at higher pressures the increase in the ejection of the fuel is not as great as with smaller pressures. This may be explained by the fact that at higher pressures and greater velocities in the nozzle passages the coefficient of friction increases more rapidly. (*Dieselmaschinen für Fahrzeuge, Allgemeine Automobilzeitung,* nos. 29-32, abstracted through *Dinglers Polytechnisches Journal,* vol. 333, no. 4, February 23, 1918, pp: 31-32, 1 fig., *e*)

1500-Hp. Gas Blowing Engine. Very brief description, with two pages of illustrations, of a gas engine and blower recently built in England for the Partington Steel and Iron Company. The engine is of the 6-crank vertical tandem type, and is rated to develop 1500 b.hp. on continuous load at 200 r.p.m. working on blast-furnace gas of 90 to 100 B.t.u. per cu. ft. The load can be increased by 10 to 20 per cent for short periods without overheating. A special speeder gear device is fitted to enable the speed to be reduced to as low as 120 r.p.m. (*The Engineer,* vol. 126, no. 3271, September 6, 1918, p. 207, and 2 pp. of illustrations, *d*)

Machine Parts

Disastrous Flywheel Explosion at Chicago. At 2.00 p.m. on the afternoon of September 19 a large flywheel exploded in engine room No. 1 of the Chicago Coated Board Company with considerable damage to life and property. The engine to which the flywheel was attached was a 24-in. by 42-in. 500-hp. simple Corliss making 108 r.p.m.

The flywheel had six spokes, had been cast in halves and bolted together at the hub and rim. The engine was thoroughly protected against overspeeding by a flyball governor equipped with the usual safety stop and by an additional engine stop arranged to be operated mechanically and electrically. Evidence indicates that the accident was not caused by overspeeding, and further, the load was constant and the speed normal.

The engineer's attention was first aroused by the noise of escaping steam and immediately after by the commotion caused by the flying parts of the wheel. The flywheel had been broken to bits, there being only two large pieces, one containing two spokes and the intervening rim, and the other a single spoke. Curiously enough, the engine to which the ruptured flywheel belonged was not damaged in the least.

The theory of the accident is that a small part of the rim first let go, severing the steam pipe, as the noise of escaping steam first heard would indicate. This so badly unbalanced and weakened the wheel that it could not withstand the strain imposed by the peripheral velocity of 4920 ft. per min.

In cast-iron rims of the section adopted for this wheel, namely, one having unequal thicknesses of metal, severe internal stresses may be set up by uneven cooling in the mold. While there were no signs of blowholes or other defects, the design of the wrecked wheel is very weak. It was made in two

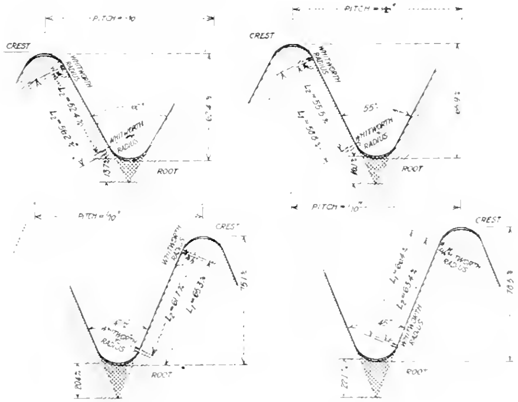

Fig. 3 Comparison of Screw Threads of Various Angles

parts with flanged and bolted rim joints located between the arms, and in addition had a belt wheel which further weakened it to a point where, according to Kent, the joints averaged only one-fifth of the strength of the rim.

The weight of the bolt flanges was concentrated in the middle of the arc between the arms, which is a bad feature of design and may account in part for the low strength allowance. Acting on the weakest part of the rim, the weight would tend to bow outward the arc of the rim between the spokes. The force would be greater when the joint was not supported by the belt, so that there would be a varying strain to fatigue and crystallize the metal in the rim between the joint and the arm. (*Power,* vol. 48, no. 15, October 8, 1918, pp. 516-519, 6 figs., *d*)

The Relation of Screw-Thread Angles to Other Functions, H. J. Bingham Powell. The writer advocates the adoption of the Whitworth form of thread as an international standard.

The radius of the Whitworth screw is said to come under the designation of a "natural" one, because many years of experience in making it show that it has about the least radius at which the tool will maintain a stable cutting point. In fact, the writer states that even in the United States he has found

the same to be true from investigations on the radii of the roots of the U. S. standard form of bolts cut by dies which were nominally supposed to have a flat root. The flat top (such as used in the U. S. S. thread) is about the worst for a tool that can be imagined, as apart from the corners rapidly disappearing by abrasion, they become overheated and brittle and fall off. Thus, the rounded top and bottom for a thread is a practical necessity, while the U. S. S. flat top and bottom are impracticable and consequently hardly ever obtained in ordinary commercial work with taps and dies.

Fig. 3 shows a comparison of screw threads of various angles. In drawing up the diagrams the author gave the "natural" Whitworth rounding at the crest and root of the threads of the several angles, since that is, in his opinion, the shape they will have as made, whether the maker set out to produce the flat U. S. S. form or the rounded root of sharp radius striven for in the international type.

In fixing on a desirable thread angle the correction necessary to the pitch diameter for any error of lead in the screw must be taken very seriously into consideration. This correction is 10 per cent greater for the Whitworth, 31 per cent greater for the British Association and 43 per cent greater for the 45-deg. angle than the correction necessary for a 60-deg. thread. This increase for the 45-deg. angles is so large as to make this angle impracticable.

The author therefore recommends for consideration as a standard international thread the Whitworth form with its "natural" rounding at the crest and root and much greater space at the root available for tolerances as compared with the U. S. S. form. (*American Machinist,* vol. 49, no. 13, September 26, 1918, pp. 571-573, 1 fig., *cg*)

Machine Shop

Casting Rings in Centrifugal Machine, E. F. Cone. Description of new process for casting piston rings and the apparatus used therefor.

In The Journal of October 1916 (p. 831) there was described a method of making cast-iron pipe centrifugally, invented by a Brazilian engineer, D. Sensaud de Lavaud. The present process is the further development of the same method and, according to the description, is remarkable both for the extremely rapid production as compared with the labor employed and for the properties of the rings themselves. As to production, one unit with about eleven men and boys delivers 18,000 to 20,000 rings a day.

The process of manufacture is comparatively simple. It consists in introducing into a rapidly revolving permanent metal mold a definite amount of hot metal of proper composition, which is immediately thrown to the outer surface of the revolving mold. There it quickly cools and assumes its definite shape. After that the ring is removed and annealed and then the inner rim of the ring is ground on a special machine.

The casting machine and the special re-assembling machine for the molds are described in the original article. An interesting apparatus has been devised for annealing the rings. It consists of a cylinder confined or suspended perpendicularly within a large iron chamber. At a certain section it is heated to the required temperature by means of an oil burner extending inside the outer casing and playing on the cylinder, the degree of heat of the rings for annealing being regulated by a pyrometer. The diameter of the pipe is about that of the rings to be annealed, thus keeping the rings to their exact shape. The heat treatment is nearly automatic. The rings are fed in at the top and as they pass down they reach the proper temperature of 1900 deg. fahr. and finally pass out at the bottom properly annealed. It is stated that this device can treat 20 rings a minute, or about 1200 an hour.

Information on the properties of the metal in the ring is based on tests made for the inventor at Columbia University, New York. From these tests it appears that the machine-cast rings had a tensile strength of 61,400 lb. per sq. in., which may, however, have been partly due to the very small size of the specimens. The ultimate resilience in compression was found to be 19.28 in-lb. and it was further found that the machine-cast rings have a very pronounced elastic limit well below the ultimate strength, which would indicate a considerable amount of uniformity in the structure of the metal. Micrographic investigation has shown the graphite to be distributed in a fine condition and the entire crystalline formation appears to be homogeneous. (*The Iron Age,* vol. 102, no. 14, October 3, 1918, pp. 801-807, illustrated, *d*)

Marine Engineering

The Yarrow Anti-Submarine Smoke System. Description of a system developed for application to merchant vessels with the view to reducing the visibility of the vessel.

It has been found that a steamer with the usual type of funnel emitting a column of smoke to a height of 150 ft. would be visible to an observer on a submarine 17.4 nautical miles away. The freeboard of the steamer being taken at 33 ft., the elimination of her smoke column would result in her remaining invisible to the submarine at all distances greater than 10.17 nautical miles. This means that with the smoke column emitted in the usual way, the area within which the steamer is visible from the submarine is 950 square miles, while with the smoke column eliminated this area is reduced to 320 square miles.

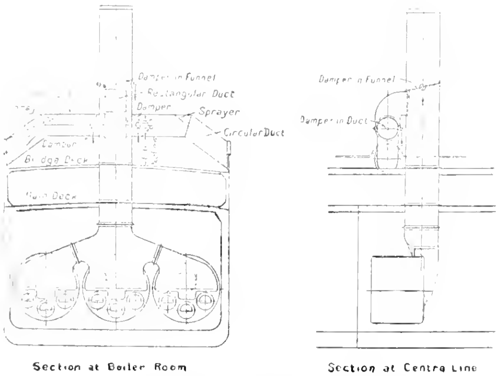

Fig. 4 Duct and Damper Arrangement of the Yarrow Anti-Submarine Smoke System

As shown in Fig. 4, in the Yarrow anti-submarine smoke system means are provided for diverting the smoke and waste gases out of the funnel into a duct or ducts leading to the sides of the ship and ejecting them on to the surface of the water by means of a water spray fitted within the ducts. The object of the water spray is to cool the gases so as to cause them to fall to the sea water level instead of rising again immediately after they leave the duct, and, further, to absorb a large proportion of the solid particles of carbon in the smoke, thus reducing its blackness and therefore its visibility.

In actual use, the smoke is said never to rise above the level of the bridge, while the hot gases cause part of the water of the spray to become steam, with the result that the smoke issuing from the side ducts is quite similar in appearance to that emitted by a locomotive, and is black only for a minute or two after the furnace fires are stoked afresh.

Actual experience at sea has shown that the draft induced by the water sprays is much superior to that obtained in the usual way from the funnel, and therefore the control of the air supply to the furnace is improved.

As shown in Fig. 4, a damper is provided in the funnel and another in each of the side ducts. The handles of the dampers are interconnected in such a way that all three dampers cannot be opened at the same time. In general, it is intended that when the system is in use the funnel damper should be closed, the damper in the duct on the leeward side of the vessel opened and the damper on the other duct closed. Different conditions may, however, require a different system of operation.

The water for the sprays is supplied by a pump in the engine room capable of delivering a jet at a pressure of 180 lb. per sq. in. The sprayer when properly regulated should produce a cone of spray, the edges of which should just touch the outlet edges of the duct and also sides of duct outlet. This condition is quite important. (*The Engineer*, vol. 126, no. 3272, September 13, 1918, pp. 218-219, 8 figs., *d*)

MANUFACTURING EAGLES AT FORD'S SHIPYARD, Chas. Lundberg, Mem.Am.Soc.M.E. Description of the Ford submarine chasers and their method of manufacture as carried out in the Ford plant on the River Rouge at Detroit.

The entire plant was built in less than five months and consists of a main structure 350 ft. by 1700 ft., of steel and glass with composition roof; a fabricating shop 155 ft. by 450 ft., to which 150 ft. more is being added; a great fit-out building, a transfer table 202 ft. wide for the transverse movement of completed hulls, and a hydraulic launching machine which gently and always under full control lowers the ship into the water.

The boats are assembled in a great building, 21 of them being under construction at one time.

Each boat is assembled on a carriage supported by car wheels, there being 12 trucks, each with four wheels under each carriage. The building of the boat comprises seven groups of operations and they are so timed as to be finished simultaneously. When a ship moves out to the transfer table on its way to launching those behind it move up in position for the next set of operations. Briefly outlined, these operations are as follows:

No. 1: Keel laid and bulkhead collars placed, also some of the floor beams, part of the longitudinal bulkheads, center and inner bulkheads. (Incidental riveting, of course, is a part of each series of operations, likewise reaming rivet holes and some welding.)

No. 2: Floor built and frames (of which there are 113) erected the entire length of the boat; athwartship bulkheads, liners, keelson and floor stringers. Engine room, tank plating, platform deck beams placed fore and aft.

No. 3: Forward deck plating, outside and after-deck plating, gunwale bar and collars, main deck beams, stanchions, engine and boiler room, rudder brackets.

No. 4: Remainder of platform deck plating; bulkheads from platform to main deck, windlass and steam-engine foundations, signal room.

No. 5: Deck bars and fittings, scuttle and manholes, watertight floors and calking.

No. 6: Forward and aft deck houses, breakwater, charthouse, strut and stern bearings, bilge and drain piping, oil compartment tunnel.

No. 7: Seacock and strainer installation, steering gear and stuffing box, steering engine and anchor, ladder stairways, oil pumps, auxiliary pumps and air compressors. Installation of shaft and propeller. Riveting, welding and calking completed, all compartments air-tested, painting and inspection completed.

An interesting part of the original article is devoted to the method of handling labor. (*The Iron Age*, vol. 102, no. 12, September 19, 1918, pp. 679-684, illustrated, *d*)

Motor-Car Engineering (See also Internal-Combustion Engineering)

HEAVY-OIL-BURNING ARRANGEMENT FOR MOTOR CARS. Description of an arrangement invented by F. A. Wilkinson to burn tar oil on an ordinary automobile.

The car is started on coal gas, which may be replaced by gasoline. When the heavy oil is first switched on and after the

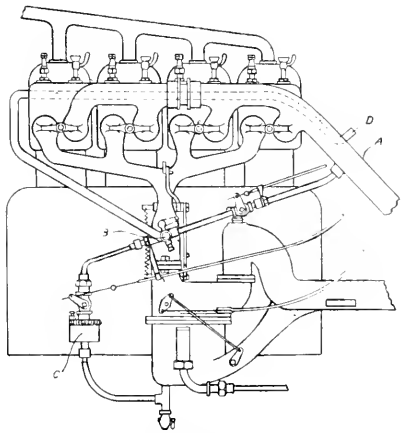

FIG. 5 WILKINSON HEAVY-OIL-BURNING ARRANGEMENT FOR MOTOR CARS

car has been standing there is a certain amount of temporary smoke emission and the fumes from the exhaust are decidedly pungent, but the car is said to run with perfectly regular firing and to pick up well.

Fig. 5 shows the arrangement used. The original carburetor of the car is retained, but additional pipes are installed. The first of these is a small pipe A leading from the exhaust pipe and admitting exhaust gases through a valve B into the inlet pipe just above the carburetor. Next comes a small heating chamber C placed alongside the float chamber and connected thereto in such a way that the level of the fuel is the same in the two chambers. In this heating chamber is a coil of wire connected with the battery which heats up the fuel in the chamber. The air is admitted through pipe D, located, as shown, partly in the exhaust pipe. The hot air from D enters the induction pipe at right angles to the fuel rising from the jet. Hence there is admission of actual exhaust gases and of very highly heated air into the induction pipe beyond the carburetor, in addition to the warm air which normally enters the car-

(... *The Engineer*, vol. 126, no. 3272, September 13, 1918, pp. 227-228, 2 figs., *d*)

Power Plants

BY-PRODUCT INSTALLATION FOR POWER STATIONS, Klingenberg. (*Zeits. Vereines Deutsch. Ing.* 62, p. 1, Jan. 5, 1918. *Elek. Zeits.* 39, pp. 176-177, May 2, 1918). The author first reviews the trend of the market for by-products. A great increase in production will cause a fall in prices and, in particular, the price of ammonium sulphate is likely to decrease owing to competition between the numerous nitrogen plants erected during the war, including those working the Haber process.

He then reviews distillation processes (coking and gas making), and deals with the erection and operation of plants for gasifying the whole of the fuel and recovering by-products. A gas of high calorific value at low temperature is required, and low temperature is needed in the producer if the tar and ammonia compounds are not to be dissociated. One of the most serious obstacles to the design of a large, high-efficiency installation is the limit of 650 to 1030 kw. obtainable from one producer unit, compared with 3000 to 5000 kw. from a steam boiler. The need of auxiliary steam supply is an important factor in the heat balance.

The author investigates in detail the relative economy of three types of power-station plant: namely, steam turbines with coal-fired boilers; steam turbines with gas-fired boilers and by-product plant; gas engines with by-product plant. In order to cover uncertainties regarding yield and price of by-products, three cases are assumed: (1) 6.44 M. per ton of coal; low yield and low prices; (2) 12 M. per ton of coal; good yield and good prices; (3) 17.56 M. per ton of coal; good yield and very high prices. Other assumptions made are: 1 to 1.5 per cent nitrogen content of coal; 68 per cent thereof recovered; 12 per cent light-load consumption of producer; 70 per cent full-load efficiency; 50 kg. tar per ton of coal; 2.2 kg. auxiliary steam per ton of coal, 0.8 kg. being raised by producer heat, 1 kg. by exhaust heat in the case of gas engines, and the rest by special boiler. The peak load of the station is assumed to be 100,000 kw., the size of the turbine units 20,800 kw. and of gas engines 6100 kw. each. The latter is relatively a higher limit than the assumed size of the turbine units, yet it involves 22 gas engines as compared with 6 turbines. The heat consumption on full load is taken to be 4360 kg-cal. per kw-hr. for steam turbines, 3570 kg-cal. for gas engines; and 13 per cent and 45 per cent of these figures on light load.

Objections to gas engines are: High total first cost; influence of gas composition; expensive attendance; repair and lubrication; vibration of foundations; small overhead capacity. Variable load involves increased heat loss and less satisfactory yield of same kw-hr. output in each case. The coal consumption of a steam-turbine plant with coal-fired boilers is exceeded in by-product plant with gas-fired boilers by 150 per cent, and with gas engines by 40 per cent. According to this, it is better to burn considerably less coal without by-product recovery than to burn much more coal in recovery plant. At least, no generalization is possible, and the economic justification for by-product recovery must be established in each particular case.

The capital costs for the three types of plant are estimated to be: Steam turbines without by-product recovery, 22.5 million M.; steam turbines with by-product recovery, 46.2 million M.; gas engines with by-product recovery, 47.6 million M. The capital burden is heavy in cases (2) and (3), but the price of coal is a more important factor with by-product recovery than without it. When the price of by-products is low, gas engines are at a disadvantage compared with steam plant, and the lower the revenue from by-products the greater the justification for direct combustion.

The author concludes that few by-product installations are economically justifiable where German hard coal (low in nitrogen) is employed. Even with medium nitrogen content it is unprofitable unless the price of tar and sulphate is well maintained. Steam turbines with by-product recovery are at an advantage compared with gas engines if the price of coal be less than 14 M. per ton. At higher coal prices, and with a by-product revenue of 10 M. per ton of coal, the field of competition of the gas engine is entered, but even then it is necessary to assume a higher load factor than can generally be realized in practice. If the by-product revenue be only 12 M. per ton, the load factor should be 60 per cent; and if the load factor be only 40 per cent, the by-product revenue should be 18 M. per ton of coal. Artificial improvement of load factor by chemical or metallurgical loads is not to be recommended if the latter could otherwise be served by water power. Direct combustion of coal is advised under any operating conditions if the revenue from by-products is less than 8 M. per ton of coal. The gasification of brown coal offers rather better possibilities than hard coal, particularly as regards the possible recovery of tar, fuel oils, and lubricating oil, but the gross saving anticipated from a quite favorable combination of circumstances does not appear to justify the commitments

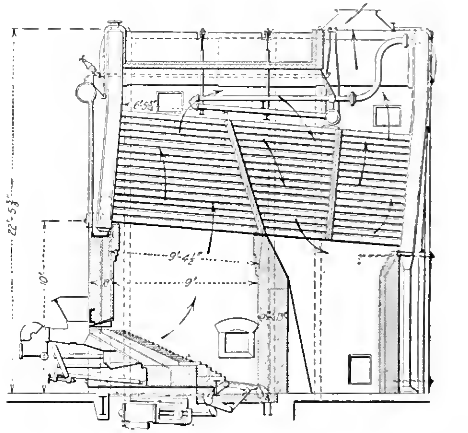

FIG. 6 SETTING FOR UNDERFEED STOKER, CEDAR RAPIDS PLANT

involved. Neither the amount of coal which could reasonably be subjected to by-product recovery, nor the revenue to be expected from such recovery, is as great as many writers have assumed. (*Science Abstracts*, Section B—Electrical Engineering, vol. 21, pt. 8, no. 248, August 31, 1918, pp. 281-283, *g*)

CEDAR RAPIDS BIG STEAM PLANT. Description of a 16,000-kw.-turbine plant giving commercial and railway service, and which in addition is selling steam for heating and also supplying large quantities of live steam for cooking. The amounts of heating steam are quite large and, for example, last January 70,000,000 lb. of steam were delivered to the heating system and the same amount of make-up had to be heated from an average temperature of 40 deg. to 210 deg. without the assistance of an economizer.

The use of so much raw water with its consequent deposits of scale and fouling of boiler tubes is one of the disadvantages under which the plant has to operate. The conditions under which the plant operates are, however, so variable that water softening is unadvisable. This variability of operating conditions makes it necessary to provide stokers which will respond to quick changes in load and will operate at considerable overload with Iowa coal. Underfeed stokers are used and the setting is as shown in Fig. 6. There the stoker is set flush with the boiler front, and with straight walls front and rear the combustion space is as large as the headroom of 10 ft. will permit, the volume approximating 880 cu. ft.

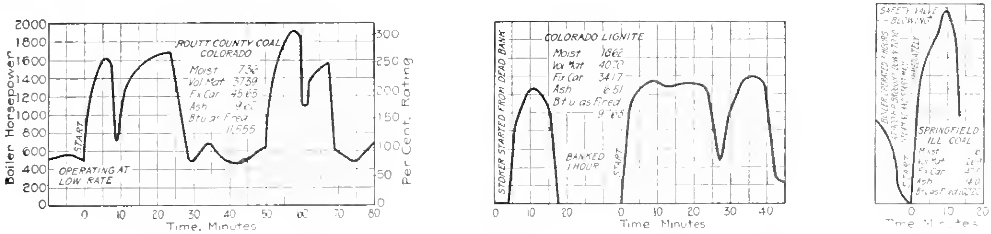

Fig. 7 Flexibility-Test Curves with Stokers on Low-Grade Fuels at Cedar Rapids Plant

Seven-retort stokers serve water-tube boilers rated at 627 hp. Operating at boiler rating, each stoker burns from 2500 to 3000 lb. of coal per hour and upon an occasion as high as 7400 lb. of coal per hour were burned, or over 1000 lb. per retort.

The three curves of Fig. 7 indicate the flexibility of operation. In the test with Colorado lignite (central figure) the stoker was started from a "dead bank." A high output was required for a short interval and then the load was taken off completely. The stoker is banked for an hour and is then called to meet a sudden and long-continued demand. The figure on the right shows a quick building up with the safety valve blowing at the top of the curve. These curves show that the stokers even when burning inferior coal will care for quick changes in load and will maintain heavy overloads at high efficiency.

In this instance the stoker engines are independent of the fan engines. The former are installed on the boiler-room floor with chain connections to lineshafts in the basement and driving chains from shaft to stoker. One engine will serve two boilers.

The electrical part of the plant is somewhat unusual in that the generation is all two-phase 2300-volt and the distribution three-phase with the exception of feeders for city service. The original article gives a single-line diagram for the two-phase, three-phase differential relays. The out-of-town service is three-phase 33,000 volts, the current being stepped up by two sets of 600-kw. two-phase three-phase transformers connected in multiple between the 2300-volt and the 33,000-volt buses.

All the high-tension lines are controlled from the operator's room equipped with means for remote control of the oil switches, as well as telephone connections to the city system and by a private line to the various stations operated by the company as well as the boiler and turbine rooms. (*Power*, vol. 48, no. 14, October 1, 1918, pp. 478-485, 12 figs. and list of principal equipment, *dA*)

New Plant of the Pennsylvania Salt Manufacturing Company. The plant is located at Wyandotte, Mich., 12 miles from Detroit, and the addition described in the present article was laid out specifically for convenience of operation, with plenty of room to make repairs to allow for future extension without disarranging the present layout.

The boiler room has been made the prime factor of the plant, and has an equipment consisting of modern types of water-tube boilers, underfeed stokers and economizers.

An interesting feature of the plant is the centering of the control of all boiler-room auxiliaries in an operating board, on which are also grouped a variety of instruments (indicating and recording) giving all information necessary for the efficient operation of the plant.

In the main feed line to the boilers there is a venturi tube with a manometer, and also a thermometer to measure the feedwater, the instruments being located on the operating board. On the board there is also a steam-flow meter for each boiler. The latter instruments show the output in each case, and the aggregate readings may be checked against the total input shown by the water meter in the supply line.

The control of the dampers is also centered on the operating board. In this board there are six panels, one for each boiler. These panels contain the handwheels to the dampers in the breeching and in the forced-draft inlets, a steam-flow meter and draft gages showing the draft over the fire and in the last pass of the boiler, and the pressure under the stokers. One panel contains, in addition to the flow meter on the feedwater referred to above, a pyrometer and multiple switch, draft gages showing the draft on the stack side of the economizers and the handwheels for controlling the vertical dampers at the economizer outlets. The last panel has two large dial gages showing the pressures at the turbine throttles, in addition to which there are the three field rheostats and ammeters for the forced-draft fans and the stoker motors.

At the side of the operating board there is a recording-gage panel containing four pressure-recording gages, two of which give the pressure at the turbine throttles and the other two record the pressure on the feedwater system, one before the economizers and the other at the delivery to the boilers.

One recording thermometer charts the temperature of the water entering the boilers and another the temperature of the water entering the economizers, in addition to which each battery is served by a CO_2 recorder.

The above constitutes an unusually complete set of apparatus and affords a good basis toward efficient operation of the plant.

Another feature of interest in the plant is the use of three eductor-type jet condensers (Fig. 8) taking the exhaust steam from the auxiliaries and the condensate from the main condensers. The latter at a temperature approximating 90 deg. is forced through the jet condensers, where its temperature is raised by the auxiliary exhaust to about 150 deg., which is considered to be the most economical temperature for the economizer.

The condensers are connected in parallel, and any number of them may be operated at one time, or the condensate may be bypassed directly to the hotwell. (*Power*, vol. 48, no. 12, September 17, 1918, pp. 406-413, 10 figs., *da*)

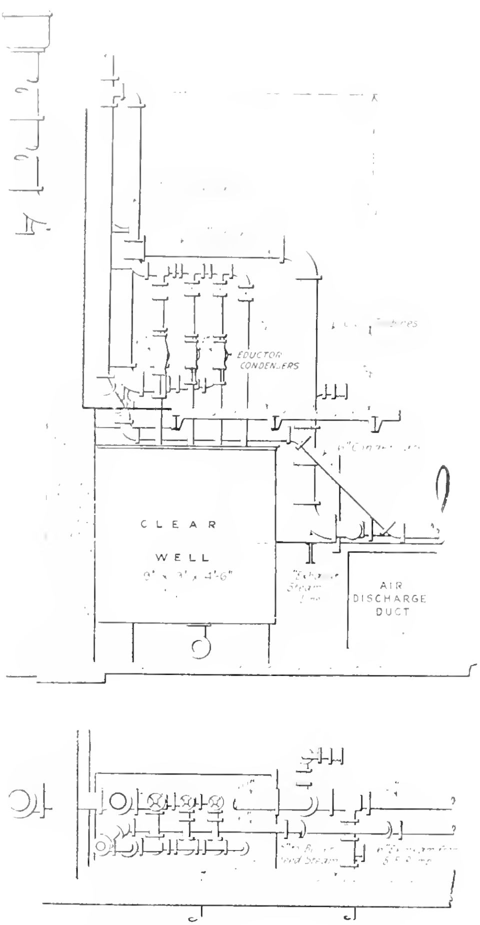

FIG. 8 ARRANGEMENT OF EDUCTOR CONDENSERS

Railroad Engineering

RENEWABLE STAY HEADS FOR LOCOMOTIVE FIREBOXES. Data of experiments by Mr. Snelson, Chief Foreman Boilermaker, in the Locomotive Works at Crewe, England. This led to the development of a new method of repairing locomotive firebox stays recently adopted on the London and Northwestern Railway Company's lines.

Fig. 9 gives a plan and elevation of one of these heads for insertion, and also shows the head in position. It is to be used chiefly for renewing small or defective stay heads. The small and defective stay head is hammered up in order completely to expand it in the hole. It is then centered, drilled and tapped to a depth of about $\frac{5}{8}$ in. for the front side of the plate. The stay end and firebox plate are then lightly skimmed up with the facing cutter. This facing cutter, which is equal in diameter to the new head, is screwed into the tapped hole to insure obtaining a face that is perfectly true with the hole. By this operation the stay is made ready for the new head. A thin copper washer is then inserted between the face of the new head and the copper stay, and the head is tightly screwed in by means of a wrench on the square end.

The heads have been tested in several instances, described in the original article and showed up quite well. Among other things, there was some uncertainty to whether the repaired stay would be strong enough to withstand the various stresses set up in the firebox. Fracture tests were, therefore, carried out in the testing department at Crewe, and it was found that even on the smaller stays there is a good factor of safety. Thus, a 1-in. stay fitted with the head of the new type in a boiler working at 150 lb. pressure per sq. in. has a factor of safety between 6.5 and 7 when the stays are pitched 4 in. apart, while on stays $1\frac{3}{16}$ in. and $1\frac{1}{4}$ in. in diameter and upward, the net section of the repaired stay is greater, and consequently stronger than the original 1-in. or $1\frac{1}{16}$-in. stay.

Various instances are cited in the original article to show

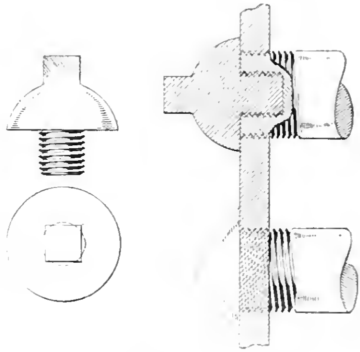

FIG. 9 SNELSON RENEWABLE STAY HEAD FOR LOCOMOTIVE FIREBOX

the durability of the new type of head. Thus in one case 21 of these heads were put in the firebox sides of a loco-stationary boiler in December 1916. Since then it has been worked continuously night and day, week ends and holidays excepted, and up to the present time not one head has given the slightest trouble. Early in October 1917 this boiler was stopped for cleaning, and advantage was taken of this stoppage to take one of the heads out for inspection purposes. It was found that in outline the form of the head was practically unchanged, even the square portion being in such good condition that it was used to withdraw the head, as it was used 10 months before to insert it.

The copper liner that had been threaded on the head was intact and the copper plate underneath the head was in splendid condition. (*The Engineer*, vol. 126, no. 3270, August 30, 1918, pp. 176-177, 5 figs., *d*)

Refrigeration

THROTTLING OF AMMONIA, Chas. D. Herter. From time to time the question has been raised whether during a shortage of ammonia any disadvantage might result if, instead of regulating several expansion valves singly, the main liquid valve (also known as the king valve) at the liquid receiver was throttled down so as to obtain at once the desired reduced feed in liquid to the refrigerating coils.

The writer comes to the conclusion that intermediate throttling of liquid is entirely proper under certain conditions, the only possible harm being more rapid wear of the valves used. From a thermodynamic viewpoint no noticeable benefit is obtained by reducing the pressure upon the liquid gradually instead of all at once, while the provision of an emergency feed valve, in addition to the main liquid valve ordinarily left fully open, is considered good practice. (*Power*, vol. 48, no. 15, October 8, 1918, pp. 530-531, *p*)

Steam Engineering

Pumping Engines for the Cairo Main Drainage. Description of the engines used in the new main drainage system of the City of Cairo, in Egypt. This machinery consists briefly of four sets of pumping engines each driving direct from the engine crossheads a set of triplex single-acting plunger pumps.

The pumping engines themselves may be described as being of the inverted vertical quadruple-expansion three-crank type having the high and first intermediate cylinders placed tandem over the center crank and the second intermediate and low-pressure cylinders placed one on either side of the first intermediate cylinder and over the outer cranks.

The chief point of interest lies in the arrangement of the high and first intermediate cylinders, which, as shown in Fig. 10, are single-acting. In fact, the arrangement is equivalent to one double-acting cylinder as far as the number of valves and amount of valve gear are concerned, with the advantage of a reduced temperature range with each cylinder.

The pistons of the two cylinders are in one piece forming what may be called a differential piston. The upper part of this piston is in plunger form and fills the high-pressure cylinder for the whole length of the stroke, thus preventing the cooling of the high-pressure cylinder walls by contact with the lower-temperature steam content in the annular space in the upper part of the first intermediate cylinder. The following advantages are claimed for such an arrangement as compared with the more usual plan of providing two superimposed double-acting cylinders: In the first place, there is a material reduction in the number of valves and their consequent working parts with a corresponding reduction in steam leakage. There is also a reduction in the overall height of the engine and, in addition, a simple and secure base is obtained for the high-pressure cylinder. Further, the gland and stuffing box on the high-pressure cylinder, which the usual double-acting construction would require, and which would tend to be a source of trouble, are eliminated.

The steam cylinders are, respectively, 17 in., 27 in., 33 in. and 49 in. in diameter with a common stroke of 36 in., and when running at normal speed of 22 r.p.m. each engine is capable of developing 200 hp.

All of the valves are actuated by a lay shaft carried along the front of the cylinders and rotated at the same speed as the crankshaft with skew gearing on a vertical shaft reaching from the crankshaft to the valve-motion lay shaft. By the use of this lay shaft heavy eccentrics, rods, and rocking levers are dispensed with. The steam valves of all cylinders are fitted with the trip motion giving practically instantaneous closing the shock of the drop valves being absorbed by oil-cataract dashpots to insure silent working, while the Corliss valves are controlled by spring dashpots of the usual type. The exhaust valves are controlled throughout by positive-motion gear.

Owing to the type of link mechanism adopted for actuating the valves, the distortion due to obliquity of the usual eccentric gear is practically non-existent; this was found to be a distinct advantage in adjusting the valve motion relatively to the actual working steam pressures, in view of the somewhat unusual differences in pressure between the upper and lower ends of the two final cylinders, due to the fact of the first two cylinders being single-acting. In order to equalize the pressures, and avoid the loss due to "drop" between succeeding cylinders, reheater receivers of ample proportion are provided. These are fitted with solid-drawn steel tubes, and are coupled to the jacket system, so that steam at initial pressure and temperature is continually circulated through the tubes, thereby drying and reheating the working steam on its passage to the succeeding cylinder. (*Engineering*, vol. 106, no. 2749, September 6, 1918, pp. 251-252 and one plate of drawings, *d*)

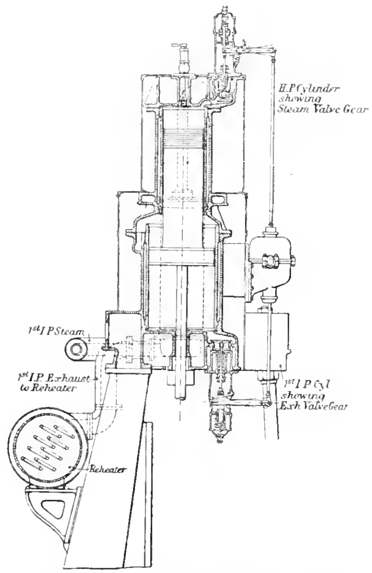

Fig. 10 High and First Intermediate Cylinders of the Pumping Engines for the Cairo Main Drainage

A New Theory of the Steam Turbine, Harold Medway Martin. Continuation of abstract of a serial article. Previous installments of the abstract appeared in The Journal, September 1918, page 784, and October, page 871.

In the previous article it was shown that adiabatic heat drop cannot under all conditions be taken as proportional to the actual effective thermodynamic head and that where the superheat is high the reheat factor is also high and vice versa.

In the present article the author shows how to determine the point at which different degrees of initial superheat are lost.

Assume for example that the initial pressure is 180 lb. absolute and that the hydraulic efficiency of the turbine is 70 per cent. Suppose the superheat to be lost at, say, 80 deg. cent. The volume of the steam is then 54.596 cu. ft. per lb. (Callendar) and its pressure is 6.8627 lb. per sq. in.

The initial pressure being 180 lb. absolute, we have

$$x = \frac{p_1}{p_2} = \frac{180}{6.8627}$$

If ρ be the ratio of the final volume to the initial volume then, since the expansion follows the law $pV^m =$ constant (where $m = \lambda$), we have $\rho = x^{1/m}$

The value of $1/m$ is given (p. 53 ante) by the relation

$$\frac{1}{\lambda} = 1 - 0.23077\,\eta = 1 - 0.23077 \times 0.7 = 0.8385$$

Whence

$$\rho = \left[\frac{180}{6.8627}\right]^{0.8385} \quad \text{and} \quad V_1 = \frac{V_2}{\rho} = 3.528 \text{ cu. ft. per lb}$$

Reference to Callendar's table shows that steam at 180 lb. absolute with this specific volume has a temperature of 331.6 deg. cent., corresponding to a superheat of 142.1 deg. cent. or 255.8 deg. fahr. By determining a number of values in this way and plotting the results as curves, the temperature at which any stated initial superheat is lost can be determined. The writer gives a table showing the appro imate temperatures in centigrade at which superheat is lost for different hydraulic efficiencies when the initial pressure is 180 lb. absolute. With the temperatures given in such a table it is possible to calculate the total effective thermodynamic head, or, to

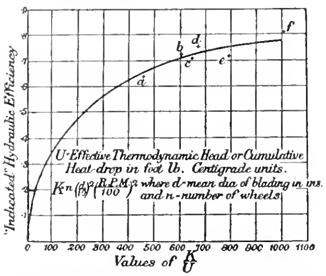

FIG. 11 "INDICATED" HYDRAULIC EFFICIENCY OF IMPULSE TURBINES IF STEAM EXPANDS IN THERMAL EQUILIBRIUM THROUGHOUT

use Professor Goudie's terms, the cumulative heat which becomes available in a turbine when expanding steam from 180 lb. absolute to 1 lb. absolute with different hydraulic efficiencies, the steam being supposed to be in thermal equilibrium throughout. The author gives a table of cumulative available heats when steam expands in thermal equilibrium from an initial absolute pressure of 180 lb. per sq. in. to 1 lb. absolute with different hydraulic efficiencies and different initial superheats. This table

TABLE 1 CUMULATIVE AVAILABLE HEATS F. P. C. WHEN STEAM EXPANDS IN THERMAL EQUILIBRIUM FROM AN INITIAL ABSOLUTE PRESSURE OF 180 LB. PER SQ. IN. TO 1 LB. ABSOLUTE; WITH DIFFERENT HYDRAULIC EFFICIENCIES AND DIFFERENT INITIAL SUPERHEATS

Hydraulic Efficiency η	Initial Superheats, Deg. Fahr.						
	0	50	100	150	200	250	300
0.5	201.3	207.2	216.2	226.9	238.9	251.1	262.4
0.6	197.4	203.5	210.3	219.4	229.6	240.4	251.4
0.7	191.1	199.2	206.7	214.2	222.6	232.9	241.3
0.8	190.7	196.3	202.5	209.3	216.9	228.5	233.6
1.0	181.1	189.5	195.4	201.7	208.2	215.0	222.0

is here reproduced as Table 1. To determine from this table the theoretical steam rate for a turbine working with different superheats a correction is required because increases in the effective thermodynamic head change the ratio of blade speed to steam speed.

This correction can be effected by means of the curve plotted in Fig. 11 on the assumption that thermal equilibrium was maintained throughout the whole expansion. In this curve the "indicated" hydraulic efficiency of a number of impulse turbines is plotted against K/U, where

$$K = n\left(\frac{d}{10}\right)^2\left(\frac{\text{R.P.M.}}{100}\right)^2$$

and U denotes Ru, where u is the adiabatic heat drop. In the above expression for K, the number of stages is represented by n, while d denotes the mean diameter of the blading. Since the average velocity of the steam is proportional to $\sqrt{(U/n)}$, the expression $\sqrt{(K/U)}$ is proportional to the ratio of blade speed to steam speed. According to the ordinary view the indicated hydraulic efficiency should give a parabola when plotted against $\sqrt{(K/U)}$, and consequently the curve in Fig. 11 should be an ellipse. The points lie badly on an ellipse, however, and the curve shown has been sketched in freehand. As will be shown later, a much better agreement between the curve and the experimental figures is obtained when the theory that the steam expands in thermal equilibrium is abandoned. (*Engineering*, vol. 106, no. 2744, August 2, 1918, pp. 107-108, abstract to be continued, *tA*)

GRAPHIC METHOD OF DETERMINING SIZE OF SAFETY VALVES, H. F. Jauss. The writer gives a simple method of determining the proper size of safety valve for a steam boiler. This method is based on the rules set forth in the A.S.M.E. Boiler Code, with a modification in the ma imum allowable lifts, which have been increased 25 per cent above those given in the Code. The reasons for this increase are: (1) That it is possible to manufacture successfully safety-valve springs capable of these

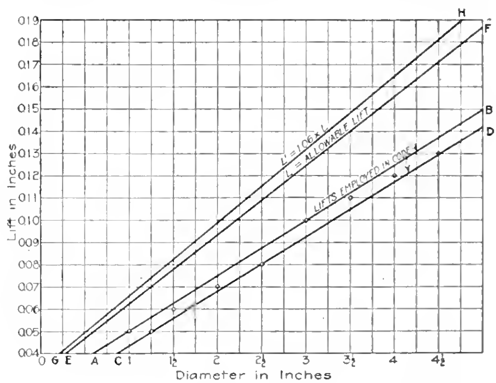

FIG. 12 RELATION OF LIFT OF VALVE TO DIAMETER

higher lifts; (2) that this decreases the number and size of valves required; (3) that the large margin of safety secured by restricting the maximum lifts to very low values as in the A.S.M.E. Code is not necessary, since at best the safety valve can only take care of a gradual increase in pressure and does not protect against a sudden increase.

The writer derives the chart in Fig. 12, where the lines *AB* and *CD* indicate the limits of the maximum lifts employed in constructing the safety-valve tables in the A.S.M.E. Boiler Code where the constant lift is employed for each size of valve regardless of the pressure. Assuming that lifts 25 per cent greater than the A.S.M.E. maximum are possible, it is easy to determine a new line *EF* indicating the maximum possible lifts for valves of various diameters.

For the construction of capacity curves, the writer uses the modified Napier's formula and also gives an alignment chart for finding the size of safety valves. A numerical example is given and fully worked out. (*Power*, vol. 48, no. 12, September 17, 1918, pp. 414-417. 3 figs., *g*)

Tests on Steam-Engine Governing, Prof. Anton Gramberg. The following tests were carried out for the purpose of elucidating the phenomena occurring when engines are automatically governed. They were carried out with a horizontal steam engine working non-condensing. The engine was equipped on the high-pressure cylinder with the so-called old Collmann valve gear regulated by a governor in the usual manner, the governor being driven as shown in Fig. 13. The position of the sleeve can be read at *r*.

The weight of the governor was 108 kg. The additional weights shown in Fig. 13 are not included in this weight.

As a rule, during the tests the governor was equipped only with the running weights displaced horizontally by hand, and so arranged as to change the speed of the engine roughly from 120 to 135 r.p.m.

In addition to this, for the purpose of experiment, there was added to the governor shaft a spindle on which the weights I and II could be located at definite intervals above and below the governor shaft. When this spindle is exactly vertical these weights exercise no effort either on the governor shaft or on the governor itself, and the spindle is in such a vertical position when the governor sleeve and the governor shaft are in exactly central position; but if the governor shaft moves out, these additional weights very rapidly create increasing moments on the governor shaft and, hence, with equal rapidity, increasing forces on the governor sleeve. These forces pass from negative values through zero to positive values (counting them algebraically in the same sense all the time) and their increase is approximately proportional to the paths traveled by the governor sleeve, the speed of the rise being approximately proportional to the distance either above or below the weights from the governor shaft.

One can investigate the action of these variable weights (which can be displaced either in the horizontal or in the vertical direction) on the governing by varying the electrical load N_{el} on the machine, so that the governor will assume various positions for *r* and then by observing the corresponding speeds *n*.

In these tests the horizontal weight was displaced first. It weighed 18.15 kg. (40 lb.) and was displaced from its normal position to the left to a distance of 0.1 m. (3.94 in.) and then shifted through a distance of 0.2 m. (7.87 in.) entirely to the right. The arm of the governor shaft, on which the force acting on the sleeve was applied was 0.141 m. (5.56 in.), therefore the displacement of the weight exerted additional forces on the sleeve equal to $18.15 \times \dfrac{0.1}{0.141} = 12.9$ kg. (28.4 lb.) or $18.15 \times \dfrac{0.2}{0.141} = 25.8$ kg. (56.8 lb.), respectively. When the output of the engine was made to vary, the readings were such as shown in Fig. 14. For the two end positions and the middle position of the governor weights there were obtained the three rising characteristic curves of governing parallel to each other.

It appears, therefore, that the horizontal displacement of the weights caused the characteristic curve of governing to shift to the right, but did not produce its turning. It affects the speed of rotation but not the degree of lack of uniformity of governing.

The behavior of the curves of equal output N_{el} (Fig. 14) of the steam-engine generator set is also of interest. At higher speeds a smaller torque corresponds to the increased output, and therefore one would expect a higher position of the governor. This is what actually occurs at all loads, but not when the set is running idle. In this latter case the internal resistances of the set determine what happens, and these play only a very minor rôle at higher loads. Now, the moment of the internal resistances increases with the speed of rotation, and therefore when the set is running idle the governor goes

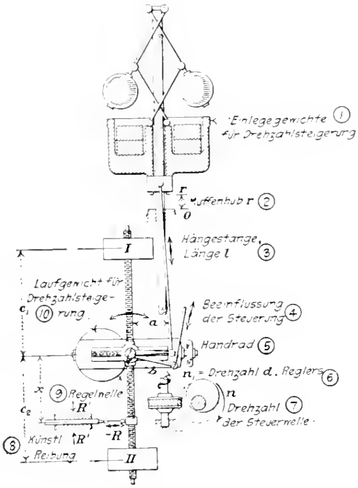

Fig. 13 Diagrammatic Sketch of the Experimental Governor Installation

(1) Additional weights for raising the speed of rotation of the governor; (2) Sleeve travel *r*; (3) Connecting rod, length *l*; (4) Valve-gear control; (5) Handwheel; (6) n_1 = r.p.m. of governor; (7) *n* = r.p.m. of the layshaft; (8) Artificial friction; (9) Governor shaft; (10) Weights for varying the speed of rotation of the governor.

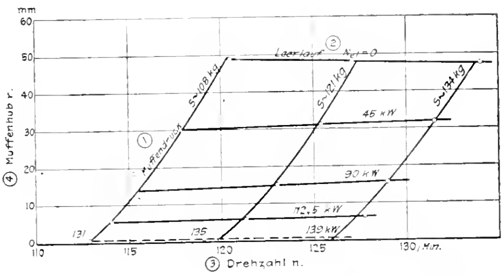

Fig. 14 Characteristic Curves of Engine Governing at Variable Speeds

(1) Sleeve pressure; (2) No-load operation; (3) Speed of rotation, *n* r.p.m.; (4) Sleeve travel.

down with the increase of speed; more steam when the set is running idle means a higher rate of speed on the engine.

If the weights be shifted in the vertical direction, the curves obtained will be those shown in Fig. 15. In that case the governor was first in its usual position. Next, the weight of 20 kg. (44.0 lb.) was placed 0.3 m. (11.8 in.) below the governor shaft, this corresponding to an addition of a product of forces × arm (this latter considered as being horizontal) = —6 m-kg. In the three instances the weight of 10 kg. (22.0 lb.) was lo-

cated 0.3 m. (11.8 in.) above the governor shaft, giving an additional moment of + 3 m-kg.

Under the influence of these additional weights the characteristic curves of governing undergo a rotation without displacement. They become steeper when the weight is located above the axis of governing and the governing itself tends to become astatic. On the contrary, when the weight is located under the governor axis, the characteristic curve becomes flatter and the regulation assumes a strongly static condition. The average speed of rotation of the engine is maintained, but the degree of lack of uniformity varies. When the weight is located below the axis it tends to pull the governor into its middle position, which makes greater variations in speed necessary in order to permit it to resume its end position. On the contrary, weights located above the governor axis push the

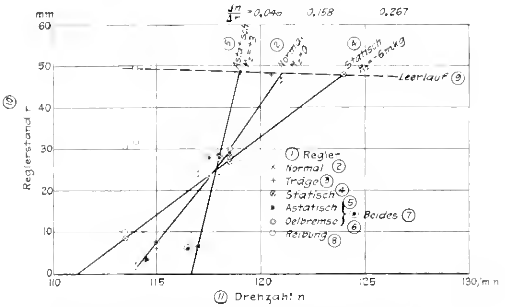

FIG. 15 CHARACTERISTIC CURVES OF ENGINE GOVERNING AT VARIABLE STATIC CONDITIONS AND VARIABLE STEAM DELIVERIES

(1) Governor; (2) Normal; (3) Sluggish; (4) Static; (5) Astatic; (6) Oil brake; (7) Both; (8) Friction; (9) No-load operation; (10) Position of governor r; (11) Speed of rotation, n r.p.m.

governor into its end position, so that only slighter variations of the speed of rotation become necessary.

In connection with Fig. 15, if weights of 10 kg. (22.04 lb.) be located 0.32 m. (12.59 in.) both below and above the governor shaft, neither the speed of rotation nor the degree of lack of uniformity of the governing will be affected. The mass of the governor is increased and the governor itself made more sluggish. The points "sluggish" and "normal" lie close to each other in Fig. 15, although the mass of the governor is increased by $20 \times (0.32\ 0.141)^2 = 103$ kg., which is considerable in comparison with the original governor mass of 130 deg. But the mass as such (that is, when it is equalized and does not come into action as a weight) has no influence on the static behavior of the governing.

Fig. 15 presents data of a further series of tests in which the motion of the governor was first subjected to damping artificially and next to molecular damping. The method by which mechanical damping was produced is shown in Fig. 13. As shown in the lower left corner of that figure, two cheeks are rubbing with a force R' (which can be adjustably varied) against a central piece drawn back and forth between the cheeks by the motion of the governor. Molecular damping is produced by an oil brake displacing this frictional damping. Fundamentally, the two arrangements are different in that in the case of an oil brake the damping force increases (by a law approaching the square law) as the velocity, and, what is more important, it converges toward zero along with the velocity. In the case of the mechanical damping device the damping force is practically independent of the velocity and is equally large when at rest. This, however, is not new.

Hence, in Fig. 15 the points, even with the oil brake in operation, lie in a regular manner, while the point of rest is not affected by the oil brake. On the other hand, the frictional damping produces a broad scattering of the point of rest of the governing and thus shows permanent irregularities.

All the above had a bearing on the question of the manner in which the speed of rotation n and the governor position r came to a permanent state under the influence of the governing properties of the governor. From this the author proceeds to an investigation of the manner in which the governor effects a passage from one position to another. This part of the article is quite extensive, illustrated by numerous curves, and is not suitable for abstracting. (*Versuche an einer Dampfmaschinenregelung*, Prof. Anton Gramberg, *Dinglers Polytechnisches Journal*, vol. 333, no. 4, February 23, 1918, pp. 25-30, 6 figs. *e*)

Testing

TESTING THE RELATIVE MERITS OF CASE-HARDENING MATERIALS, Chas. N. Underwood, Mem.Am.Soc.M.E. Case hardening may be said to consist of two parts: the first, carburizing the steel shell about the low-carbon soft steel; and the second, hardening this carburized shell by quenching when at a high heat. The second element is easily controlled and the problem is therefore only to find a case-hardening material best apt to give up its carbon to the steel. A test of such a material resolves, therefore, into finding a material which will give the deepest, densest and most uniform case under constant conditions of time, temperature, packing and quenching.

The present article describes the method of testing employed by the Remington Typewriter Works. The test pieces, 3½ in. long and 1 1/16 in. in diameter, were cut from a bar of round, bright machine-screw steel and packed in boxes, two pieces in each box. The box was completely filled with the case-

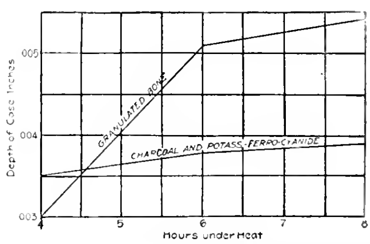

FIG. 16 RESULTS OF TESTS ON CASE-HARDENING MATERIALS

hardening material and the cover sealed with fireclay. Three boxes were packed with each kind of material, the materials tested being charcoal and potassium ferrocyanide, and granulated bone.

Special attention was paid to the proper location of the boxes in the furnace. The boxes were placed in rows and one row was removed from the furnace after four hours, one row after six hours, and one row after eight hours. As each box was removed the test pieces were taken out and quenched in cold water and the test numbers checked to insure the accuracy of the record. A log of the furnace temperatures was kept throughout the test. From this log it appears that after the specimens were placed in the furnace the temperature was raised until it reached 1800 deg. fahr. about one hour later.

The temperature was then cut down to, and held at, approximately, 1600 deg. fahr.

After hardening the test pieces were taken to the grinding

room and a groove was ground through the case completely around the circumference at about the center of the piece. The pieces were then sawed into two parts at the groove and the cut end of one of the pieces ground flat, highly polished with very fine emery and etched with a 20 per cent solution of nitric acid. Two lines perpendicular to one another were then scribed on this polished surface by means of a fine needle set in a steel holder, the depth of these lines, to a certain extent, indicating the hardness of the case. The original article describes, in some detail, the method of measuring the depth of case.

Fig. 16 gives the plotted results of measurements with the two case-hardening materials, which indicate that for a four-hour run the charcoal mixture gave a deeper case, but for longer runs granulated bone appeared to be more efficient. With both materials, however, the depth of case increased steadily up to a period of six hours, further increase of depth being at a much slower rate. (*American Machinist*, vol. 49, no. 13, September 26, 1918, pp. 569-571, 3 figs., *ep*)

Telescopic Focusing Apparatus for Photomicrography, A. F. Hallimond. There are certain difficulties in using an ordinary vertical camera in connection with the microscope. When the plate is supported at a distance of 10 in. or more above the microscope the height of the focusing screen often becomes the source of much inconvenience. Oscillation of the camera at opening of the dark slide is also troublesome.

To obviate these difficulties the telescopic arrangement described and illustrated in the present paper was designed. It resembles the ordinary form of reflex focusing camera. The rays proceeding from the microscope eyepiece which would normally converge to a focus on the photographic plate are reflected horizontally by a movable mirror. This mirror is attached to a metal plate large enough to cut off all light from the camera when in proper position and is held there by an adjustable stop. The deflected beam is focused by the telescope objective with the focal length of 4 in. upon cross-wires and the image so formed is seen together with the cross-wires when examined through the eye lens having a focal length of ¾ in.

To each length of camera there corresponds a fixed position of the focus to which the cross-wires must be set, but after this graduation has once been made it is sufficient in taking a photograph to fix the telescope for the proper camera length and focus the microscope so that the image is clearly defined on the cross-wires. The apparatus appears to be quite simple. (Paper before the September Meeting of the *Iron and Steel Institute,* abstracted through advance copy, 3 pp. 1 fig., *d*)

Ship Strain Recorder. A new device to record the "give" of a ship has been developed by F. R. McMillan, research engineer of the Concrete Ship Section, and H. S. Loeffler, assistant research engineer of the Section.

When equipped with this device, every strain that a ship experiences in a storm or, for that matter, in any weather, is recorded by little zigzag waves on a strip of paper which passes under a recording needle in the instrument. The apparatus was tried out on the concrete steamer *Faith* on her first voyage.

The "Strainagraph" is built somewhat on the principle of the seismograph. It may be destined to play an important part in future ship designing, for it gives a simple medium for comparison of the relative strength of different types of ships. Numbers of these instruments, placed in different parts of the ship, would show any weaknesses and give the expert a workable chart upon which to build an analysis or "diagnosis" of a ship's seaworthiness.

Primarily the instrument was designed to test out the qualities of the concrete ship just now passing from the experimental stage.

The strainagraph is attached at any point in a ship where it is desired to know the strain. A series of levers which multiply 140 times any movement transmitted to them is actuated by a plunger bar fixed to the ship at a point 40 in. distant. Thus the distance recorded on the chart is 5600 times the actual movement in any one inch of length.

The chart showing the record has a line at the top with breaks at intervals. Attached to the instrument is a clock which serves to measure on the chart the time during which the record is produced. Every double break in the top line marks the end of a minute and every single break the passing of a quarter of a minute.

The recording pen which records the zigzag line in the center of the chart travels upward when recording compression and downward when recording extension.

The instrument on the *Faith* was located amidships on a longitudinal deck beam about midway between hatches 2 and 3 on a line along the port side of these hatchways. (*Emergency Fleet News*, October 3, 1918, p. 13)

Varia

Mast Turning Lathe. The Traylor Shipbuilding Corporation, Cornwells Heights, Pa., has in operation in its yard a mast turning lathe that is one of the new developments in shipbuilding since the Emergency Fleet Corporation was created. Formerly the making of masts was a long and laborious operation fit for the best work of especially skilled men. The machine will handle timbers for a mast up to 100 ft. long and 3 ft. in diameter. The timber, after being centered and set up in the machine, which usually requires about half a day, is revolved at a speed of 50 r.p.m., by means of an electric motor, thus coming in contact with the cutter head, which is mounted on a carriage attached to the motor, and set at right angles to the mast. The cutter head revolves at a speed of 700 r.p.m. In this head are three hooked knives, which cut the material from the mast.

The carriage is propelled by a wire rope on a gypsy head, which also is run by a motor, the feed of the carriage being practically the same as on an old-fashioned sawmill.

When a mast is extra long and sags in the middle, it is necessary to put a steady rest at the point where the sag is greatest, thereby making the timber run true. To get the shape of the mast, that is, the taper at the top, it is necessary to set a rail which is bolted down to the bed of the machine and bent in exact position as the profile of the mast which is to be cut. On this rail runs a shoe, controlling the cross-movement of the carriage. If the rail is set away from the machine, it pulls the carriage closer to the center of the mast. If it is set nearer it moves the carriage further away. (*Emergency Fleet News*, Oct. 3, 1918, p. 12, *d*)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Survey.

CORRESPONDENCE

CONTRIBUTIONS to the Correspondence Departments of The Journal by members of The American Society of Mechanical Engineers are solicited by the Publication Committee. Contributions particularly welcomed are suggestions on Society Affairs, discussions of papers published in The Journal, or brief articles of current interest to mechanical engineers.

Ships for Foreign Trade

The Shipping Board is already taking cognizance of the opportunities and possibilities of trade development through the increase of the merchant marine of the United States. The following letter from Chairman Hurley of the Shipping Board has been sent to the Society:

To the Secretary:

The time has come for Americans everywhere to put themselves solidly behind American ships.

Our railroads must no longer stop at the ocean. We are building an American merchant fleet of twenty-five million tons—three thousand ships. We are backing modern ships with modern port facilities, establishing our bunkering stations all over the globe and will operate with American railroad efficiency. We will carry American cargoes at rates corresponding to our railroad rates—the cheapest in the world. Fast American passenger-and-cargo liners will run regularly to every port in Latin America, the Orient, Africa, Australia.

Are your members taking steps to use these ships to increase their own prosperity? Do they realize that American products of factory, farm and mine can be delivered to customers in foreign countries on terms which will build lasting trade? Do they realize the possibilities for bringing back raw materials to extend their products and trade?

We must all take off our coats and work to bring these American ships home to the people of every American interest and community. The manufacturer must think of customers in Latin America as being as accessible as those in the next state. The farmer must visualize ships carrying his wheat, cotton, breeding animals, dairy products and fruit to new world markets. The American boy must think of ships and foreign countries when he chooses a calling.

Has your organization appointed a live committee on Merchant Marine? Is the chairman of this committee a man of international vision? Are you applying the new world vision to the interests represented in your organization and learning what ships can do toward widening their markets?

Public neglect ruined our old mercantile marine. Congress was not to blame—it simply reflected the indifference toward ships of the average American. Once more we have a real American merchant fleet under way, backed by far-reaching policies for efficient operation. We must dispel indifference and keep our flag on the trade routes of the world. We are going to take trade from no other nation. But we must serve our own customers and help other nations in their ocean-transportation problems after the war.

Edward N. Hurley, *Chairman*,
United States Shipping Board.

Washington, D. C.

Recent Improvements in the Manufacture of 85 Per Cent Magnesia Insulation

To the Editor:

It has frequently been brought to the writer's attention that the results published in his paper entitled The Heat-Insulating Properties of Commercial Steam-Pipe Coverings are not fair to J-M 85 Per Cent Magnesia because of the fact that the samples tested were not representative of the J-M 85 Per Cent Magnesia manufactured at the time the paper was published and since that time.

The samples were taken from a stock where they had been stored for a considerable period, and in the interval between the time they were manufactured and the time the paper was published very important improvements had been made in the process of manufacturing. The writer has had excellent opportunities to observe the effect of this improvement in manufacture since he became associated with the H. W. Johns-Manville Company in the capacity of consulting engineer.

However, the new material was tested by the writer at the University of Wisconsin several months before he became connected with the H. W. Johns-Manville Company and the results given below are quoted from the report of that test. The test was made by identically the same methods and on the same apparatus as the test previously reported in the writer's paper. Furthermore, subsequent tests have checked very closely with the test of the new Magnesia here given, which fact shows that a uniformly better product has been developed.

"The test of J-M 85 Per Cent Magnesia, results of which are given in Trans.Am.Soc.M.E., Vol. 37, pp. 944, 946 and 958, was made in November 1914 and the sample was taken from the stock at the University Heating Station, where it had been on hand for some time, probably more than a year. Therefore, the new sample tested in February and March 1916 represented entirely a different product embodying the improvements in manufacture which had been made in the intervening period of two or more years.

"Description of samples:

	New	Old
Pipe size, in.	5.00	5.00
Weight per foot, lb.	2 73	2 92
Thickness, in.	1.11	1.08
Apparent thickness, in. (½ of outside diameter of covering—½ of outside diameter of pipe)	1.18	1.13

"Results of test:

DATE OF TEST: FEBRUARY 23 TO MARCH 2, 1916

Temperature Difference	B.t.u. per Sq. Ft. of Pipe Surface per Deg. Temp. Dif. per Hr.		Efficiency, Per Cent	
	New	Old	New	Old
50	0 373	0.435	80 9	77 7
100	0.381	0 438	82 3	79 6
200	0 397	0 446	85 1	83 3
300	0 413	0 455	87.3	86 1
400	0 429	0.469	89 4	88 4
500	0 445	0 488	91.4	90 6

"A comparison of the above figures shows the great superiority of the new Magnesia over the old."

L. B. McMillan.

New York, N. Y.

To Readers of The Journal

At the time these pages were approved for publication, there was a strike of press feeders in the printing establishments of New York City, including the one from which The Journal is issued. This will account for any delay experienced by readers in receiving the present number.

SOCIETY AFFAIRS

A Record of the Current Activities of the Society, Its Members, Council, Committees, Sections and Student Branches; and an Account of Professional Affairs of Interest to the Membership

THE one great lesson of the war is the bringing home of the essential need of all to be mutually helpful—that we are interdependent—as individuals, as professions, as peoples.

It is not inconsistent with Washington's admonition against entangling alliances that this nation should develop "cultural relations" with other countries.

I was about to say neighbors, because we shall soon cease to regard any place as distant. Past-President Hartness told me the other day that shortly we would use the aeroplane as a developer of new sections in much the same manner as the railroad half a century ago, with the advantage that no highway is required.

Among the specific activities to which the Secretary wishes to attract attention is the American Engineering Standards Committee.

It is proposed to organize a committee representing the Government and the professional societies on much the same lines as the British Engineering Standards Association.

This association has for over fifteen years been doing consistent work representative of the whole British nation, whereas in the United States, however meritorious individual pieces of work, notably, specifications for materials, screw threads, boiler code and safety standards, nevertheless they have been haphazard and are representative only to the degree of care with which the individual sponsor society secured representative delegates to its conferences.

The International Electrotechnical Commission, the Pan-American Scientific Congress, the International Engineering Congress and the Aircraft Stadardization Board, in all but the first of which representatives of this Society have taken a conspicuous part, have led at least the English-speaking people to the necessity for Anglo-American Standards. The Secretary is in hope that international standardization will be contemporaneous with Anglo-American, but if that is an ideal not yet capable of attainment, let us by all means proceed with Anglo-American.

In another column is the letter from Mr. Hurley respecting our Merchant Marine. President Main would like all those in the Society who are interested to advise him and give their opinions as to how the Society may respond.

Intimately bound up with Mr. Hurley's invitation is the subject of development of relations with Central and South America. We have in the Monroe Doctrine the most emphatic basis for further intercourse. On the staff of the Society at headquarters we have, too, Mr. Leon Cammen, who speaks and reads sixteen languages, and Mr. Jesse E. Vera, who has traveled extensively in South America and speaks the languages fluently. The Secretary, therefore, is not only carrying out a lifelong activity but is confident he is doing that which the Society generally wishes to be done, namely, to encourage professional organizations throughout the world to send visitors to us and to promise every assistance.

The Secretary has long established intimate friendships with officers of sister institutions abroad, and with the aid now of the Society's linguists greetings in one's own tongue can be given each visitor.

Incidentally it should be remarked that both Mr. Cammen and Mr. Vera contribute to the Engineering Survey given monthly in THE JOURNAL.

The Secretary would consider it a privilege to arrange introductions for members going abroad and, vice versa, hopes in their foreign correspondence all members will encourage prospective visitors to America to expect a warm welcome at Society headquarters.

CALVIN W. RICE,
Secretary.

Council Notes

A MEETING of the Council was held on the afternoon of Friday, September 20, 1918, at Tarrytown, New York, at the home of Past-President Worcester R. Warner. There were present: Charles T. Main, *President;* H. de B. Parsons, Wm. H. Wiley, *Treasurer;* Worcester R. Warner, D. S. Jacobus, R. H. Fernald, C. T. Plunkett, John Hunter, Arthur M. Greene, Jr., James Hartness, John Stevens, L. P. Alford, *Chairman Meetings and Program Committee;* George A. Orrok, *Chairman Publication Committee,* and by invitation, Henry Hess, *Chairman Standardization Committee;* George H. Barrus, *Chairman Power Test Committee;* F. R. Low, *Chairman Advisory Board, Power Test Committee,* L. C. Marburg, representing the *Local Sections Committee,* and Calvin W. Rice, *Secretary.* This was the first meeting of the Council at which under the amendments to the Constitution voted in effect at the Spring Meeting in June, 1918, the Chairman of the Standing Committees of Administration had a seat in the Council.

BUSINESS FROM THE PRESIDENT

Committee on Aims and Organization. The President reported that as a result of conferences and suggestions from the Local Sections Committee, he had given his hearty approval to a suggested committee, similar to that appointed by the American Society of Civil Engineers, whose purpose it would be to discuss and formulate the aims and activities of the Society in the light of modern development and present-day thought and assist in finding an effective method of coöperation with the engineering profession for carrying out these aims. Following a report by Mr. Marburg, the President was empowered to appoint a committee on Aims and Organization, to be composed of one member from each Local Section and seven members at large.

STANDING COMMITTEES OF ADMINISTRATION

Finance Committee. The recommendation of this committee as presented in the Budget of date October 1, 1918, was approved, showing a total appropriation of two hundred and thirty-five thousand five hundred and thirty-five dollars ($235,535) for the fiscal year ending September 30, 1918.

Engineering Index. The Council approved the initiation of an engineering index as part of THE JOURNAL.

Meetings and Program Committee. The appointment of C. B. Auel, H. L. Whittemore, Byron Cummings, as members of the Sub-Committee on Protection of Industrial Workers, was approved.

Prof. Wm. Kent. A committee of three to prepare a memorial to Professor Kent was approved, to be appointed by the President.

Local Sections Committee. On recommendation of this committee, it was voted to approve the exchange of courtesies with the Los Angeles Engineering and Architects' Association.

The petition from the Cleveland members for authority to form a Section of the Society in Cleveland, as the mechanical-engineering section of the Cleveland Engineering Society, was also approved.

OTHER STANDING COMMITTEES

Standardization Committee. This committee was authorized as representing The American Society of Mechanical Engineers, to take definite and active steps to assist with the formation of the American Engineering Standards Committee.

Research Committee. The chairman reported that three of the sub-committees of this committee are at present very actively at work on the subjects of lubricants, bearing metals and flow meters, and it was hoped to organize in the near future some additional special committees.

PROFESSIONAL COMMITTEES

Screw Threads and Threaded Parts. The appointment of E. M. Herr, *Chairman;* E. H. Ehrman, *Vice-Chairman;* Stanley G. Flagg, James Hartness, A. M. Houser, Frank O. Wells as a Committee on Screw Threads and Threaded Parts was approved.

The duties of this Committee will be advisory, and its members will be ex-officio members of all of the existing committees considering screw-thread standards, and such existing committees will automatically become sub-committees of the new committee.

One of the functions of the committee will also be to follow the activities of other societies and governments in the work of screw-thread standardization and avoid duplication, and an effort will be made to bring together all interests and obtain results generally acceptable.

British Engineering Standards Association. In response to an invitation of the Association, asking that the Society coöperate in standardization of Milling Cutters and Small Tools, the President was empowered to appoint a committee for this purpose.

Boiler Code Committee. Interpretations Nos. 194, 195, 196, 197, 198, 199, and reopened cases 190 and 191, of this committee were accepted. They have been published in THE JOURNAL.

The printing of the revised Boiler Code was approved subject to the approval of the entire Boiler Code Committee.

Fire Hose Couplings. A suggested standardization of Fire Hose Couplings, with an invitation of the National Board of Fire Underwriters, was approved and referred to the President, with power to appoint a Committee on Fire Hose Couplings.

SPECIAL COMMITTEES

War Activities. The Secretary presented progress reports of the following War Activities Committee: War Industries Readjustment, Machine Tool Committee and Gages Committee.

APPOINTMENTS

By the President. George A. Orrok and F. R. Low to represent the A.S.M.E. on a Joint Journal Committee, of Engineering Council.

Council of (Women's) Organizations for War Service: Mrs. Chas. Ethan Davis.

National Safety Council, St. Louis, September 16 to 20, J. P. Calderwood, M. W. Alexander, C. M. Hansen, as Honorary Vice-Presidents.

Informal Corresponding Committee on Screw Threads with British Engineering Standardization Association. E. M. Herr, *Chairman;* E. H. Ehrman, *Vice-Chairman;* R. E. Flanders, F. O. Wells, L. V. Benet, appointed as a committee, to be called British Informal Corresponding Committee—which is designed to help screw-thread standardization work in an informal way through educational methods.

By the Council. Dr. W. F. M. Goss was appointed to fill the unexpired term of two years of the late Dr. F. R. Hutton on the John Fritz Medal Board of Award.

Dr. Ira N. Hollis was appointed Chairman of the Student Branch Committee.

Adjournment was taken to meet in Indianapolis on the occasion of the Joint Section Meeting of the Mid-Western Sections on October 25. (This meeting was later postponed on account of the epidemic of Spanish influenza.)

CALVIN W. RICE,
Secretary.

Organization and Proceedings of National Screw Thread Commission

THE Commission for the Standardization of Screw Threads, authorized by Congress in accordance with Act No. 10852 of the House of Representatives, of which mention was made on page 875 of THE JOURNAL for October, was formally appointed by the Secretary of Commerce on September 21, and has been divided up into the following committees:

1 *Pitches, systems, form of thread*—F. O. Wells, Com. S. M. Robinson, E. H. Ehrman, H. T. Herr, H. W. Bearce, secretary.
2 *Tolerances, classification*—James Hartness, E. H. Ehrman, Col. E. C. Peck, H. L. Van Keuren, secretary.
3 *Nomenclature and terminology*—F. O. Wells, Com. E. J. Marquart, Major O. B. Zimmerman, Robert Lacy, secretary.
4 *Gages and methods of test*—Col. E. C. Peck, James Hartness, Com. E. J. Marquart, H. L. Van Keuren, secretary.

Seven of the members of these committees are members of the Society, namely, Messrs. Wells, Ehrman, Herr, Hartness, Peck, Zimmerman and Lacy.

As stated in the bill, the duties of the Commission are to ascertain and establish standards for screw threads, which shall be submitted to the Secretary of War, the Secretary of the Navy and the Secretary of Commerce for their approval. These standards, when approved, shall be adopted and used in the manufacturing plants under the control of the War and Navy departments and so far as practicable in all specifications for screw threads in proposals for manufactured articles, parts or materials to be used under the direction of these departments. It is also intended by the bill that the Secretary of Commerce shall promulgate such standards for use by the public and publish the same as a public document.

The first hearing for the purpose of obtaining data and views from manufacturers and users of screw-thread products was held on October 7 in the Engineering Societies Building, New York City, at which the following topics were discussed:

1 As a national standard, is there any objection to the continua-

tion of the U. S. Standard system of thread diameters and pitches for general use in practically its present shape?

2 As a national standard, is there any objection to the adoption of the S. A. E. system of diameters and pitches of fine threads?

3 As a national standard, to what extent could the A. S. M. E. system of standard machine screws be adopted?

4 There seems to be a general feeling that in standardization we should make it possible to cover several classes of work and there has been suggested a minimum of four classes of fits to provide for different grades of work ranging from reasonably wrench-tight fits to very loose fits. Would such a classification, including at least four classes, be sufficient for all grades of work encountered in the various systems of threads previously mentioned or would a classification including more than four classes be required?

5 Is there any objection to adopting the "standard hole" practice for screw threads—that is, the practice of making all the taps for any particular thread of one basic size and securing the required fit by changing the diameter of the screw on male threaded work which is to assemble with the nut cut by the basic tap?

The consensus of opinion of those present was as follows:

1. The U. S. system should be continued practically in its present form for the ordinary threaded work, to which it is well adapted.

Objections were raised to its use for diameters less than ½ in. on the ground that for small work the U. S. pitches are too coarse and the threaded work too much weakened by excessive depth of thread.

2. The S. A. E. system is satisfactory for use where finer threads are necessary, as, for example, in automobile aud aeroplane work.

3. The A. S. M. E. machine-screw system should be used to supplement the U. S. system for diameters less than ¼ in., and all sizes from 14 to 30 should be discontinued in order that there may be no overlapping of the two systems. A minority thought that all A.S.M.E. sizes should be retained.

4. Classification of Fits. The general opinion was that four classes of fits would be ample to provide for all ordinary threaded work, and that very probably three classes would be sufficient, since it was felt that wrench fits, stud fits, etc., which could not be covered by general specifications should be classed as "Special," and no attempt made to include them in the regular classification.

5. Standard Hole Practice. There was a sharp difference of opinion on the question of whether the nut or the screw should be made basic, with the majority favoring the former.

A part of the objection to making the hole basic arose from a misapprehension. It was suggested that if the tap or the tapped hole were made basic it would be necessary to carry in stock several sizes of bolts in order to provide for different classes of fits. Such, however, is not the case, since in general only a single class of fit will apply to each threaded product, and only that class would be carried in stock. For example, machine screws should be made within certain tolerances, while bolts for agricultural machinery would require larger tolerances, and there would be no necessity for providing for machine-screw fits on agricultural-machinery bolts, or for "agricultural fits" on machine screws.

A second hearing was held in New York on October 21. Further hearings will be held at New York, Dayton, Detroit, Washington and other places as may be advisable, and manufacturers and users of screw-thread products are invited to attend the various hearings. Those desiring to be present should submit their intention in writing, together with a statement covering the points they wish to bring to the attention of the Commission.

After sufficient information is secured from the manufacturers and users, the Commission will decide upon the screw-thread systems to be promulgated for use as national standards and will recommend tolerances for the interchangeable manufacture of various threaded products in which the standard thread systems are used.

Ambrose Swasey's Second Gift to the Engineering Foundation

To his original gift to the United Engineering Society of $200,000 for engineering research, which made possible the establishment of the Engineering Foundation, Mr. Ambrose Swasey, Past-President Am.Soc.M.E., has added $100,000. This splendid gift, making a total of $300,000, is an expression of Mr. Swasey's appreciation of the war service already rendered by the Engineering Foundation; and of his belief in the urgent need for research in applied science in this country.

The following appreciation of Mr. Swasey's generosity has been received from the Trustees of the United Engineering Society and the Engineering Foundation:

Said Plutarch a long time ago, "To appreciate a man's work at the full it is well to know the man himself, his circumstances and the incidents of his career." He might as truly have said "gift" instead of "work."

Ambrose Swasey, engineer, collaborator with scientists, promoter of engineering research, patron of the Engineering Foundation, advancer of the good of mankind, modest gentleman and generous giver, is, happily, well known to a great many engineers, who will therefore more fully appreciate his recent additional gift, for the use of the Engineering Foundation, the purpose of which is "the furtherance of research in science and engineering, and the advancement of the profession of engineering and the good of mankind."

But full appreciation of a gift of money necessitates more than acquaintance with the giver and knowledge of the amount. Its timeliness; its inspiration; the character and continuity of its benefits, all must be comprehended. But whose imagination, though far-visioned as the great telescopes Mr. Swasey has built, can see the limits of benefit of such gifts as he has made to the Engineering Foundation, attracting—as they will—other gifts and evidences of devotion to a great cause? Every such gift lays responsibilities upon the recipients. Will American engineers grasp not merely their pecuniary value but also emulate the spirit of fraternity and desire for harmony which have accompanied them? Shall we not work together and with Ambrose Swasey to advance still further the good of mankind, thus to demonstrate an acceptance of our obligations to humanity which is a counterpart in a democracy of the *noblesse oblige* of aristocratic tradition?

Timeliness is a wonderful feature of Mr. Swasey's gifts. The first was made in the early stages of the present struggle of the nobler elements of the world against the ignoble, which has come to be "the people's war." It enables the Engineering Foundation to join with the National Academy of Sciences in responding to the President's request to bring into coöperation governmental, educational, industrial and other research agencies in the interest of the national defense and scientific and industrial research, by establishing the National Research Council. This council of scientists and engineers has already a fine record of achievement.

To his first large gift, the principal of which is still intact, Mr. Swasey has now added generously at another psychological moment. As the great conflict seems nearer an end, there lies immediately before humanity a great era of physical reconstruction, and, vastly more, an era of spiritual advancement and elevation such as has never yet been experienced. Many of the problems of human relationships, of justice and of mercy, await the genius of the engineer for their solution, quite as much as do the tasks of construction and the development of physical resources. Let us go forward with Ambrose Swasey into the fields of opportunity. Let differences be put aside and a united, mighty effort be exerted for the advancement of the engineering profession and of mankind.

ALFRED D. FLINN, *Secretary*,
United Engineering Society and Engineering Foundation.

A Society badge found in a public building in Philadelphia has been received at Society's headquarters. Further information may be obtained by addressing the Secretary's office.

ANNUAL MEETING PROGRAM

New York, December 3 to 6, 1918

(Tentative; Other Papers to be Announced Later)

Tuesday Evening, December 3

Report of Tellers of Election and Introduction of the President-Elect

Presidential Address, followed by Reception

Wednesday Morning, December 4

Business Meeting: Amendments to Constitution; Reports of Standing Committees of Administration and Standing Committees; Reports of Special Committees, including Standardization of Flanges and Pipe Fittings

Preliminary Report of the Committee on Aims and Organization

Wednesday Noon

Luncheon and Address by Dr. George W. Kirchwey, formerly Dean of Columbia Law School, on A Message from the Legal Profession

Wednesday Afternoon (Simultaneous Sessions)

MACHINE-SHOP SESSION

Measurement of Thread Gages, H. L. VanKeuren

Standards for Large Taper Shanks and Sockets, Luther D. Burlingame

It is also expected that reports will be presented on the work of the British Engineering Standards Association

In connection with this session, the Bureau of Standards has arranged for an exhibit of the measuring apparatus and methods of the Bureau in testing screw-thread gages.

JOINT SESSION ON REFRIGERATION

The American Society of Refrigerating Engineers will join with this Society in a session on Refrigeration, with the following subjects:

Refrigerating Plant Efficiency, Victor J. Azbe

Topical Discussion on Fuel Economy in Refrigerating Plants

GENERAL SESSION

Weights and Measures of Latin America, Frederick A. Halsey

Papers on Management, with particular reference to the U. S. Shipping Board

Wednesday Evening

Lecture on The Achievements of Naval Engineering in the War by William L. Cathcart, Lieutenant-Commander, U. S. N. R. F.

Thursday Morning, December 5

Keynote Session on the general subject of Engineering of Man Power

Papers and addresses will be contributed to this session on: Organization; Standardization and Administration of Wages; Non-Financial Incentives; Incentive of Control in Industry; Employment of Labor; Dilution of Labor; Intensive Training; Human Relations in Industry

Thursday Afternoon (Simultaneous Sessions)

KEYNOTE SESSION

Continuation of morning session on the general subject of Engineering of Man Power

TEXTILE SESSION

Industrial Power Problems, W. F. Uhl

Properties of Airplane Fabrics, E. Dean Walen

Daylight vs. Sunlight in Sawtooth Roof Construction, W. S. Brown

Factory Stairs and Stairways, G. L. H. Arnold

GAS-POWER SESSION

The Cooling Losses in Combustion Engines as Affecting Design, C. A. Norman

Discussion of Certain Problems in Regard to Marine Diesel Oil Engines, J. W. Anderson

This session will be largely devoted to a discussion of the subject of oil engines

Thursday Evening

Motion pictures relating to the technical side of war; dancing will follow

Friday Morning, December 6 (Simultaneous Sessions)

POWER-PLANT SESSION

The Conservation of Heat Losses from Pipes and Boilers, Glen D. Bagley

Chemical and Physical Control of Boiler Operation and Application of Simple Formula for Estimating the Heat-Loss Items, E. A. Uehling

GENERAL SESSION

The Relative Corrosion of Alloys, R. B. Fehr

The Relative Merits of Cast-Iron, Wrought Iron and Steel Pipe for House Drainage Purposes, Wm. P. Gerhard.

The Design and Maintenance in Operation of Hydraulic Valves and Fittings for Use with Pressures from 1000-8000 Lb. Per Sq. In., Wm. W. Gaylord

Mechanical Features of the Vertical-Lift Bridge, Horatio P. Van Cleve

INDIANAPOLIS MEETING POSTPONED

Although the ban on public meetings was about to be removed in Indianapolis at the time the Council meeting and the meeting of the Mid-Western Sections was scheduled to be held in that city, October 25 and 26, it was nevertheless considered advisable to postpone the event to a later date.

The meeting is tentatively scheduled for November 15 and 16 and members will receive individual notice. If this arrangement can be made, the Indianapolis committee will endeavor to carry through the program as arranged for the original meeting. The program of the meeting was as follows:

First Day

9:30 a. m. Registration at Claypool Hotel.

11:30 a. m. Meeting of the Committee on Local Sections and members of the Executive Committees of the Mid-Western sections.

12:30 p. m. Informal luncheon at the Claypool. The Mayor of Indianapolis will welcome the visitors and President Main will respond.

2:00 p. m. Symposium on Fuel Conservation:

Session opened by Professor Charles Russ Richards, Dean of the College of Engineering and Director of the Engineering Experiment Station of the University of Illinois.

An explanation of the Regulations of the Fuel Administration, by Dr. P. B. Noyes, Director of Publicity and Information, U. S. Fuel Administration.

What the Fuel Administration Expects of the Engineer, by David Moffat Myers, Advisory Engineer, U. S. Fuel Administration.

Fuel Economy on the Railroads, by Major E. C. Schmidt, of the Railway Fuel Economy Division.

Discussion, in which the Administrative Engineers of the Fuel Administration and members of the Society will participate.

Storage of Coal, by Prof. H. H. Stoek, University of Illinois.

6:30 p. m. Informal dinner, at which nominee for President M. E. Cooley, is expected to speak, followed by war pictures.

Second Day

9:00 a. m. Symposium on Research.

Opening addresses by Profs. Arthur M. Greene, and Walter Rautenstrauch, members of the Society's Committee on Research.

Address by Mr. C. E. Skinner, Engineer, Research Division, Westinghouse Electric & Manufacturing Co. on Organized Research in Connection with the Industries.

Address by Dr. W. J. Lester, Vice-Chairman of the Engineering Division, National Research Council.

Paper to be submitted by Dr. H. M. Howe, Chairman of Engineering Division of the National Research Council.

Discussion by members of the Society.

12:30 p. m. Informal luncheon at place arranged by the Local Committee.

2:30 p. m. Visit to Nordyke & Marmon's plant to witness the manufacture of the Liberty Motor.

AMONG THE SECTIONS

The Committee on Local Sections gives the following information to the Local Executive Committees on the subject of formulating local constitutions and by-laws in conformity with the national by-laws governing Local Sections which have been in successful operation since October 1917.

These national by-laws were the result of two years' work on the part of the major committee, and they were framed with the object of covering all the variety of conditions existing in the several centers, and at the same time affording opportunity to the individual Sections to carry on activities of local interest.

To date a number of the Sections have given attention to this matter of constitution and by-laws, and for the benefit of the other committees who might like to institute this piece of work the Committee on Local Sections drafted a blank form of constitution which has been sent to all the Sections through the medium of the record books of their chairmen and secretaries.

It is interesting to review some of the documents which govern the Local Sections' activities. It should be noted that in some cases the coöperation is so close that the name of our Section has been written in the local society constitution.

The By-Laws of the Affiliated Technical Societies of Atlanta antedate our national by-laws, having been adopted in 1913. The fundamentals of this organization are that the local sections of the national engineering societies and the Chemical Society and the Engineering Association of the South have equal rights and privileges. The by-laws are brief, governing the executive committee and the order of business at the meetings. All the members of the participating organizations are included as members of the Affiliated Association.

The document of St. Louis exemplifies very forcibly the unification and coöperation of all the Societies in that important center. The Association is managed by a Council on which are represented the Engineers' Club and each of the affiliated societies. This Council has jurisdiction over all matters of joint interest in so far as its decisions shall not conflict with the rules of the individual societies. The constitution provides for the joint action on all local public affairs presented for consideration to any one or more of the societies. It also provides for action on national public affairs, and the Council is empowered to refer questions to the consideration of one or more national engineering bodies through their affiliated societies. In all the other articles of the constitution which cover meetings, dues and services the idea of joint action on all matters predominates.

The constitution of the Birmingham Section was adopted in March 1916 and provides inclusively for the organization of the Birmingham Section. The document states that the objects of the local Section shall be the professional improvement of the members of the A.S.M.E. residing in and near Birmingham; the encouragement of social intercourse among them, the advancement of engineering in its several branches, the advancement of the engineering profession in the opinion of the general public, and the influencing in a dignified manner of the solution of public questions involving engineering and scientific consideration. The constitution provides for membership, for officers and their duties, for the annual and monthly meetings, and for amendments.

The Indianapolis Section, which is only two years old, has already a very complete constitution and by-laws, very similar to that of Birmingham in the statement of objects of the Section, in the membership, the officers, and meetings. The by-laws provide for the order of business at the meetings, for the nomination of officers, and for the parliamentary standards.

The New York Section operates under a constitution only, which was adopted on May 1, 1918. The constitution is brief, and its articles cover the name of the section, membership, officers, nominations and miscellaneous.

Philadelphia has been considering a constitution this summer, and a draft of the proposed constitution was presented at its September meeting. The significant feature of the Philadelphia constitution is the provision for the Executive, Papers, Meetings, Public Relations, Research, Nominating, Auditing and Membership Committees. The organization in Philadelphia, therefore, is more nearly comparable with the organization of the parent Society, and the suggestion this document develops is that it may be desirable to encourage the local executive committees to form sub-committees parallel with the committees of the major organization with a view to increasing the inter-committee relations of the parent society, and thus contribute very materially to the strength of the organization.

Minnesota has also drafted a constitution which is now under consideration for adoption. The document itself states that it has been drawn up "to cover in detail the peculiar organization which has been developed for the Minnesota Section and its particular purpose is to form a guide for future work so that activities can be carried along with uniformity." The article on membership provides for local members who are not members of the A.S.M.E. and includes members of the Student Branch in the State of Minnesota as full members of the Section. In the article entitled Activities the object of the Section is stated to be for the holding of meetings for the presentation and discussion of papers relating to engineering, and to the allied arts and sciences, and also for holding meetings of social intercourse, and making trips to plants engaged in engineering enterprises.

In all the constitutions formulated so far, there is a significant element of individuality. The provision of the national by-laws is that local sections may frame their own rules, but they should conform as far as possible with the spirit of the national rules. The various interpretations of these sentiments by the local committees are interesting, and it is to be hoped that soon each one of our twenty-two sections will adopt a form of by-laws which will most nearly meet its local needs.

Section Meetings

BIRMINGHAM

October 24. The program for this event of the local society, held at the Birmingham Civil Association's rooms, was under the auspices of the Birmingham Section. E. H. Rosseau, chief engineer of the Birmingham Machine & Foundry Co., delivered an interesting and timely paper, illustrated with balopticon views, on The Manufacture of Raw Sugar. The meeting was followed by a buffet lunch.

JAMES W. MOORE,
Secretary.

BOSTON

October 17. A meeting of the Section, together with the Boston members of the A.I.E.E., A.S.C.E., Waterworks Association, Worcester Section, Providence Engineering Society, and the Manufacturers' Association of Eastern Massachusetts, was held in Lorrimer Hall. Magnus W. Alexander, Mem.Am.Soc.M.E., read a paper on The Elements of the Labor Problem.

ELMER SMITH,
Secretary.

CHICAGO

October 28. A joint meeting with the Chicago Section of the A.I.E.E. was held, the subject being Illumination. A paper was read by Professor Clewell.

ARTHUR L. RICE,
Secretary.

CLEVELAND

October 4. The newly established Section organized with the following officers: E. S. Carman, *Chairman;* J. H. Stratton, vice-chairman; J. H. Herron, secretary, and Willard Brown, treasurer.

J. H. HERRON,
Secretary.

INDIANAPOLIS

October 25-26. The joint meeting of the Council with the mid-western sections has been postponed, due to the influenza epidemic.

CHARLES BROSMAN,
Secretary.

LOS ANGELES

The Los Angeles Section united with the Technical Societies of Los Angeles in an official effort to assist the fourth Liberty Loan. This definite act on the part of the profession should be the forerunner of future nation-wide organization for civic welfare.

T. J. ROYER,
Secretary

CONNECTICUT
(New Haven Branch)

October 9. This meeting was postponed due to the influenza epidemic.

E. H. LOCKWOOD,
Secretary.

MINNESOTA

October 7. A meeting was held at the rooms of the St. Paul Association. Dinner was served at 6.30 and there were 40 members and guests present. F. W. Speer, Jr., Chief Chemist of the H. Koppers Co., Pittsburgh, read a paper on By-Product Coking, Particularly in Its Relation to the Steel and Iron Industry. Mr. Speer gave a short history of the development of the coke industry. Then by means of a series of lantern slides he described a complete by-product coke plant, and told in a very concise manner how the coke is produced and the by-products conserved. The lecture was followed by a lively discussion.

Among the guests were Capt. L. P. Riggins, Lieut. B. A. Meixner, and Lieut. J. J. Hanson, of the Ordnance Department, U. S. A.

RAY MAYHEW,
Secretary.

NEW ORLEANS

October 14. The Section held its monthly meeting in conjunction with the Louisiana Engineering Society.

E. W. CARR, JR.,
Secretary.

NEW YORK

September 28. At the invitation of Mr. John Hunter, a member of the Council and naval constructor of the Standard Shipbuilding Corporation, members of the Section were guests of the company on the occasion of a double launching at the Shooter's Island yard, Staten Island, of two 7500-ton vessels, the steamships Monmouth and Dallas. Probably 750 men and women participated and the company provided two commodious excursion steamboats to carry the party between the Battery and the shipyard, and tendered an unexpected collation after the launching.

H. D. EGBERT,
Secretary.

PHILADELPHIA

September 24. The initial meeting of the 1918-1919 season was held at the Engineers' Club. The address of the evening was given by W. H. Blood, Jr., of the American International Shipbuilding Corporation, on The Making of Hog Island, the Greatest Shipyard in the World. This address was illustrated with many lantern slides, and film showing the launching of the first vessel from that yard.

At this meeting the proposed by-laws for the government of the Section, mentioned above, were submitted.

October 22. This meeting was postponed, due to the influenza epidemic.

J. P. MUDD,
Secretary.

ST. LOUIS

September 27. The first of the fall meetings was held in the Daniel Boone room at the Statler Hotel, preceded by a dinner. J. A. Whitlow, Administrative Engineer of the United States Fuel

October 23. This meeting was postponed, due to the influenza epidemic.
J. P. Morrison,
Secretary.

SAN FRANCISCO

September 26. As reported in the October Journal, a joint meeting of the local section of the A.S.C.E., A.S.M.E., A.I.M.E., A.I.E.E. and A.C.S. was held in the Engineers' Club, under the auspices of the local section of this Society.

The subject was Fuel Conservation, and consisted of a Symposium by the following speakers:

Albert E. Schwabacher, U. S. Fuel Administrator for California, Fuel Conservation; A. H. Markwart, Civil Engineer, Production of Energy; D. M. Folsom, U. S. Fuel Administration, Oil Division, Future Requirements of Oil; John A. Britton, V. P. and General Manager, Pacific Gas & Electric Co., The Use of Gas as a Conservation Measure; H. G. Butler, Power Administrator, Electric Consolidatioins and Their Relation to Fuel Conservation; P. M. Downing, Chief Engineer Electric Department, Pacific Gas & Electric Co., Sources of Energy Supply; Harry S. Markey, Mem. Am. Soc. M. E., District Steam Heating as Related to Fuel Conservation; Major George F. Sever, War Industries; W. J. Davis, Pacific Coast Engineer, General Electric Co., Railroad Electrification as a Fuel Conservation Measure; and Professor Edmund O'Neill, Mem.A.C.S., The Chemical Side of Fuel Conservation.

The reading of these papers was followed by a general discussion.
George L. Hurst,
Secretary.

Student Branches

The new military program as outlined by Secretary Baker calling for an increase of the Army by more than two million men by July 1, 1919, has vitally affected the technical colleges throughout the country. Since the students are not in any sense in a deferred or favored class, and will practically all be assigned to active service within the next year, schools and colleges obviously must undergo fundamental changes in school practice in order to render effective service.

In about 550 institutions Students Army Training Corps have been established, and these institutions will therefore cease to function as purely academic universities and will become a part of the Nation's war machine. The object of establishing these units is to utilize effectively the plant, equipment and organization of the colleges for selecting and training officer-candidates and technical experts for service in the existing emergency.

The Corps is divided into two sections, the Collegiate (or "A") Section and the Vocational (or "B") Section. The units of the "B" Section were formerly known as National Army Training Detachments. They aim to train soldiers for service as trade specialists in the Army.

The "A," or Collegiate Section, inaugurated October 1, is open to registrants who are members of some authorized college, university or professional school. Students of authorized institutions may join the Students Army Training Corps by voluntary induction into the service. They thus become members of the Army on active duty, receiving pay and subsistence, subject to military orders, and living in barracks under military discipline in exactly the same manner as any other soldier.

The housing, subsistence and instruction of soldiers in both branches of the Students Army Training Corps is provided by educational institutions under contraett with the Government.

The members of the Students Army Training Corps are voluntarily inducted into the service, and are ordinarily allowed to choose the branch of the service for which they wish to be prepared. This freedom of choice, however, is not absolute. It depends upon the individual's qualifications and upon the needs of the service at any particular time. The status of a member of the Students Army Training Corps is that of a private.

Members of the Students Army Training Corps, having already been inducted into the service, will not come under the operation of the Selective Service Law. It is expected that the members of Collegiate Sections will be transferred from institutions every three months in age groups, the twenty-year-old men going first, the nineteen-year-old men going next, and the eighteen-year-old men last, roughly corresponding to the period at which men of these ages will be called under the Selective Service Law. As these groups leave the colleges their places will be taken by new contingents obtained by individual induction, or, if necessary, in depot brigades. Students of such subjects as engineering, chemistry and medicine may be required to finish their courses where the needs of the service make this desirable.

Members of Vocational Sections will ordinarily remain at the institution for two months and will then be assigned to various branches of the service in which technicians are needed.

In addition to 11 hours per week of military training the course of study in the Collegiate Section of the Students Army Training Corps will consist of the ordinary college or technical courses grouped and modified in such ways as are necessary to meet the needs of the War Department.

Members of Vocational Sections will pursue such subjects as auto-driving, auto-repair, bench woodwork, sheet-metal work and electrical work, etc., in addition to 13½ hours per week of military training.

Members of both sections will attend courses on the Issues of the War.

At certain specified institutions, a limited number of registrants may, upon indicating their preference, be inducted into the Navy or the Marine Corps. Such men will wear naval uniforms, and pay their own expenses individually from an allowance made to them by the Navy Department. The Naval and Marine Sections will attend all drills and exercises of the Students Army Training Corps.

In this new development the Committee on Student Branches hopes there will be an opportunity for furthering the work of the Student Branch Organization. If the very full curricula preclude the holding of meetings of Student Branches it is hoped a skeleton organization with regularly appointed officers will be formed in order that the privileges of Student Branch membership may be obtained.

Society Donates Rooms to War Department

As a policy, the Society has no "slacker" rooms at its headquarters. The Committee on Education and Special Training, directing the Students' Army Training Corps, numbering 150,000 men in the principal colleges of America, are now the Society's guests and occupy the Members' Reception Room and the Council Room as headquarters for the Second District of the Committee.

Recently also the Congressional Commission on Standardization of Screw Threads has met in the Society's rooms. The Council considers it an honor to have headquarters freely used by the Government or by committees of other societies—in fact, *Service to the Utmost* is the Society's motto.

NECROLOGY

WILLIAM KENT

In the death of William Kent on September 18, announcement of which was made in the last number of The Journal, the Society has lost a member who will be sadly missed by a very large number who have regularly met him at the Society's meetings, or have come in contact with him in a professional way.

Mr. Kent was an organization member of the Society, and Vice-President from 1888 to 1890. He was preëminently versatile, an original thinker, a ready speaker, an author and frequent contributor of papers and technical articles, and an engineer whose services were much in demand in a consulting capacity or as an expert in patent cases. He was a regular attendant at the Annual and Spring Meetings, and probably contributed more largely to the discussion of the various papers than any other member, besides being the author of no less than 12 papers, a number of which were noteworthy contributions to engineering knowledge.

As the author of the Mechanical Engineers' Pocket-Book his name became known among engineers the world over, and through this medium he rendered an almost incalculable service to the engineering profession. For many years Mr. Kent had followed the practice of clipping and filing data on engineering subjects, and this material was made the basis of the first edition of his book in 1895. At that time practically the only American engineering pocketbooks were Trautwine, in the civil engineering field, and Haswell, largely mechanical, but dealing with engineering of an earlier day when rule-of-thumb rather than research was the main reliance. In Kent's book the practice was followed of summarizing the data and giving the sources of authority, so that any of the subjects could be investigated further.

William Kent

William Kent was born in Philadelphia on March 5, 1851. He was educated in the schools of that city, and later, while employed with the Jersey City Gas Company, he attended the night classes of Cooper Union for a period of five years. He then became connected with the blast furnace of Cooper, Hewitt and Company, Ringwood, N. J., where he remained until 1874. Becoming convinced of the necessity of further education, he entered Stevens Institute of Technology, first as a special student in chemistry, and later, at the instance of the late Dr. Robert H. Thurston, enrolled himself in the senior year class, graduating in 1876 with the degree of mechanical engineer. During his senior year he engaged upon investigations for Dr. Thurston upon the alloys of copper. During 1884-1885 he was president of the Alumni Association of the Institute.

From 1877 to 1879 he was editor of the *American Manufacturer and Iron World* of Pittsburgh, resigning to become superintendent of the open-hearth plant of the Schoenberger Steel Company. Leaving the steel business he took charge of the Babcock and Wilcox Company's Pittsburgh office, later being transferred to the New York office. While with this company he made numerous inventions on boilers, furnaces and boiler accessories. In 1887 he became general manager of the Spring Torsion Balance Scale Company and developed the methods and machinery for building this highly sensitive scale.

In 1891 Mr. Kent began the practice of consulting engineer and in 1895 became associate editor of *Engineering News*, a connection continued until 1903, at which time he was offered and accepted the position of dean of mechanical engineering in the L. C. Smith College of Applied Science in Syracuse University. He remained at Syracuse until 1908, when he became general manager of the Sandusky Foundry and Machine Company, Sandusky, Ohio. In 1910 he resumed his consulting engineering practice and at the same time became contributing editor to *Industrial Engineering*.

Besides his Mechanical Engineers' Pocket-Book, Mr. Kent was also the author of Steam Boiler Economy, Investigating an Industry, Bookkeeping and Cost Accounting for Factories, as well as papers presented before the numerous technical societies of which he was a member, and articles contributed to the technical press. He was a lecturer at many colleges and technical schools, including Yale, Cornell, University of Illinois, West Virginia University, Stevens Institute, Brooklyn, Franklin and Worcester Polytechnic institutes, and many others.

Mr. Kent was regarded as an authority on steam-boiler practice and on shop management. He was an earnest advocate of the principles of scientific management as enunciated by Frederick W. Taylor and was one of the charter members of the Taylor Society. He was also an inventor and designed the wing-wall furnace to secure complete combustion where there was not room for the Dutch-oven furnace, and developed a gas producer similar to the Dawson, but entirely independently of the latter. Singularly, his American patents and the English Dawson patents were issued on the same day. Many other inventions and devices are to his credit.

He also was engaged upon numerous investigations, notably work for the Babcock and Wilcox Company on high-volatile coals, for the New York Edison Company on smoke abatement, and in New Jersey with regard to certain water rights. Latterly he devoted much of his time to patent cases as an expert.

Besides his membership in this Society, he was a member of the American Society of Heating and Ventilating Engineers, of which he was president in 1905; American Institute of Mining Engineers; Society for the Promotion of Engineering Education; American Association for the Advancement of Science, and a number of others. He was a member of the Power Test Committee of the A.S.M.E. In 1907 he received the degree of Doctor of Engineering from Syracuse University. He is survived by his wife, one daughter and two sons, Robert Thurston Kent, and Lieut. Edward R. Kent, U. S. A., both engineers.

A. C. BEESON

A. C. Beeson was born in Salem, Ohio, on February 26, 1845. He was educated in the "village schoolhouse" there, obtaining in

addition a fair knowledge of mechanics in his father's machine shop. His first employment was at Pithole, Pa., in 1865, where he engaged successively in pumping and drilling wells. It was not until 1868 that the opportunity, which proved to lead to his life's work, came to him when he was engaged as gauger by the Titusville Pipe Co. and assigned to duty in the Pleasantville district. In June 1870 he entered the service of Vandergrift & Forman and constructed a pipe line from White Oak Station, now Trunkeyville, to Fagundas. The rapid extension of the oil fields in the early seventies was accompanied by unusual activity in pipe-line construction and Mr. Beeson was called on to construct pipe lines in districts of widely separated localities.

When Vandergrift & Forman organized the Fairview Pipe Line, the piping system was vastly extended under Mr. Beeson's direct supervision. He remained with this company and its successor, the United Pipe Lines, until 1885, when he purchased and took charge of a natural-gas plant in the lower-country oil towns. In 1889 he disposed of his gas interests and returned to the pipe-line industry as superintendent of the Western & Atlantic Pipe Line with headquarters in Pittsburgh. He was appointed superintendent of the Indiana Pipe Line upon its organization in 1899 and later vice-president, which position he held at the time he was taken ill. He died on September 10, 1918. He became an associate-member of the Society in 1914.

W. A. BLONCK

W. A. Blonck was born on April 30, 1872, in Wriezen, Germany. His early education he obtained in the Real Gymnasium of Wriezen, later receiving the degrees of M. E. and E. E. from Mittweida, Saxony, in 1893.

His first position was with the Royal Saxon Railways, Dresden, on construction work of transmission lines in connection with a three-phase power station for Dresden depots. In 1894 he was employed by Körting Brothers, Hanover, Germany, to design electric machinery and apparatus, and the following year he was connected with Siemens and Halske, Magdeburg, Germany, on the estimates and supervision of construction of isolated factory plants. From 1896 to 1901 he was with Ganz & Co., Budapest, Austria-Hungary, working on estimates and supervision of construction of steam and hydraulic municipal plants in Bulgaria, Hungary and Austria. In 1901 he came to the United States and for about a year was with the Chicago Edison Co., Chicago, Ill., on the preliminary work of the design of the large Fisk Street power plant. From 1902 to 1904 he was associated with the Arnold Electric Power Station Co., Chicago, when he became electrical engineer in charge of construction and operation for the Chicago and Milwaukee Electric Railroad Co. The years from 1905 to 1912 he had consulting offices in Chicago where he specialized on reports, design and construction of railway, light and industrial plants. In 1912 he became president of the W. A. Blonck Co., Inc., Chicago, which position he occupied at the time of his death, January 14, 1918.

Mr. Blonck was particularly interested in the development of the boiler efficiency meter and upon his submitting his investigations and tests in that connection to The Franklin Institute, received a Certificate of Merit for establishing graphically the zero method of best boiler efficiency. He also conducted special investigations of boiler-furnace operation and definite methods of doing away with guesswork in the fire room. He became a member of the Society in 1916.

ROBERT MUNN DIXON

A Tribute by The Secretary

Robert M. Dixon, for 31 years a member of The American Society of Mechanical Engineers and the chairman of its Finance Committee, died suddenly at his home at East Orange, N. J., on October 17, 1918. His death came as a great shock to his many friends, as he had been at business regularly and apparently had been in his accustomed health and had attended to his affairs with his usual energy and attention to their many details up to the very date of his passing away.

Robert M. Dixon

It has been the writer's privilege, as Secretary of this Society, to be intimately associated with Mr. Dixon in relation to its numerous activities where his sound judgment and constructive suggestions were not only helpful, but of the greatest intrinsic value.

His interest in the Society as an organization was deep-seated and very real, and it would be impossible to give an adequate appreciation of the service which he rendered. He served on the Finance Committee for ten years, for over eight years as chairman. During this period, the income of the Society was nearly doubled; the indebtedness occasioned by the acceptance of the Carnegie gift of the Engineering Building, nearly $100,000, was paid off and the cash surplus of the Society brought up to an excess of $100,000.

It was a part of Mr. Dixon's financial policy and direction that in so responsible and important a work as the Society is undertaking, it should accumulate as an essential part of that responsibility a sufficient cash surplus to provide for unforeseen and unprovided-for expenses of administration (as publications, meetings, etc.) so that their future would be assured beyond any possible doubt.

The Society is one-fourth owner and administrator of real estate worth $2,500,000, besides the publisher of its annual volume of Transactions and the monthly Journal, costing annually $100,000.

In this capacity as chairman of the Finance Committee, Mr. Dixon was a most faithful attendant upon the meetings of the Council, invariably contributing the broadest concept of the Society's duties and recognizing that the technical and even the ethical success of the Society is to a large degree dependent upon a sound financial administration.

The bringing up, therefore, of the Society from a position of lesser importance relatively, both in its membership and in its financial standing, to that of the sister professional societies, to that of one of the leading professional societies of the United States, is a work deserving of the highest praise, and to its success Mr. Dixon contributed conspicuously.

Robert M. Dixon was born at East Orange, N. J., September 19, 1860, in the house where he lived at the time of his death. He was educated in the public schools and graduated from Stevens Institute of Technology in the class of 1881, with the degree of M. E. Subsequently, he took a great deal of interest in the affairs of the Institute, was elected president of the Alumni Association for the period 1898-1899, and was an alumni trustee from 1890 to 1893.

His engineering work began with the Delaware Bridge Company, of Trenton, N. J., where he was employed for two years until March 1883, when he was made assistant engineer of the Pintsch Lighting Company, which was merged with the Safety Car Heating and Lighting Company in 1887, with Mr. Dixon as chief engineer. He was elected vice-president of the Safety Car Heating and Lighting Company, January 15, 1902, and was made president of the company in May 1907, which office he was holding at the time of his death.

Mr. Dixon spent the greater part of his life in the field of railway-car heating and lighting, and was identified with the early application of steam from the locomotive for heating railway passenger cars and with the development of gas and electricity for lighting railway cars. He was also active in the field of harbor and coast lighting.

He was elected on the Board of Trustees of the United Engineering Society, as representative of this Society, December 1917, and was also member of the Finance Committee of the United Engineering Society.

Mr. Dixon gave a great deal of attention to railroad matters and was active as an executive officer of the New York Railroad Club from its earliest days as a club of railroad men. He served as treasurer of the club from 1903 to the time of his death. He was formerly chairman of the finance committee of the club, and was a member of its executive committee for 35 years.

WILLIAM J. KEEP

William J. Keep, for many years consulting engineer for the Michigan Stove Co., Detroit, and one of the best-known writers of the country on foundry topics, died on September 30 following an accident, when he was knocked to the pavement by a street car and sustained fatal injuries.

Mr. Keep was born in June, 1842, in Oberlin, Ohio. He attended Oberlin College for his freshman and sophomore years and was graduated from Union College, Schenectady, N. Y., in 1865, with the degree of civil engineer. He served an apprenticeship with the Globe Iron Works, Cleveland, and obtained his shop experience with Fuller, Warren & Co., Troy, N. Y. From 1865 to 1868 he was employed by Hubbell & Brothers, Buffalo stove manufacturers, when he became associated again with Fuller, Warren & Co. and was with them for about eight years. During the years of 1872 to 1877 he delivered a course of lectures to the senior class of Rensselaer Polytechnic Institute. From 1875 to 1881 he manufactured stoves on his own account in the city of Troy.

In 1902 his treatise on Cast Iron was published, which is the best known of his writings. In 1885 Mr. Keep brought out some results of his studies of the relation between the shrinkage of

William J. Keep

cast iron and the composition of a foundry mixture. Later he devised a method and apparatus known as "Keep's Test" which he later named "Mechanical Analysis," for the determination of shrinkage in cast iron, and in this way to regulate the cupola mixture. For this purpose he used a ½-in. test bar. He elaborated his method of testing after making many thousands of tests in the investigation of the relation between the chemical analysis of cast iron and its physical properties, and the results were embodied in his writings.

Mr. Keep became a member of our Society in 1893 and from 1903 to 1905 was vice-president. He was also a member of the American Institute of Mining Engineers, the (British) Iron and Steel Institute, the International Association for Testing Materials, the American Foundrymen's Association, the American Association for the Advancement of Science, the Detroit Engineering Society (Past-President), honorary member of the Rensselaer Society of Engineers, and The Franklin Institute.

ROLL OF HONOR

DIED IN THE SERVICE

Walter Antosch, Chief Machinist, U. S. S. Westbridge, U. S. Navy.

Arthur H. Burges, Sergeant, 23d Engineers, U. S. Army, American Expeditionary Forces, France.

William R. King, Major, Ordnance Department, U. S. Army, Aberdeen Proving Ground, Md.

The following list of those in the Service is made up of the names of members of the Society sent in during the month of October. The number of stars in the service flag is now over 1100.

Abbott, Edward R., Captain, Chemical Warfare Service, U. S. Army.

Armstrong, Walter J., Captain, Ordnance Department, U. S. Army

Barnaby, Ralph S., Ensign, U. S. Navy, Inspection Division of Naval Flying Corps.

Benson, Carl N., Machinist, Second Class, U. S. Navy, assigned to U. S. S. *Montclair*.

Buckingham, J. E. E., First Lieutenant, Engineers Corps, U. S. Army, assigned to Co. 7, Engineer Officers' Training School, Camp Humphreys, Va.

Bunker, W. D., Captain, Engineers' Corps, U. S. Army.

Chance, T. M., Major, Chemical Warfare Section, U. S. Army, assigned to Edgewood Arsenal, Md.

Clark, Albert J., Main Ship Cr 21, Naval Aviation Detachment, Cambridge, Mass.

Coldwell, C. B., Second Lieutenant, Ordnance Department, U. S. Army.

Cottman, Lewis W., Major, Gas Defense Division Chemical Warfare Service, U. S. Army.

Dagavarian, Nishan A., Chief Machinist's Mate, U. S. Steam Engineering School, U. S. Navy; assigned to Stevens Institute, Hoboken, N. J.

Danforth, T. Dwight, Second Lieutenant, Field Artillery, U. S. Army.

Demorest, William J., Captain, Ordnance Department, U. S. Army.

Everett, Chester M., Captain, Sanitary Corps, U. S. Army, Fort Oglethorpe, Ga.

Fell, Hugh P., First Lieutenant, Company D, Second Battalion, 37th Engineers, American Expeditionary Forces, France.

Fogler, B. B., Major, Mechanical Research and Development Section, Chemical Warfare Service, U. S. Army, assigned to Washington, D. C.

Fuller, Ray W., Major, Ordnance Department, U. S. Army.

Geddis, Robert H., Corporal, 16th Company, 152d Depot Brigade, Camp Upton, N. Y.

Goalwin, Harry A., Enlisted Medical Corps, U. S. Army.

Hanson, J. J., First Lieutenant, Inspection Division, Ordnance Department, U. S. Army, assigned to Minneapolis Steel & Machinery Co., Minneapolis, Minn.

Hill, George F., Captain, Ordnance Department, Chemical Warfare Section, U. S. Army.

Jackson, F. Raymond, Chief Machinist's Mate, U. S. Navy, Candidate Steam Engineers' School for Officers, Stevens Institute of Technology, Hoboken, N. J.

Judson, Cyrus F., Captain, Ordnance Department U. S. Army, assigned to Camp Logan, Houston, Tex.

Karmazin, John, Captain, Military Intelligence Division, General Staff, U. S. Army.

Kiefer, Paul J., Ensign, U. S. Navy, U. S. Navy Steam Engineering School, Hoboken, N. J.

Lacy, Robert, First Lieutenant, Company I, Engineer Officers' Training School, Camp Humphreys, Va.

Leh, C. F., Candidate, Engineer Officers' Training Camp, Camp Humphreys, Va.

Lincoln, C. W., Private, Co. E, 3d Regiment Air Service Mechanics' School, St. Paul, Minn.

Lockett, Kenneth, Captain, Engineers, U. S. Army.

Lucke, Charles E., Lieutenant-Commander, U. S. Navy.

Lundgren, Edwin, Coast Artillery, U. S. Army, assigned to Fort Monroe, Va.

Lundquist, Joseph M., Private, U. S. Infantry, assigned to Camp McArthur, Tex.

McArdell, Wesley, Private, Ordnance Student Officer Training School, Erie Proving Grounds, Port Clinton, O.

McIntosh, Samuel F., Captain, Ordnance Department, U. S. Army.

McMurtry, Alden L., Major, War Plans Division, General Staff, U. S. Army.

Mitchell, George L., Private, Intelligence Section, American Expeditionary Forces, France.

Muir, Leonard S., Second Lieutenant, Air Service Aeronautics, U. S. Army, assigned to Wilbur Wright Field, Dayton, O.

Mullergren, Arthur L., Lieutenant, Quartermaster Department, U. S. Army, Camp Funston, Kan.

Munson, Charles C., First Lieutenant, Air Service, Aircraft Production, U. S. Army.

O'Rourke, F. W., Private, Enlisted Ordnance Corps, U. S. Army, assigned to Ordnance School of Explosives Manufacture, Columbia University, New York

Peacock, Howard G., Private, 3rd Chemical Battalion, U. S. Army, Edgewood Arsenal, Edgewood, Md.

Porter, L. L., Ensign, U. S. Navy.

Price, A. M., Captain, Ordnance Department, U. S. Army.

Roe, J. W., Major, Air Service, Aircraft Production, U. S. Army.

Shirley, Harvey J., Machinist's Mate, 2nd class, U. S. Navy; attached to Student Army Training Corps, Navy Section, Cincinnati, O.

Slaughter, W. B., Jr., Master Engineer, U. S. Army, Searchlight Depot, American Expeditionary Forces, France.

Smith, Cameron O., Major, Ordnance Department, U. S. Army; assigned to the New York District Ordnance Office.

Smith, Harry R., Candidate, 30th Trench Battery, Field Artillery Corps Officers' Training School, Camp Zachary Taylor, Ky.

Spofford, Harry H. R., Ensign, U. S. Navy; assigned to U. S.S. *Mercury*.

Stanton, R. B., Jr., First Lieutenant, Student, Company 5, Engineer Officers' Training School, Camp Humphreys, Va.

Stinson, Karl W., Second Lieutenant, School of Military Aeronautics, U. S. Army, assigned to Princeton University, N. J.

Stuber, A., First Lieutenant, Signal Corps, U. S. Army.

Thayer, Paul W., Private, Co. D, First Replacement Regiment Engineers, Washington Barracks, Washington, D. C.

Turnbull, M. J., First Lieutenant, Engineers' Corps, U. S. Army.

Walker, Charles A., Second Lieutenant, R. E., British Expeditionary Forces, France.

Whitcraft, Arthur, Captain, Ordnance Department, U. S. Army.

White, Edward F., Lieutenant, U. S. Navy.

Women's Auxiliary of the A. S. M. E.

The Women's Auxiliary of the Society, coöperating with the Council of Organizations for War Service, offers opportunities for service in the centers established by the Section on Aliens, listed below. The officers of the Auxiliary hope to interest an increasing number of women through the two thousand members residing in the Metropolitan District and further information may be secured from the chairman of the Auxiliary, Mrs. Charles Ethan Davis, 885 West End Avenue, New York, N. Y.; telephone Academy 3167.

In New York City: Arnold Toynbee House, 331 East Broadway; Music School Settlement, 55 East Third St.; Emanuel Brotherhood, 309 East Sixth St.; Public School No. 74, 220 East Sixty-third St.

In Brooklyn: Brownsville Library, Glenmore Ave. and Watkins St.; Brownsville Children's Library, Stone and Dumont Aves.; Bushwick Library, Bushwick Ave. and Seigel St.; De Kalb Library, Bushwick and De Kalb Aves.; East Library, Arlington Ave. and Warwick St.; Eastern Parkway Library, Eastern Parkway and Schenectady Ave.; Greenpoint Library, Norman Ave. and Leonard St.; Kings Highway Library, 1608 Kings Highway; Leonard Library, Devoe and Leonard Sts.; Ridgewood Library, 496 Knickerbocker Ave.; Saratoga Library, Hopkinson Ave. and Macon St.; South Library, Fourth Ave. and Fifty-first St.; Williamsburgh Library, Division and Marcy Aves.; Winthrop Library, North Henry St. and Engert Ave.

Assistants are also desired for other branches of the Council's work, such as War Camp Community Service centers, baby-saving campaigns, etc. Details may be obtained from Miss Bernays at the Council's headquarters, 18 West Thirty-fourth Street, New York, N. Y.; telephone Knickerbocker 365.

At the Engineer Officers' Training School

A member of the Society who is in touch with the requirements of the officers' training schools offers the following suggestions for prospective applicants:

To those of our membership who are contemplating applying for engineer officers' commissions, a few notes on their status while in training will be instructive.

The embyro officer receives from the Adjutant-General a telegram appointing him a commissioned soldier, whereupon he puts a snug-fitting uniform decorated with bars or oak leaves and castles, and proceeds to Camp A. A. Humphreys, Virginia, chest well puffed out.

After reporting at the E. O. T. S. headquarters he becomes rapidly disillusioned as to his importance, and finds before nightfall that so far as the camp is concerned he is just a buck private. For the first four weeks he will receive daily about seven hours' infantry drill instruction, which will include the manual of arms, pack drill, bayonet drill, tent pitching, guard, outpost and reconnaisance duties. The rest of the course will be occupied with military engineering, such as bridges, pontoons, trench and dugout building, demolitions, military law, field service regulations, administrations.

The student officer will then take his turn at acting as commander or other officer.

The important point which all students should grasp at once is this: Their ability as engineers is not questioned and it is taken for granted that they are really capable; but what the army needs is *soldiers*, and it is the duty of the commanding officer in charge of the training school, and his assistant instructors, to make the men into soldiers. This means discipline, knowledge of warfare and, in the case of officers, the ability and personality to be in command of men.

LIBRARY NOTES AND BOOK REVIEWS

REVIEWS of books of special importance to mechanical engineers by members of the Society and those particularly qualified, brief descriptive notes of accessions to the Library of the United Engineering Society, items of interest relating to the Library's activities, etc.

CONCRETE STONE MANUFACTURE. By Harvey Whipple. Concrete-Cement Age Publishing Co., Detroit, 1918. Cloth, 5 x 7 in., 318 pp., 82 illus., 104 pl. $1.50.

A textbook for manufacturers of factory-made concrete units, based on the practice of various successful enterprises. Discusses plant layout, operation, methods, materials, finishing, building regulations, tests, etc.

FRENCH-ENGLISH AND ENGLISH-FRENCH DICTIONARY OF AVIATION By Robert Morris Pierce. N. Y. Languages Publishing Co., New York, 1918. Paper, 4 x 7 in., 12 pp. $0.60.

A brief bilingual dictionary of words and phrases, with the pronunciation carefully indicated.

GUIDE TO THE USE OF UNITED STATES GOVERNMENT PUBLICATIONS. By Edith E. Clarke. The Boston Book Co., Boston, 1918 Cloth, 6 x 9 in., 308 pp. $2.50.

A guide to the history, use, cataloguing and classification of United States government publications. Written primarily for librarians and library workers, it is broad enough in scope to serve as a laboratory manual for all who use the government publications inside libraries and out. Contains four bibliographies dealing with different phases of the subject.

HANDBOOK OF MECHANICAL AND ELECTRICAL COST DATA. Giving Shipping Weights, Capacities, Outputs and Net Prices of Machines and Apparatus, and Detailed Costs of Installation, Maintenance, Depreciation and Operation, together with Many Principles and Data Relating to Engineering Economics. By Halbert P. Gilette and Richard T. Dana. First Edition. McGraw-Hill Book Co., Inc., New York, 1918. Flexible Cloth, 5 x 7 in., 1734 pp., illus. tables. $6.

This handbook is similar in method to the authors' two previous handbooks covering costs in the field of civil engineering and can be used to supplement them. It is almost entirely devoted to purely electrical and mechanical subjects. Chapters on general economic principles, depreciation, repairs and renewals are included.

CONDENSED CATALOGUES OF MECHANICAL EQUIPMENT. With Mechanical Equipment Directory. Standardization Work of the Society, List of Transactions Papers, and Engineering Data are included. Eighth annual volume, October 1918. N. Y., The American Society of Mechanical Engineers. Cloth, 6 x 9 in., 812 pp., illus.

This edition of Condensed Catalogues has been enlarged by approximately thirty per cent. Four hundred and fifteen firms are represented by publication of catalogue data constituting a gain of nearly 100 firms as compared with the 1917 volume. The general directory of mechanical equipment has also been expanded to include over 3700 firms, classified under more than 2700 topics, and the directory of consulting engineers has been enlarged and improved. A subject list of the papers that have appeared in the thirty-nine volumes of the Transactions of the Society is included, together with a selection of engineering data from the Journal of 1917 and a summary of the Society's work on engineering standards. The volume is designed to be a primary reference work for buyers and users of mechanical equipment, giving the engineers specific data to assist in the selection of suitable machinery for various purposes.

MODERN NAVIGATION BY SUMNER-ST. HILAIRE METHODS. The First Published Work Devoted Exclusively to the Elucidation of This Subject, Now So Generally Used in the U. S. Navy. By Frank Seymour Hastings. Appleton & Co., New York, 1918. Cloth, 4 x 6 in., 84 pp. $0.75.

Presents the methods used in the Navy in an elementary form. Contains the merchant-marine method, the Sumner method and the Marcq St. Hilaire method. Intended as a supplement to the authors' Navigation—A Short Course.

PERSONALS

IN these columns are inserted items concerning members of the Society and their professional activities. Members are always interested in the doings of their fellow-members, and the Society welcomes notes from members and concerning members for insertion in this section. All communications of personal notes should be addressed to the Secretary, and items should be received by November 15 in order to appear in the December issue.

CHANGES OF POSITION

RALPH E. CARPENTER has assumed the duties of director of service with the Aluminum Castings Company, Cleveland, O. He was formerly associated with The Taft Peirce Manufacturing Company, Woonsocket, R. I., in the capacity of sales manager.

WILLIAM T. WATERS, formerly connected with the Illinois Central Railroad, Chicago, Ill., as mechanical inspector, has become associated with Kehm Brothers Company, Chicago, Ill., and is now in charge of their contract for power and process piping at the U. S. Nitrate Plant, No. 3, Toledo, O.

ROBERT L. CLEGG has been appointed New England editor of *The Iron Age*. He was, until recently, vice-president of the Gardner Printing Company, Cleveland, O.

DAVID A. CHAPMAN, formerly vice president of the Dangel Company and the Touraine Company of Boston, is now with the U. S. Shipping Board as supervising engineer in charge of the training of chief engineers for turbine-driven ships, with headquarters at 173 Milk Street, Boston, Mass.

LOUIS J. SECKELS of the United Filters Corporation, San Francisco, Cal., has accepted the position of assistant engineer with the Oregon Short Line Railroad Company, Salt Lake City, Utah.

E. N. BATES, JR., assistant professor of mechanical engineering, Pennsylvania State College, State College, Pa., has become associated with the office of Grain Standardization, Bureau of Markets, Washington, D. C.

CLIFFORD LEE, formerly mechanical engineer, India Rubber Company, New Brunswick, N. J., has become affiliated with the Hercules Powder Company, Nitro, West Va.

FRANK C. SPENCER, until recently efficiency engineer, Western Electric Company, Chicago, Ill., is now connected with The Colt Patent Fire Arms Company, Hartford, Conn., in the capacity of superintendent of the Browning Gun Department.

STANWOOD W. SPARROW has left the employ of the Robert T. Pollock Company, Boston, Mass., to become associate engineer at the Bureau of Standards, Washington, D. C., in charge of the work in the altitude laboratory.

W. VAN ALAN CLARK, until recently engineer of plants, Tuco Products Corporation, Chicago, Ill., has entered the employ of the U. S. Shipping Board, Emergency Fleet Corporation, Philadelphia, Pa.

WILLIAM H. GRIFFITHS, leading designer, Department 29, Pratt and Whitney Company, Hartford, Conn., has accepted a position with the Remington Arms Union Metallic Cartridge Company, Bridgeport, Conn.

R. RENTON HIND has become affiliated with the Pacific Commercial Company, Manila, P. I. He was formerly connected with the Honolulu

Iron Works Company, Honolulu, Hawaii, in the capacity of consulting sugar-house engineer.

Albert Whatmore has been appointed chief engineer, Erith Oil Works, Ltd., Erith, Kent, England. He was formerly chief assistant engineer, The Olympia Oil and Coke Company, Ltd., Selby, York, England.

Vincent C. George, formerly instructor, Pennsylvania State College, State College, Pa., has been associated with the Engineering Extension Division, University of Wisconsin, Madison, Wis.

William L. Doten, formerly mechanical engineer with The Lamson Company, Boston, Mass., has assumed similar duties with the Sturtevant Mill Company,, Dorchester, Mass.

J. W. Brussel, until recently supervisor of machining at the Dayton Engineering and Laboratories Company, has accepted the position of superintendent with the Wright-Martin Aircraft Corporation, Long Island City, N. Y.

Edwin F. Church, Jr., formerly professor of machine design, West Virginia University, Morgantown, W. Va., has assumed the duties of professor of mechanical engineering, Brooklyn Polytechnic Institute, Brooklyn, N. Y.

Ira B. Dole, until recently connected with the Federal Creosoting Company, Bound Brook, N. J., in the capacity of agent, has become affiliated with the American Creosoting Company, of Hugo, Okla.

William Mulheron, until recently associated with Westinghouse, Church, Kerr and Company, New York, has become connected with the Chester Shipbuilding Company, Ltd., Philadelphia, Pa.

Roy B. Fehr has resigned his position as assistant professor of mechanical engineering at Pennsylvania State College, State College, Pa., to become assistant physicist for the Recording and Computing Machine Company, Dayton, Ohio.

M. R. Walton, formerly works manager of the Pennsylvania Salt Manufacturing Company, Natrona, Pa., is now employed as mechanical engineer with the Firestone Steel Products Company, Akron, Ohio.

George M. Keenan has become identified with the Lehigh Navigation Electric Company, Allentown, Pa. He was formerly connected with the Little Rock Railway and Electric Company, Little Rock, Ark., in the capacity of chief engineer.

C. A. Holdbridge, formerly factory manager of the Metalwood Manufacturing Company, of Detroit, Mich., has assumed the duties of mechanical superintendent of the Chalkis Manufacturing Company, Detroit, Mich., who are making 3-in. anti-aircraft guns for the United States Government.

Charles L. Frederick, formerly vice-president and general manager of the Passaic Metal Ware Company, Passaic, N. J., has assumed the duties of general manager of the Thurlow Steel Works, Chester, Pa. Mr. Frederick has recently had his Christian name changed, by order of the court, from Karl to Charles.

Andrew Westwater has resigned his position as chief engineer of the G. M. Standifer Construction Company, Vancouver, Wash., and has opened an office at Seattle, Wash., as consulting marine engineer and naval architect. Mr. Westwater has been appointed consulting marine engineer and Pacific Coast Representative of the General Ordnance Company, Denver, Colo., which is now using its shops for building marine engines and auxiliary machinery for marine service.

Frank H. Crockard, late president of the Nova Scotia Steel and Coal Company, and formerly vice-president and general manager of the Tennessee Company, has returned to Birmingham district as president of the Woodward Iron Company.

John J. Chisholm has started on his duties as superintendent of power for the Woodward Iron Company. He was formerly superintendent of power of New Orleans Railway and Light Company, New Orleans, La.

ANNOUNCEMENTS

In the 1918 Year Book the address and business connection of A. L. Roberts (1909), should have been listed as follows: Designing Engineer, Bethlehem Steel Company, Bethlehem, Pa., and for mail, 17 N. Centre Street, Bethlehem, Pa.

Howard M. Gassman will act as associate chief fuel conservator for the State of Alabama.

Edward G. Jay, Jr., has accepted the position of hull fittings engineer with the American International Shipbuilding Corporation, Hog Island, Pa. Mr. Jay will, however, still maintain his consulting engineering office in Philadelphia, Pa.

Arthur H. Morse has accepted the position of supervisor of technical training in the War Education Department of the University of Cincinnati, Cincinnati, O.

John Calder, who for a year after returning from France was engaged in organized seaplane production on a quantity basis at Keyport, N. J., has resigned as vice-president and general manager of the Aeromarine Plane and Motor Company of that city, and has assumed his consulting practice in industrial reports, organization and management at 35 West 39th Street, New York. Mr. Calder is also actively identified with the development of an all-steel airplane and has recently been elected vice-president of the Boyd Motors Corporation, controlling it.

Victor J. Azbe has terminated his connections with the Anheuser Busch Brewing Association, and has opened a consulting engineering office at 2194 Railway Exchange Building, St. Louis, Mo. His work will be in the direction of general power-plant efficiency.

Leon B. Jones, assistant engineer of the gas department of the Pacific Gas and Electric Company, San Francisco, Cal., has enlisted as a private of engineers in the United States Army. Mr. Jones has devoted much time and thought recently to the extraction of toluol from manufactured gas, and has been active in assisting the gas defense service of the United States Army.

Miss Kate Gleason has assumed the presidency of the First National Bank of East Rochester in the absence of H. C. Eyer, former president, who has left for Europe to engage in Y. M. C. A. work. Miss Gleason is probably the first woman to become president of a national bank of issue.

Edgar Buckingham, of the Bureau of Standards, has been appointed physical associate to the scientific attaché to the American embassy at Rome.

APPOINTMENTS

W. J. Armstrong, manager of the crushing and pulverizing sales department of the Jeffrey Manufacturing Company, Columbus, O., has recently received an appointment as Captain in the U. S. Army, and has been assigned to the Ordnance Department in Washington, D. C.

Herbert B. Reynolds, formerly mechanical assistant to superintendent of motive power of the United Railways and Electric Company, Baltimore, Md., has been appointed fuel engineer, U. S. Bureau of Mines.

Charles E. Waddell, of Asheville, has been appointed chief of conservation for North Carolina.

EMPLOYMENT BULLETIN

***The Secretary** considers it a special obligation and pleasant duty to make the office of the Society the medium for assisting members to secure positions, by putting them in touch with special opportunities for which their training and experience qualify them, and for helping any one desiring engineering services. The Society acts only as a clearing house in these matters.*

GOVERNMENT POSITIONS

Stamps should be inclosed for transmittal of applications to advertisers; non-members should accompany applications with a letter of reference or introduction from a member; such reference letter will be filed with the Society records.

PRODUCTION, PLANNING AND SCHEDULING ENGINEERS to act as assistant shop superintendents in the Hull Division. Salary to start $6 per day. Location, New York. G0513-K.

ORDNANCE DEPARTMENT desires men as Directors of Training Departments to develop intensive training of workers in their factories at Philadelphia. G0667-K.

CHIEF INSPECTORS having considerable shop experience on steel and forging work and on machining of steel and trench warfare material. Positions will pay from $2500 to $3000 per annum, but men of considerably high calibre than seems commensurate with these salaries are asked to assist in this work. Location, Cincinnati District Ordnance Office. G0672-K.

SHOP INSPECTORS ON BARBETTE CARRIAGES are desired by Maryland Plant. Position requires engineer having had experience in the assembly of heavy machinery, in gathering and consolidating complete data from the rough forging or casting to finished carriage, also data of shop maneuvering tests before shipment. Salary $2400 per annum. G0673-K.

CONSTRUCTION DIVISION desires men as City Managers and assistant to officer in charge of Military Camps of 40,000 men. Men must possess initiative to meet all emergencies of maintenance and repair, and ability to command working force of 400 to 950 men. Prefer men over 40 years of age with administrative experience in operation of public utility properties. Although the salary is not commensurate with ability, the need for responsible men is urgent. G0681-K.

INSPECTORS AND PRODUCTION ENGINEERS. Large engineering concern requires the services of several men to inspect and expedite the production of electrical and mechanical apparatus on Government and essential work. Reply quickly, stating age, education, brief outline of experience, salary expected and when available. Location, New York City. G0687-K.

ENGINEERS from 30 to 35 years of age having general manufacturing experience on mechanical work desired by plant in West

Virginia. Position temporary, about 3 months, with possibility of becoming permanent. Salary $200-$250 per month. G0690-K.

UNITED STATES RAILROAD ADMINISTRATION desires draftsmen on power-plant design. Salary $120-$175 per month. Location, New York City. G0691-K.

DETAIL DRAFTSMEN AND DESIGNERS. Munitions Plant in Brooklyn desire services of two men. Salary to start $30 per week. G0695-K.

ORDNANCE DEPARTMENT desires two experienced mechanical engineers for experiment and development work on munitions and fuses. Salary $250 to $350 per month. G0702-K.

DRAFTSMEN. The Navy Department is desirous of obtaining the services of draftsmen Salary commensurate with ability. Location, Washington. G0717-K.

ASSISTANTS in important research work in the fatigue of metals, especially as applying to war problems, such as aircrafts, crank shafts and electric welding of ships. Investigations to be carried on at own laboratory or at laboratory in Middle West. G0719-K.

DESIGNERS AND DRAFTSMEN for experiment station. Positions would exempt from draft. Salaries for designers up to $185 a month; for draftsmen up to $115. Location, Connecticut. G0739-K.

FOREST SERVICE. Engineers and assistant engineers are desired. Salary for engineers from $1800 to $3000; assistant engineers from $1500 to $1800. Location, Middle West. G0744-K.

HULL DRAFTSMEN. Those having experience in wooden hulls preferred. Location, New York. G0747-K.

NAVAL GUN FACTORY needs technical graduates who are competent designers of jigs, tools and gages. Salary $4 to $6.88 per day. Location, Washington. G0748-K.

MECHANICAL AND SAFETY ENGINEER having two or more years' practical shop experience. Must be tactful and able to confer with high executives and Government officials. Excellent opportunity to make wide acquaintance in engineering profession. Salary $1800 to $2500. Apply by letter. Name will not be given in this record. G0767-K.

CIVILIAN POSITIONS

BIG OPPORTUNITY in an old-established business for practical man who can offer a few specialties for manufacture, one with combination of mechanical and executive ability understanding sheet-metal and light-screw machine work and who can develop sheet-metal specialties that can be marketed to afford volume production to the factory. Location, New York. K-0460.

ELECTRICAL ENGINEERS on plans and specifications. Some drafting. Americans wanted. Salary $1200, $1400 or higher if necessary. Location, New York Central. K-0718.

SALES ENGINEERS in various district offices. Air compressor manufacturer. State qualifications, experience if any, and compensation expected. K-0216.

MECHANICAL ENGINEER. Excellent opportunity for technical man with shop and drafting-room experience with growing concern in Connecticut making high-grade specialized product. Work interesting and carries considerable responsibility. Give full particulars. K-0257.

ASSISTANT TEST ENGINEER, technical graduate not subject to draft, with experience in steel heat-treatment and testing work for growing concern in Connecticut making high-grade specialized product; knowledge of chemistry an advantage. Good opportunity and work interesting. Give full particulars in answering. K-0258.

INSTRUCTOR IN MECHANICAL ENGINEERING to teach descriptive geometry, machine drawing, some laboratory work, and elementary steam engineering. Salary $1800 per year. Location, Ohio. K-0433.

MECHANICAL ENGINEER with experience in design, testing, and general engineering work in connection with small and medium steam turbines. Must have good business and executive ability, reduction-gear experience also desirable and be able to handle variety of work in connection with steam turbines and turbine-driven machines. Give full details of training, experience and salary expected. Photograph desirable. Location, Connecticut. K-0464.

MECHANICAL ENGINEER with machine-shop experience for position similar to master mechanic. Salary, $50 to start. Location, Brooklyn. K-0468.

PROFESSOR OF MECHANICAL ENGINEERING in charge of department, technical graduate with both teaching and practical experience. Give full statement of training and experience, references and late photograph. Salary $240 per month for next ten months. Location, Idaho. K-0471.

MECHANICAL ENGINEER AND DESIGNER with extensive experience in the design and construction of shipbuilding cranes, derricks, drag-line excavators and similar work. High-grade man wanted to take charge. Location, Pennsylvania. K-0475.

DRAFTSMAN, high-grade man with experience on boiler design. Salary $175 to $225. Location, Pennsylvania. K-0482.

DRAFTSMAN, high-grade man with experience on locomotive-crane design. Salary $175 to $225. Location, Pennsylvania. K-0483.

DRAFTSMAN, high-grade man with experience on the design of steel towboats and barges. Salary $175 to $225. Location, Pennsylvania. K-0484.

SEVERAL FIRST-CLASS DRAFTSMEN with broad engineering experience. Good future for right men. Location, Ohio. K-0496.

THREE ENGINEERS, experienced in substituting mechanical equipment for hand labor. Must be familiar with all kinds of conveying equipment. Good future for right men. Location, Ohio. K-0497.

ASSISTANT MECHANICAL ENGINEER familiar with general machinery in machine shop and mill engineering; must be competent to lay out and direct installation of new machinery and direct repairs and alterations on present equipment. Concern manufacturing mechanical rubber goods and employs about 2000. Technical graduate preferred. Salary $1500 to $2000, depending on man. Location, Massachusetts. K-0498.

MECHANICAL ENGINEERS AND DRAFTSMEN for designing machinery wanted by large and long-established company, located near New York City. K-0502.

TURBINE DESIGNER, experienced, capable of taking complete charge of design and construction of turbines and reduction gears, wanted by large and long-established company, located near New York City. K-0503.

DRAFTSMEN AND DESIGNERS, experienced in calculating automatic machinery, typewriters, etc. Permanent positions offered to competent men. Location, New York City. Salary about $35 per week. K-0512.

MECHANICAL ENGINEER, five years' experience or better for gas and fuel company. Salary $175 to start. Location, Colorado. K-0669.

DRAFTSMEN AND TRACERS, electrical and mechanical engineers for plant layout work. K-0670.

CHECKER on patterns and drawings. Prefer man with textile-machinery experience, although not absolutely essential, if experienced with other lines of machines. Location, Boston. K-0671.

MECHANICAL ENGINEER to supervise completion and later maintenance of Government plant on power side, requiring some construction experience, heat, light, sanitary distribution of power and electrical engineering. Splendid opportunity for right man. Location, New Jersey. K-0675.

DRAFTSMAN on power building and power-plant piping. Salary depends on man. K-0676.

DRAFTSMAN on layout of crushing and ore plant. Transmission work, elevators and conveyors. Salary depends on man. K-0677.

DRAFTSMEN familiar with foundation plans, arranging of machinery and shop equipment in connection with large extension to plant. Rate approximately $1.00 per hour. Time and a half for overtime beyond eight hours. Location, Camden, New Jersey. K-0678.

POWER-HOUSE ENGINEER to study operating conditions, repair and execute plans and methods for increasing economy, in power house of 6,000 kw. generating capacity, serving an essential industry. Excellent opportunity for advancement to position of assistant chief engineer for man with executive ability. State full details of education and experience, age, draft status and salary expected. Location, Detroit. K-0683.

MECHANICAL ENGINEER in connection with construction and maintenance department of large manufacturing plant executing only Government orders. Applicant must be competent to study and design heating and steam-distribution problems, air-conveyor systems, installation of motors, line shafting and conveyor for handling materials. Technical education desirable but not necessary. Give full details of education and experience, age, nationality, draft standing and salary expected. K-0684.

ASSISTANT ESTIMATOR on minor buildings, alterations, rearrangements and items of equipment in large manufacturing plant executing war orders. Ability to make free-hand sketches necessary but skill as a draftsman or technical education unnecessary. Position affords opportunity for advancement in construction and maintenance department. State experience, age, nationality and draft status. Information confidential. Location, Detroit. K-0685.

CHIEF DRAFTSMAN capable of taking charge of drawing room employing three or four men, in designing equipment, minor buildings and rearrangements in large manufacturing plant, engaged exclusively in war work. Technical education or expert skill as designer unnecessary. Must be thoroughly practical and experienced in factory arrangement and operation. State education, experience in detail, age, draft standing and salary expected. Information confidential. Location, Detroit. K-0686.

EFFICIENCY ENGINEERS with at least one year's experience; preferably college men, mechanical, electrical or civil engineering training. Salary $125 to $175 with yearly bonus amounting to 60 up to 90 per cent of year's salary, depending on earnings of company. Location, New York. K-0688.

JUNIOR ENGINEERS, three, willing to learn efficiency engineering; preferably college men, mechanical electrical or civil engineering training. Salary $100 to $125 per month with yearly bonus amounting to 60 up to 90 per cent of year's salary, depending on earnings of company. Traveling involved. Draft exempt. Location, New York. K-0689.

WORKS MANAGER for plant located in New Jersey manufacturing several lines of specialties, must have broad general business experience and good judgment and be familiar with modern duplicate parts manufacture. Preferably technical graduate who has worked with up-to-date productions, central controlling and planning system.

Man capable of earning $6,000 to $7,000. Position will develop to general manager and possible opportunity for acquiring substantial interest in company, if services are satisfactory. Location, New York. K-0693.

COMBUSTION ENGINEER who will go to the bottom of things and give some logical solution of power-plant troubles in paper mills. Young progressive man or older man beyond the draft age; some drafting, designing, etc. Good opportunity. Liberal salary, depends generally on the ability of man. Location, Middletown, Ohio. K-0696.

YOUNG MECHANICAL ENGINEER as assistant to consulting engineer for a large nationally-known manufacturing concern. Must be technical graduate and in deferred classification under selective service act. Experience in heating and power-plant engineering desirable. Work is directly connected with the war work; position permanent with excellent opportunities for advancement. Location, New York City. Outline experience and state salary expected. K-0699.

METALLURGIST. Preferably with smelting experience in copper or lead, either civil or mechanical. Salary from $3500 to $5000. Headquarters, New York. K-0700.

DRAFTSMEN in shipbuilding line. Location, Staten Island. K-0701.

MECHANICAL DRAFTSMEN, 10 on industrial plant layout. Salary $30 to $50 per week. Location, New York. K-0704.

INDUSTRIAL DRAFTSMEN, three; salary $30 to $50 per week. Location, New York. K-0705.

TRACERS, three, about $30 per week. Headquarters, New York City. K-0706.

MACHINE SHOP FOREMAN, competent to supervise lathes, milling, boring, and screw-machine hands. Salary $2800 per year. Location, Philadelphia. Apply by letter. K-0709.

INSTRUCTOR for steam engineering. Location, Seattle, Washington. K-0710.

HIGH-CLASS MECHANICAL ENGINEER having both the training and experience which will fit him to act in the capacity of chief engineer to master mechanic of plant, capable of taking care of the mechanical power and refrigerating engineering connected with a packing house. If qualified to have charge of all the construction work as well as the engineering end. Location, Ohio. K-0711.

COMBUSTION ENGINEER for large industrial plant in South operating 12,000 hp. steam plant; state technical training, practical experience and salary earned and expected, together with copies of references. K-0712.

MECHANICAL DRAFTSMAN (women with necessary qualifications will be accepted) with some experience in building construction. Experience in furnace-combustion work preferred. Permanent position. State age, experience and salary expected. Location, New York City. K-0714.

CHIEF ENGINEER capable of handling new 16,000 kw. turbine-driven steam-power generating station. Position is with public service corporation. Requires man who can take complete charge of the plant, looking after its economical operation and maintenance. No duties other than operation of plant. Location, Philadelphia. K-0716.

ELECTRICAL ENGINEERS on plans and specifications. Some work on drafting board. Americans wanted. Salary $1200, $1400 or higher if necessary. Headquarters, New York City. K-0718.

TWO MECHANICAL DRAFTSMEN with piping experience. Salary as high as $60 per week, depends on man. Location, Wilmington, Del. K-0720.

FOUR MECHANICAL DRAFTSMEN with industrial-plant experience. Salary as high as $60 per week, depends on man. Location, Wilmington, Del. K-0721.

TWO MEN with reinforced concrete experience. Salary as high as $60 per week, depends on man. Location, Wilmington, Del. K-0722.

FOUR MEN, structural-steel designers. Salary as high as $60 per week, depends on man. Location, Wilmington, Del. K-0723.

SEVERAL MEN to inspect and expedite the production of electrical and mechanical apparatus on government and essential work for large engineering concern in New York City. Apply quickly, stating age, education, brief outline of experience, salary expected and when available. K-0724.

SALES ENGINEER, technically-educated man, preferably between ages of thirty and forty, with successful experience in sales problems in metal-manufacturing industries. Liberal salary and interesting, patriotic work for one with right qualifications, which must include a vigorous personality and ready command of written English. In reply, state age, college or technical school, date and degree, whether married or single, specify chronologically account of business experience, present and expected salary. Location, Boston, Mass. K-0725.

COMPETENT BOILER INSPECTOR, to be employed by Hawaiian Sugar Planters' Association, for inspection of boilers of sugar mills and pumping plants, locomotives, etc., on members' plantations. Must understand boiler-insurance companies' requirements. State training, experience, references, and salary expected. K-0726.

EMPLOYMENT DIRECTOR for a small machine shop building engines for Government work. Location, Western Pennsylvania. Man thoroughly competent to get men, keep them, and arrange for the training of unskilled labor to enable it to do skilled machinist's work. Permanent position and good salary. New York concern. K-0727.

APPRAISERS for number of manufacturing properties. Salaries would depend on qualifications of applicants. Philadelphia concern. K-0728.

ELECTRICAL AND MECHANICAL ENGINEER. Under civil service law. Position will pay about $3,300 per year at the start and $3,600 as soon as incumbent has fully demonstrated ability to satisfactorily handle work. Includes operation, maintenance and repair of electric lighting system for boulevards and parks, including high-tension transformer sub-stations, and transmission lines, and all auxiliary apparatus; also design, maintenance and repair of illuminating equipment in all park buildings. Preparation of plans and specifications for alterations and new electrical construction work and supervision of their execution will also be included. Location, Illinois. K-0729.

APPRAISER on general machinery, machine shop and all mechanical machinery. Salary $1500 to $3000. Headquarters, New York City. K-0730.

SUPERINTENDENT for metal-stamping plant in Alexandria, Indiana. Man should be experienced in both metal-stamping and screw-machine work, also die and tool making. About 200 men employed in plant devoting 95 per cent of its production to war orders. K-0731

PRODUCTION MANAGER who is able to deserve by his ability and experience, a salary of $9,000 or $10,000 per year. Needs to be a good production manager in the fullest sense of the word. K-0732.

DESIGNING ENGINEER in charge of drafting and design work in connection with the application of roller bearings to all kinds of industrial apparatus. Age 26 to 40. Thoroughly familiar in machine shop and drafting room on heavy machinery design. Location, New York City. Salary $2000. K-0733.

SUPERINTENDENT OR PRODUCTION MANAGER. Quality of handling men and system of more importance than mechanical ability. Location, Connecticut. K-0743.

CHIEF OPERATING ENGINEER to have charge of the power plant, 9000 hp., 3250-kw. capacity, an additional steam plant for heating and industrial purposes of about 400 hp., large hydraulic pump room giving power for benches, rams, etc., and several other centres of steam-using apparatus. Salary about $3000 a year. Location, near New York. K-0745.

GENERAL FOREMAN in plant department to have charge of from 150 to 200 men, made up of electricians, plumbers, steamfitters, carpenters, painters, laborers, etc., who would be responsible for the maintenance and construction work in a plant employing about 3000 hands. Position about $3000 a year. Plant is running between 90 and 100 per cent for the government, mostly on direct orders for the Army and Navy. Location, near New York City. K-0746.

ENGINEERS to train and develop in the fundamentals of firm primarily engaged in the distillation of coal tar with resultant principal production of bituminous road and roofing materials, with the ultimate object of filling operating positions in various plants as foreman, head chemist, assistant superintendents, or superintendents. Preferably men of chemical engineering training, but not essential. As contemplated work will eventually be of an executive nature, ability to handle men is a desirable asset. Location, New York. K-0749.

SALESMAN for special class of machinery. Man with technical training and ability to meet the engineering staffs of large organizations. Location, Ohio. K-0750.

DESIGNERS on tools, jigs and fixtures. Salary $40 a week. Location, Brooklyn, New York. K-0751.

DRAFTSMEN experienced in construction and repair of machinery for industrial plants, qualified to design special machinery and making layouts of new equipment. Prefer men with chemical-plant experience or who have done drafting for consulting engineer. Permanent position in an essential industry with 40 per cent of plant devoted to government work. State qualifications and details of past experience. Salary $1400 to $1600 to start. K-0752.

ELECTRICAL ENGINEER principally for shop inspection and to superintend the erection of electric monorail and traveling-crane equipment, with incidental miscellaneous office and field work. Man in class 2D, 3 or 4 of the draft. K-0753.

DRAFTSMAN to do all-around work connected with engineering department. Metallurgical and chemical concern. Location, New York. K-0754.

ASSISTANT EMPLOYMENT MANAGER, man with some mechanical training. Appointment can be made through New York office. Location, Connecticut. K-0288.

DRAFTSMEN for Connecticut plant. Men of recognized ability desired. Appointment can be made through New York Office. K-0289.

TIME-STUDY WORK, men of ability. Location Connecticut. K-0290.

YOUNG ENGINEER over draft age, single, to go to head office in Chile, S. A., of company operating several plants in nitrate district. Should have some experience in industrial cost analysis and efficiency work, in addition to general engineering experience. Salary $3000 a year to start. K-0316.

DRAFTSMAN for proposition department. Design of power-house and boiler-rooms and making estimates of costs, as an aid to sales department. Believe opportunities for young men of ability are exceptional. Location, New Jersey. K-0207.

FIRE PROTECTION ENGINEER. Large plant in Detroit requires man to guard

against fire hazards. Should be fully informed as to modern fire-prevention methods, with sufficient training and education in electricity and chemistry to fully appreciate hazards of this sort. In applying, state age, draft status, nationality, extent of education, detailed experience, present employment, etc. K-0247.

CONTROLLING INTEREST in prosperous machine tool and gage manufacturing concern to be sold for best offer. Present owner to enter service. Well known firm of wide reputation. Location, Connecticut. K-0259.

CAPABLE PRACTICAL MAN to take entire business control of machine shop building special machinery, gages and tools. Engineer with business knowledge and experience in this line of work preferred; interest in the business may be acquired by the right man. Location, Connecticut. K-0260.

SALESMAN familiar with sale, design and making of special machinery, tools, gages and fixtures; practical mechanical experience necessary. Good opening for right man. Location, Connecticut. K-0261.

ENGINEERS, college graduates, men out at least a year, for general shop engineering work with growing concern. Work leads to industrial management. State full particulars. Location, New Jersey. K-0265-E.

EXPERIENCED COPY WRITER to handle building construction and equipment accounts. Exceptional opportunity with New England agency for man who knows the contracting field and can show satisfactory evidence of ability through copy and catalogue matter already written. K-0267.

MECHANICAL DRAFTSMEN with technical education, experienced on vacuum-heating systems and high-pressure steam piping. Location, New York. K-0329.

DRAFTSMEN with experience in conveying machinery and general engineering. Salary, $175 to $200. Location, New Jersey. K-0336.

TOOL MAKERS OR MACHINISTS. Location, Newark, New Jersey. K-0341.

DRAFTSMEN, some experience in chemical plants. Location, New York City. K-0346.

MECHANICAL DRAFTSMEN experienced in power-transmission and machinery-arrangement work. Work in question will probably be over two months' duration and good salaries will be paid competent men. Traveling expenses from New York to West Virginia and return, and living quarters furnished without charge. K-0347.

MECHANICAL DRAFTSMEN in electrical department of large railroad company. Men familiar with large power-station work. Immediate work in hand is installation of a 20,000 kw. turbo-generator with the necessary condensing apparatus, boilers, stokers, coal and ash handling apparatus, etc. Salary, $174 per month. Location, New York. K-0352.

MACHINE DESIGNERS on fixtures, jigs, etc., flat salary of $25 and opportunities at high rates by the hour. Location, Connecticut. K-0353.

SALES ENGINEER, energetic and willing to work. Must be thinker with engineering college degree, one year shop work on machine design, or a high-school education with two or three years shop work on machine design. Between 25 and 32, draft exempt, or class 4. Salary $1500 to $1800. Location, New York as headquarters to travel. K-0355.

DRAFTSMEN on power-house layout and piping. Salary depends on man. Location, New York. K-0382.

DRAFTSMAN on marine-engine work in factory having large Government contract. Permanent employment for the right party. One having oil engine experience preferred. Location, New York State. K-0384.

SHIPBUILDING DRAFTSMEN. Salary, $35 to $40. Location, Brooklyn, N. Y. K-0386.

TURBINE MAINTENANCE ENGINEER. Man for inspection of turbine and auxiliary equipment and taking care of the major repairs to apparatus, for large power company operating several stations. Location, Pennsylvania. K-0412.

BOILER MAINTENANCE ENGINEER. Man for inspection of boiler and boiler-room apparatus. One with construction experience in large boilers preferred. Location, Pennsylvania. K-0413.

SUPERINTENDENT for growing concern having machine shop, foundry, pattern and blacksmith shop just starting on attractive specialty, requires capable superintendent experienced in above lines, and a good systematizer. Excellent opportunity for young man. Location, Michigan. K-0417.

SALES ENGINEER having thorough technical and practical knowledge in electrical work, telephone equipment and installation and equipment of electrical apparatus in general, to travel Pacific Coast for New York corporation. Man between 25 and 35, having good personality and appearance coupled with selling ability, preferably in class 4A of draft. Knowledge of shipbuilding industry is desirable. Traveling expenses paid. Salary, drawing account plus commission. K-0692.

EXPERIENCED COKE OVEN OPERATOR and supervising gas-works engineer in city near Atlantic seaboard, where residence conditions are agreeable and excellent schooling and college education available for children. Write, giving in detail experience and technical education, references, expected salary and how soon available. Applications will be considered confidential. An excellent permanent position for the right man. K-0742.

HIGH-CLASS MAN who has combined engineering and selling ability. Location, Buffalo, New York. K-0755.

ASSISTANT ENGINEER with technical training and experience in construction and repairs of industrial plants, qualified to design special machinery and capable of making layouts of new equipment so as to obtain efficient utilization of floor space and economical plant operation. Permanent position. Prefer man with experience in chemical plant or office of consulting engineer. State qualifications and details of past experience. Salary, $1500 to $2000, according to ability. Location, Southern Ohio. K-0756.

MECHANICAL DRAFTSMAN in engineering department in our New York office. Pay $150 to $175 per month for man capable of doing detail work and light designing. Location, New York. K-0757.

NEW YORK FIRM OF INDUSTRIAL AND SCIENTIFIC MANAGEMENT ENGINEERS desires to take into their engineer staff with purpose of training, men who are draft exempt for work classified as "essential" by a number of District Boards and by the Provost General's office. Splendid training is given in production increasing and management work in large variety of industries, together with opportunity for managerial position. K-0758.

DRAFTSMAN experienced in mill and power piping, all classes of heating. Man over 36 years of age or else with dependents. Location, Massachusetts. K-0760.

SALES ENGINEER, prominent pumping machinery concern desires to add four men to its sales organization, to sell centrifugal pumps and steam turbines. Only men who know machinery, who are versed in the pump and turbine atmosphere, and who are fully conversant with the engineering problems involved in erection and operation of centrifugal pumps and steam turbines will be considered. Liberal salary plus commission on each sale and choice of four sales territories, namely New York, Philadelphia, Detroit, or Boston, is offered. Location, New York. Apply by letter. Name confidential. K-0761.

ELECTRICAL AND MECHANICAL ENGINEER. Position will pay about $3300 per year at the start and $3600 per year as soon as the incumbent has fully demonstrated his ability to satisfactorily handle the work. Under civil service law. Work includes operation, maintenance and repair of electric lighting system for boulevards and parks, including high-tension transformer sub-stations, and transmission lines, and all auxiliary apparatus; also the design, maintenance and repair of illuminating equipment in all park buildings. Preparation of plans and specifications for alterations and new electrical construction work and supervision of their execution will also be included. Location, Illinois. K-0729.

MEN AVAILABLE

Only members of the Society are listed in the published notices in this section. Copy for notices should be on hand by the 12th of the month, and the form of notice should be such that the initial words indicate the classification. Notices are not repeated in consecutive issues.

MEMBER, mechanical engineer, technical education, 12 years' experience plant layout, structural steel, timber construction, conveying, elevating, power-transmission machinery. Now in sole charge work involving expenditure $200,000 designing, purchasing materials, directing field work. Minimum salary $350 month. K-261.

TECHNICAL GRADUATE with 10 years' experience in steam and hydraulic power-plant design and construction work, desires position with concern engaged in essential business, also plant-operation and plant-machinery installation work. K-262.

EXECUTIVE ENGINEER, M. I. T. graduate, Member. 20 years' experience along mechanical electrical lines, and in organizing and purchasing. American; location preferred, New York City or vicinity. K-263.

CHIEF DRAFTSMAN OR PRODUCTION ENGINEER, 10 years' experience as draftsman, designing, motors, jigs, tools, plant layout, furnaces, charge of machine-shop production, efficiency, at present on consulting work; position desired in New York City, Newark, or vicinity. Salary $180 to $200 per month. Married, three dependents, American, 33 years of age. K-264.

DESIGNING AND MAINTENANCE ENGINEER. Mechanical engineer, University of Pennsylvania graduate, desires connection as designing engineer or chief draftsman with concern where merits would be appreciated. Past experience includes design, erection and maintenance of large industrial and power-plant installations in supervising capacity. At present engaged as designing engineer. K-265.

PRODUCTION ENGINEER, competent in plant and production equipment, open for engagement preferably in metropolitan district. K-266.

WORKS MANAGER OR ASSISTANT. Graduate of Purdue University, degree of M.E.; 18 years' experience in freight-car work. Experienced in heavy presses, steel and hydraulic presses. Designer of dies for heavy pressing. Familiar with tank-car construction and maintenance. Location, middle west preferred, but other location considered if the inducements are there. Married, over 36, probably draft exempt. K-267.

MECHANICAL ENGINEER desires executive position offering greater opportunities than present position as works engineer for large company. Member, age 38, married. Technical graduate, practical experience in carpentry, plumbing and machine shop. Drafting experience in mining machinery, power pumps and electrical machinery. Engineering experience covers power-plant work, both generation and distribution. Repair and maintenance, new construction and industrial work in general, especially equipment for pattern, wood, box-making and machine shops, iron and brass foundries, grinding, polishing, buffing, hardening, japanning, coslittizing, electro-plating and other special processes. In charge of work relative to compensation and labor laws,

welfare, safety, watchmen's and firemen's organization, public relations. Can handle big propositions and large numbers of men successfully. K-268.

SALES ENGINEER having business-getting record is open for engagement as manager of sales, in charge of responsible district office or on a basis in line with experience and qualifications. Can give satisfactory evidence of ability and character. Change is contemplated because of present conditions curtailing activities. K-269.

TOOL SUPERINTENDENT, ASSISTANT CHIEF ENGINEER, CHIEF DRAFTSMAN. Progressive, energetic engineer, desires to make connections with manufacturing concern needing an engineer with training and broad experience as well as ability to produce results. Excellent references, open for engagement about December 1. K-270.

PRODUCTION OR PRODUCTION EQUIPMENT ENGINEER, or other responsible position, designing or manufacturing end or both. Must be war work. Salary about $4000. Would like to correspond with party needing self-starting man. Practical mechanic and designer. Experience covers originating, designing, building and operating numerous special and standard automatic and semi-automatic machines for producing wide variety of articles from wire, sheet metals, paper, wood, etc., for assembling labor saving, processing, conveying, cost reducing, etc. Punches and dies, jigs, fixtures and tools and general engineering, routing, cost accounting, bookkeeping, time study and production. 28 years old, married with family, draft exempted. Will go anywhere. K-271.

INDUSTRIAL AND SALES ENGINEER possessing ability to supervise plant manufacturing iron and steel products, specializing in power-house equipment. Trained mechanical engineer, experienced in purchasing, designing, manufacturing and sales promotion. Able to take entire charge of business and successfully market product, desires permanent executive position to start about $6000 and advance rapidly as results are shown. American, 40, married, with family, very successful record and large earning capacity. K-272.

INDUSTRIAL ENGINEER, designer, complete experience from shop apprentice to sales agency, technical graduate, 43 years of age, married, faultless record, will go anywhere, especially coast district in south. K-273.

MECHANICAL ENGINEER, age 24, wishes position preferably in Middle West. K-274.

MECHANICAL ENGINEER, now chief engineer of an industrial car company, desires position with manufacturing company, as mechanical engineer, or other executive position. Ten years' experience in general mechanical engineering. Thoroughly conversant with technical and practical side of standard railway and industrial equipment. Competent to assume full charge and to produce results. Salary not less than $3600. K-275.

FOUNDRY SUPERINTENDENT OR MANAGER, thoroughly practical, iron, brass, and composition foundry man, having wide experience on all classes of iron and brass castings. Over draft age; satisfactory references furnished, also satisfactory reason for wishing to make change from present position. K-276.

TECHNICAL EXECUTIVE with broad American and foreign experience desires position abroad, preferably in reconstruction work in France or England. American-born, college graduate, associate member, age 31, Class 4. Experience as engineer and executive in production, design, tool-work, organization, and management. Well-balanced, resourceful, dependable. Salary $8000 to $10,000. K-277.

POWER-PLANT EXECUTIVE. Technical graduate, age 31, Class 4 of draft, with 10 years' experience in power-plant construction, reconstruction, operation and management, desires position of this nature more directly connected with war work. At present employed. Salary considered $3600 to $4000. K-278.

MECHANICAL ENGINEER Member, age 45, married, technical graduate. 20 years' experience, covering design, construction, operation of cement plants. Thoroughly conversant with boilers, engines, turbines, motors; at present superintendent of large plant, wants to change for larger responsibilities; will go anywhere, available any time. K-279

PRODUCTION ENGINEER. Thorough experience in planning, dispatching, cost system. Analytical, creative ability and tact rated the highest. Age 32, 4th class draft. Salary $5000. K-280.

TECHNICAL GRADUATE with over ten years' experience in design, construction, operation and maintenance of manufacturing and power equipment is desirous of making new connection as mechanical engineer or in other executive capacity in line with his qualifications. Capable and conscientious worker with the best of references. Minimum salary $3600. K-281.

EXECUTIVE, 38, desires connection where mechanical training, including 18 years in design, development, manufacture, sale and installation of boiler room equipment would be of service; traveled extensively, familiar with fuel problems, excellent correspondent, hard worker. Chicago preferred K-282.

INDUSTRIAL OR PUBLIC UTILITY EXECUTIVE, member, technical graduate, age 46, American, Protestant. Unusual combination of general business, financial and engineering experience. Thoroughly grounded in mechanical and electrical engineering, including design, construction, operation, examinations, appraisals, utilities and industrial undertakings. Especially successful in organizing and directing large working forces for construction and operation in different sections of the country where local conditions and labor problems differ greatly. A profit-sharing arrangement with a small enterprise that has a future or salary commensurate with ability. K-283.

CANDIDATES FOR MEMBERSHIP

TO BE VOTED ON AFTER NOVEMBER 21

BELOW is a list of candidates who have filed applications since the date of the last issue of The Journal. These are classified according to the grades for which their ages qualify them, and not with regard to professional qualifications, i.e., the ages of those under the first heading place them under either Member, Associate or Associate-Member, those in the next class under Associate or Associate-Member, those in the third class under Associate-Member or Junior, and those in the fourth under Junior grade only. Applications for change of grading are also posted. Total number of applications 164.

The Membership Committee, and in turn the Council, urge the members to scrutinize this list with care and advise the Secretary promptly of any objections to the candidates posted. All correspondence in this regard is strictly confidential. Unless objection is made to any of the candidates by November 21, and provided satisfactory replies have been received from the required number of references, they will be balloted upon by the Council.

NOTE. The Council desires to impress upon applicants for membership that under the present national conditions the procedure of election of members may be slower than under normal conditions.

NEW APPLICATIONS

FOR CONSIDERATION AS MEMBER, ASSOCIATE OR ASSOCIATE-MEMBER

Alabama

DEMPSTER, William J., Fuel Agent, Montgomery Light & Traction Co., Birmingham
JONES, George W., Draftsman, Republic Iron & Steel Co., Birmingham

California

AUSTIN, Henry W., Senior Mechanical Engineer, Interstate Commerce Commission, San Francisco
KINGWELL, William A., Owner, Brass Foundry & Machine Works, San Francisco
LLOYD, Bruce, Manager, Engineering Dept., Henry Lund & Co., San Francisco

Connecticut

MURPHY, Frederick H., Assistant Superintendent, Remington Arms U. M. C. Co., Bridgeport

District of Columbia

BELLONY, Alexander M., Captain, National Army, War Dept., Washington
BLACKWOOD, Joseph H., Mechanical Expert & Patent Attorney, Washington
BREARLEY, James A., First Assistant Examiner, U. S. Patent Office, Washington
MILLER, Elton W., Mechanical Expert, Chemical Warfare Service, War Dept., Washington
SIMPSON, Frederick, Assistant Mechanical Engineer, Quartermaster Corps, U. S. A., Washington

Florida

HUDSON, Frank L., U. S. Shipping Board, Jacksonville

Illinois

BAUEREISEN, Ralph J., Well Contractor, Partner, C. P. Brant & Co., Chicago
CASBERG, Carl H., Assistant to General Superintendent, Rockford Drilling Machine Co., Rockford
ELLIS, Russell E., President, R. E. Ellis Engineering Co., Chicago
EXTON, Alfred H., Chief Engineer, American Manganese Steel Co., Chicago Heights

FISHLL, FRED, Vice-President & Treasurer, E. E. Elli Engineering Co., Chicago

GARDNER, LESTER H., Supt. Engineering & Planning, Rock Island Arsenal

GREEN, J. BIRCHARD, President, Chicago Steel & Wire Co., Chicago

JOHNSON, CLARENCE G., Consulting Engineer, Union Utilities Co., Chicago

KEHM, AUGUST, President, Kehm Bros. Co., Chicago

MAY, HARRY C., General Superintendent, Chicago, Indianapolis & Louisville R. R., Chicago

MUELLER, JACOB W., Managing Estate of Solomon Mueller, Belleville

SONEN, CLAYTON L., Industrial Engineer, L. V. Estes, Inc., Chicago

Indiana

ADDINGTON, MARTIN L., Tool & Gauge Maker, Nordyke Marmon Co. Indianapolis

BESSOM, EARL A., Chief Engineer, Wheeler Schebler, Carburetor Co., Indianapolis

Iowa

JACOBSON, ERNST, Consulting Engineer, Davenport

Maryland

MITCHELL, GEORGE W., U. S. Army Chemical Warfare Section, Edgewood Arsenal, Edgewood

Massachusetts

CHANDLER, LEONARD D., Member of Firm, Rideout, Chandler & Joyce, Boston

APPLEGATE, WILLIAM A., Chief Draftsman, Morgan Construction Co., Worcester

KNOWLES, FRANK E., Superintendent of Inspections, Factory Mutual Insurance Co.'s., Boston

LEARY, FRANCIS J., Hydraulic Engineer, Chas. W. Praray, New Bedford

LUSK, WALTER F., Chief Steam Engineer, American Writing Paper Co., Holyoke

Michigan

HANDLOSER, ROBERT C., Manager, Branch Office, Motch & Merryweather Mchy. Co., Detroit

HEATH, LEWIS W., Treasurer, General Manager, Consolidated Press Co., Hastings

LEWIS, JOHN G., Vice-President & Factory Manager, Detroit, Screw Works, Detroit

MORRISSEY, JOHN M., Field Superintendent & Service Engineer, Diamond Power Specialty Co., Detroit

New Jersey

KOPF, EMIL A., Assistant to Mechanical Engineer, Singer Mfg. Co., Elizabeth

MEEKS, HOWARD V., Treasurer, The Gardner & Meeks Co., Union

MURPHY, TIMOTHY J., Field Engineer, American Steel & Wire Co., Trenton

WATTS, GEORGE A., JR., Salesman, General Utility Man, Watts Campbell Co., Newark

New York

BERNDT, IRVING A., Vice-President, C. E. Knoeppel & Co., Inc., New York

BORSUK, ANTON, General Superintendent, Presto Machine Works, Brooklyn

CHAMBERLAIN, REGENALD P., Tool Designer, Pierce Arrow Motor Co., Buffalo

COFFEY, BARTON H., Chief Engineer, Cooling Tower Co., Inc., New York

EDWARDS, HARRY D., Chief Draftsman, The Linde Air Products Co., New York

EVANS, LEIGH R., Vice-President & Factory Manager, Cyclemotor Corp., Rochester

FEILD, WILLIAM T., Construction & Maintenance Engineer, American Car & Fdry. Co., Depew

FLIFLET, THORLEIF, Chief Engineer, Walter Kidde & Co., Inc., New York

FREE, ALBERT V., Assistant to Principal in Charge of Academic Work, Saunders Trades School, Yonkers

GRIMMER, FREDERIC H., Machine Shop Superintendent, Cameron Machine Co., Brooklyn

HOPF, HARRY A., Consulting Industrial Engineer, New York

KELLER, M. W., Manager, Engineering & Research Dept., Oneida Community, Ltd., Kenwood

KNAPP, ARTHUR, President, Arthor Knapp Engineering Corp., New York

LOFTIN, ALEXANDER J., Assistant to Superintendent, Fidelity & Casualty Co. of New York, New York

McCULLOUGH, CHARLES H., JR., Vice-President & General Manager, Lackawanna Steel Co., Buffalo

MANVILLE, KEITH R., Designer, Curtiss Engineering Corp., Long Island City

NEUBAUER, GEORGE A., Mechanical Engineer, The Buffalo Pitts Co., Buffalo

PACKARD, ROLAND A., Superintendent of Power, Barnet Leather Co., Little Falls

SEARLE, ERNEST M., Mechanical Engineer, Standard Oil Co. of New York, Albany

SHAFFER, MATTHEW T., Mechanical Engineer, The Barrett Co., New York

THOMAS, EDWARD H., Chief Inspector of Chemical Plant Construction, Ordnance Dept., U. S. A., New York

VAN GORDER, WINFRED H., Superintendent, C. J. Tagliabue Mfg. Co., Brooklyn

VUILLEUMIER, RUDOLPH, Chief Engineer, Pintsch Compressing Co., New York

WHITAKER, HARRY E., Engineer, Ford, Bacon and Davis, New York

North Carolina

MAULDIN, EARLE, Engineer of Construction, R. J. Reynolds Tobacco Co., Winston-Salem

MEISTER, CONRAD L., Mechanical Engineer, A. C. L. R. R., Wilmington

Ohio

ANDERSON, HAROLD, N., President, Anderson Rolled Gear Co., Lakewood

CASE, ALLANDO A., Instructor, Machine Shop Practice, Ohio State University, Columbus

DRAKE, WILLIAM A., Secretary and Sales Manager, The Brownell Co., Dayton

GARDNER, ROLLAND, Commercial Engineer, Westinghouse Elec. & Mfg. Co., Cleveland

JONES, SIDNEY W., Inspector, New Construction, Youngstown Sheet & Tube Co., Youngstown

KEYS, WALTER C., Acting Director of Engineering, The Standard Parts Co., Cleveland

KNECHT, ARTHUR E., Production Engineer, National Cash Register Co., Cincinnati

MORRIS, GEORGE M., President & Treasurer, The Morris Machine Tool Co., Cincinnati

PILLIOD, CHARLES J., Designer, The Pilliod Co., Swanton

SHIELDS, FRANK S., President, The Cleveland Planer Co., Cleveland

Pennsylvania

AUSTIN, WALTER M., Electrical Engineer, Westinghouse Elec. & Mfg. Co., E. Pittsburgh

BROSIUS, EDGAR E., Contracting Engineer, Pittsburgh

CUNNINGHAM, OTTO H., Charge of all fuel and power conservation work, Allegheny Steel Co., Breckenridge

FULLER, JOHN T., Mining Engineer, Aluminum Co. of America, Pittsburgh

HUGHES, HARRISON H., Master Mechanic, Carnegie Steel Co., By-Product Coke Wks., Clairton

KLINE, CHAS. W., Draftsman, New Jersey Zinc Co., Palmerton

MERRITT, JAMES S., Philadelphia Manager, The Engineer Co., New York Philadelphia

SCHRANZ, CHARLES A., Manager, Hydraulic Machinery Dept., R. D. Wood & Co., Philadelphia

SLOAT, BENJAMIN C., Div. Superintendent of Hull Construction, American International Shipbuilding Corp., Hog Island

SULLENBERGER, JOHN K., Construction Engineer, Bethlehem Steel Co., Bethlehem

WRIGHT, RAYMOND D. B., Sales Engineer, Harrison Safety Boiler Woorks, Philadelphia

ZINK, JOHN H., Construction Engineer, Bethlehem Steel Co., So. Bethlehem

Texas

BASTION, J. A., Construction Engineer, The Texas Co., Port Arthur

WILSON, CHESTER W., Consulting Engineer, American Smelting & Refining Co., El Paso

Virginia

TOPHAM, WILLIAM O., Superintendent Engineer and Engineer, Surveyor Shipping Control Committee, Newport News

WEIDMAN, WILLIAM R., Captain Engineers, 517th Service Battalion, Camp A. A. Humphreys

Washington

BOUSCHOR, WILLIAM E., Puget Sound Manager, Williamette Iron & Steel Wks., Seattle

FLODIN, JOHN, Draftsman, C. M. Standifer Construction Corp., Vancouver

MATHESON, W. SCOTT, Vice-President and Manager, Westerman Iron Wks., Seattle

West Virginia

STEVENSON, CHARLES M., Works Engineer, Rollin Chemical Co., So. Charleston

Wisconsin

NAGLER, FORREST, Sales Engineer, Allis-Chalmers Mfg. Co., Milwaukee

Canada

WOOD, REGINALD H., Lieutenant, Chief Engineer, Esquimalt Naval Dockyard, Esquimalt, B. C.

England

JOHNSON, LAWRENCE W., Consulting Engineer & Technical Director, Messrs. Banks, Warner & Co., Ltd., London

France

PIERCE, PAUL L., Lt. Col., Ordnance Dept., U. S. N. A., American Expeditionary Forces

Mexico

TAYLOR, WILLIAM R., Chief Mechanical Engineer, Mexican Eagle Oil Co., Minatitlan

South America

McINTYRE, OTIS L., Mechanical Superintendent, Cerro de Pasco Copper Corp., La Fundicion, Peru

FOR CONSIDERATION AS ASSOCIATE OR ASSOCIATE-MEMBER

Arizona

BUCHEN, JOSEPH C., Mechanical Engineer, Miami Copper Co., Miami

California

CARTER, THOS. F., Mechanical Engineer, Western Pipe & Steel Co., Los Angeles

New York

INGLEE, CLINTON, Treasurer & General Manager, National Water Main Clearing Co., New York

LAPP, ROY B., Plant Engineer, Ingersoll Rand Co., Painted Post

PAVITT, WILLIAM H., Assistant Chief Engineer, Wilputte Coke Oven Corp., New York

Ohio

SCHUTTLER, CARL H., Assistant District Supply Manager, U. S. Shipping Board Emergency Fleet Corp., Youngstown

Pennsylvania

FLETCHER, HOWARD J., Production Manager, Miller Lock Co., Frankford

Washington

MAGUIRE, WALTER J., Chief Inspector, Pacific Coast Steel Co., Seattle

SEIM, OLIVER P., Dispatcher, Navy Yard Puget Sound, Bremerton

FOR CONSIDERATION AS ASSOCIATE-MEMBER OR JUNIOR

California

HOUGHTON, HARRY S., Construction Engineer, C. F. Braun & Co., San Francisco

Connecticut

HUMASON, LAWRENCE C., Secretary & Treasurer, The Peck & Young Mfg. Co., Forestville

MERRY, ARTHUR A., Assistant Works Manager, Pratt & Whitney Co., Hartford

MILLINGER, William A. F., Assistant Engineer, American Can Co., Bridgeport

District of Columbia

ABRAMS, Lawrence B., Engineer, Ingersoll-Rand Co., Washington
MAIER, Dwight C., Aeronautical Mechanical Engineer, Bureau of Aircraft Production, War Dept., Washington

Illinois

FISCHER, Franz W., General Superintendent, The Liquid Carbonic Co., Chicago

Massachusetts

GEORGE, Harry A., Chief Cost Accountant, The Heald Mch. Co., Worcester

Michigan

BAITS, Stuart G., Engineer, Hudson Motor Car Co., Detroit

New Jersey

MULLER, Joseph, Mechanical Designer, Crocker-Wheeler Co., Ampere
REITZEL, Jacob H., Rate-Setter, Crocker-Wheeler Co., Ampere

New York

BAUMEISTER, Paul A., Mechanical Engineer, Ingersoll-Rand Co., New York
LAHRS, Louis J. T., Director of Physical Education, Y. M. C. A., Buffalo
LEINROTH, Jean P., Foreman of Welding Dept., Bossert Corp., Utica
MARTIN, Walter H., Small Tool Engineer, Arthur Knapp Engineering Corp., New York
NEWBY, Clarence L., Engineer, Hyatt Roller Bearing Co., New York
PIPEROUX, Rene P., Chief Estimating Engineer, Honolulu Iron Wks., New York
STEELE, Francis J., Jr., Assistant Chief Draftsman, Naval Auxiliary Reserve, New York
WILLIAMS, Harry H., Safety Engineer, Wynkoop Service, New York

Ohio

FELLOWS, John A., Assistant Superintendent, Machine Dept., American Rolling Mill Co., Middletown
STOESSER, Leo P., Production Engineer, The American Rolling Mill Co., Hamilton
WHITMAN, Ray B., Assistant to Chief Inspector, U. S. Shipping Board, Emergency Fleet Corp., Cleveland

Pennsylvania

KLEIN, Stephen L., Superintendent, Lykens Valley Fuel Co., Williamstown
SHEPHEARD, George R., Assistant Chief Engineer, The Viscose Co., Marcus Hook

Wisconsin

FRASER, John, Jr., General Manager, The Fraser Co., Milwaukee

Canada

McKINNON, R. A., Factory Manager, McKinnon Industries, Ltd., St. Catherines

Hawaii

SEMPLE, David M., Works Manager, Catton Neill & Co., Ltd., Honolulu

FOR CONSIDERATION AS JUNIOR

California

COBERLY, Clarence J., Engineer, California Burdett Oxygen Co., Los Angeles

Connecticut

NELSON, Ralph M., Assistant Mechanical Engineer, Ashcraft Mfg. Co., Bridgeport

Delaware

GROW, Harold J., Assistant Foreman, Welding Dept., Bethlehem Shipbuilding Corp., Wilmington

District of Columbia

OLIVER, Herman G., Experimental Engineer, Science & Research Div., U. S. A., Washington

Georgia

McGOWN, Clark Y., Ordnance Dept., U. S. A., Camp Hancock

Indiana

STILZ, Oscar W., In Charge of Production Dept., Nordyke & Marmon Co., Indianapolis

Maryland

HINE, Russell C., Steam Engineer, Consolidated Gas, Electric Light & Power Co., Baltimore

Massachusetts

BLUE, Edward W., Scovell, Wellington & Co., Boston

Missouri

SIROKY, Edmond, Instructor in Mechanical Engineering, Washington University, St. Louis

New Jersey

CHANDLER, Sherman M., Assistant Engineer, Standard Aero Corp. of New York, Plainfield
EDWARDS, William W., Millwright, Dusenberg Motors Corp., Elizabeth

New York

ANDERSEN, Andreas H., Manager, A. Hermansen, New York Branch, New York
CETRULE, John, Chief Inspector, Blair Tool & Mch. Wks., Inc., New York
DOXSEY, Arthur M., Assistant Engineer of Tests, Hull Division, Navy Yard, New York
HAUSEL, Walter M., Assistant to Chief Draftsman, Otis Elevator Co., Yonkers
HYDE, George G., Assistant Engineer of Design & Construction, Eastern Potash Corp., New York

Ohio

WHITE, Thomas H., Assistant to Vice-President, White Motor Co., Cleveland
WUEST, Frank W., Assistant in Planning and Time-Study Dept., The Lodge & Shipley Mach. Tool Co., Cincinnati

Oregon

FERRELL, Fred C., General Foreman, Spokane, Portland & Seattle Ry., Portland

Pennsylvania

BRITTON, Howard, Jr., Representative, Brass Goods Dept., Manning, Maxwell & Moore, Inc., Pittsburgh
NICHOLAS, John E., Shop Engineer, Bethlehem Steel Co., Bethlehem
RABE, Frederick W., Condenser Test Floor Engineer, Westinghouse Elec. & Mfg. Co., Wilkinsburg
TEFFEAU, Louis M., Mechanical Draftsman, A. I. S. B. Co., Philadelphia

France

LEISTER, Fayette, Master Engineer, 103rd Engineers, U. S. A., American Expeditionary Forces
PAULES, Parvin E., Lieutenant, Aviation Section

CHANGE OF GRADING

PROMOTION FROM ASSOCIATE

Michigan

STANBROUGH, Duncan G., General Superintendent, Packard Motor Car Co., Detroit

New York

PRICE, Melvin, Assistant Professor of Machine Design, University of Rochester, Rochester

PROMOTION FROM ASSOCIATE-MEMBER

Missouri

RUPP, Manning E., Superintendent, Shell Forging Plants, Curtis & Co. Mfg. Co., St. Louis

New Jersey

KING, Frank A., Construction Engineer, Wright-Martin Aircraft Corp., New Brunswick

New York

HAMPSON, Donald A., Mechanical Executive, Morgans & Wilcox Mfg. Co., Middletown
OBERG, Erike V., Editor, "Machinery," New York

PROMOTION FROM JUNIOR

District of Columbia

FOGLER, Ben B., Major, Mechanical Research, Chemical Warfare Service, Washington

Massachusetts

HERRICK, Daniel A., General Superintendent, Julian d'Este Co., Boston

Mississippi

SHARP, John T., Superintendent, Canton Elec. Light & Water Wks., Canton

New Jersey

MOON, Alfred G., Maintenance Engineer, Hercules Powder Co., Kenvil

New York

LINKER, Abraham, Designer on Industrial Plant, Perin & Marshall, New York
McMILLAN, Luther B., Consulting Engineer, H. W. Johns-Manville Co., New York
MANDEL, Arthur C., Engineering Dispatcher, Wright-Martin Aircraft Corp., Long Island City
OSBOURN, Millard P., Chief Engineer, Badenhausen Co. (Reinstatement), New York
REBER, James B., Superintendent, Columbian Rope Co., Auburn
VAN DERVORT, Adrian O., Superintendent, Hammett Machine Works, Troy

Pennsylvania

PRIEBE, Ernest B., Chief Draftsman, Stoker Eng. Dept., West. Elec. & Mfg. Co., E. Pittsburgh

SUMMARY

New Applications	164
Applications for change of grading:	
Promotion from Associate	2
Promotion from Associate-Member	4
Promotion from Junior	11
Total	181

SUMMARY SHOWING AVERAGE AGE AND POSITIONS OF APPLICANTS ON BALLOT OCTOBER 24, 1918

Average age of applicants:	
Members	39
Associates	38
Associate-Members	32
Juniors	25
Aeronautical Mechanical Engineer	1
Associate Editor	1
Chief Engineer	2
Assistant Chief Engineer	1
Consulting Engineer	2
Designers	3
Draftsmen	2
Chief Draftsmen	3
Executives (Pres., Vice-Pres., Secy., Treas., Mgrs.)	20
Foreman	1
Inspector	1
Assistant Inspector	1
Instructor	1
Master Mechanic	1
Mechanical Engineers	14
Assistant Mechanical Engineers	2
Motor Engineer	1
Operating Engineer	1
Plant Engineer	1
Production Officer	1
Professor	1
Resident Engineer	1
Sales Engineer	1
Superintendents	5
Assistant Superintendent	4
Miscellaneous	17

UNITED STATES GOVERNMENT SERVICE

Major	1
1st Lieuts	2

SELECTED TITLES OF ENGINEERING ARTICLES

THE section Selected Titles of Engineering Articles comprises an index to current articles on mechanical engineering and related subjects.

This work has been made possible by the remarkable collection of current technical periodicals available in the Library of the United Engineering Society, which is one of the greatest and most complete collections in the world. The Library receives, even now, when some of the foreign periodicals have ceased to come to its shelves, close to a thousand different papers, magazines and transactions of societies in the engineering and scientific fields, in not less than ten languages. The Society's engineering staff examines these publications as they are received and prepares the cards which are ultimately used in the Selected Titles section of THE JOURNAL.

Chief attention is paid to articles directly concerned with the branches of mechanical engineering. When it is thought they will be of interest or value to mechanical engineers, however, other articles are listed, in the realms of physics and chemistry; civil, mining and electrical engineering, technology, etc.; and in subjects in broadly related fields such as training and education, safety engineering, fire protection, employment of labor, welfare work, housing, cost keeping, patent law, public relations, etc. Cross-references are introduced and where the titles themselves are not sufficiently descriptive, explanatory sentences are appended. The main abbreviations used in the items are given at the bottom of this page.

PHOTOSTATIC PRINTS

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AERONAUTICS

Aerostatics

Military Aerostatics, H. K. Black. Aerial Age, vol. 7, nos. 24, 25, 26, Aug. 26, Sept. 2, Sept. 9, 1918, p. 1167, 1 fig., p. 1219, p. 1267, 1 fig., vol. 8, nos. 2 and 3, Sept. 23 and Sept. 30, 1918, p. 65, 1 fig., p. 119, 1 fig. Aug. 26: Science of ballooning; Cocquot type, Model *M*, operated by Royal Flying Corps. Sept. 2: Parachute harnesses. Sept. 9: Dimensions of American observation balloons. Sept. 23: Construction of balloon winches. Sept. 30: Handling a balloon in the field.

Altitude

An Alignment Chart for Obtaining Heights from Observations of Pressure and Temperature, A. H. Stuart. Aerial Age, vol. 7, no. 26, Sept. 9, 1918, p. 1275. Constructed by solving Laplace's equation between height above datum level and pressure and temperature of atmosphere, by means of a d'Ocagne alignment chart.

Problems in Flying at High Altitudes, W. Kasperowicz (Translated from French by Augustus Post). Flying, vol. 7, no. 8, Sept. 1918, pp. 714-715. Changes produced by reduced air pressure.

Bolts

On the Strength of Bolts in Airplane Structure, John Case. Aeronautics, vol. 15, no. 252, Aug. 14, 1918, pp. 134-139, 17 figs. Formulæ and rules for design; strength of bolts, in spars and the like, when subject to transverse loads at the ends; distribution of loads between bolts holding single plate under tension; distribution of load between bolts of joint subjected to bending. (To be continued.)

Enemy Aircraft Exhibit

The London Enemy Aircraft Exhibit. The Fokker Biplane, G. Douglas Wardrop. Aerial Age, vol. 8, nos. 2 and 3, Sept. 23 and 30, 1918, pp. 68 and 87, 1 fig. and p. 130, 1 fig. Sept. 23: Data of design of captured German machine of D VII type. Sept. 30: Halberstadt two-seater.

Engines

Aluminum Pistons for German Airplane Engines, C. Vickers. Brass World, vol. 14, no. 9, Sept. 1918, pp. 258, 1 fig. Drawing and description of aluminum piston taken from a 230-hp. Benz motor of captured Aviatik biplane.

Enemy Aircraft Engines (VIII). Automobile Engr., vol. 8, no. 116, July 1918, pp. 194-199, 11 figs. 180-hp. Mercedes: cylinders and other parts; lubrication; ignition; water-circulation system; power and consumption curves.

Modern Aeronautic Engines (II), Herbert Chase. Jl. Soc. Automotive Engrs., vol. 3, no. 3, Sept. 1918, pp. 205-208, 17 figs. Details of Sunbeam and Rolls-Royce (English) and Hall-Scott (Am.) engines. (Concluded.)

The Design of Aeroplane Engines, John Wallace. Aeronautics, vol. 15, nos. 251 and 252, Aug. 7 and 14, 1918, pp. 116-118, 7 figs., and 141-143, 6 figs. Aug. 7: Remarks on two-cylinder engines; twin-cylinder Vee engine; horizontally opposed twin; three-cylinder; four-cylinder vertical. Aug. 14: Three-cylinder radial engines; five-cylinder radial. Determination of results. (Continuation of serial.)

The 240-H.P. 8-cylinder Mercedes. Aerial Age, vol. 7, nos. 25 and 26, Sept. 3 and 9, 1918, pp. 1220-1221, 4 figs., pp. 1270-1274, 17 figs. Sept. 3: Detailed report on design of a captured German two-seater; summary of tests; cylinders; reduction gear. Sept. 9: Crank chamber; vertical driving gear; lubrication; water circulation; water-pump test report; ignition; air pump; engine data; general analysis of weights of parts.

The 300-H.P. Maybach Aero-Engine. Engineering, vol. 106, no. 2748, Aug. 30, 1918, pp. 226-228, 17 figs. Detailed and illustrated description of the six-cylinder German engine. Also published in Engineer, vol. 126, no. 3270, Aug. 30, 1918, pp. 184-186, 7 figs. and in Flight, vol. 10, no. 36, Sept. 5, 1918, pp. 995-1000, 10 figs. Connecting rods; valve gear; cam diagram and valve timing; crankshaft. (Continuation of serial.)

Individual Types

A Fokker Biplane of Recent Type. Flight, vol. 10, no. 30, July 25, 1918, pp. 829-831, 1 fig. Details of a captured German machine.

Some New Enemy Airplanes. Aviation, vol. 5, no. 4, Sept. 15, 1918, pp. 235-237, 9 figs. Dimensions and nature of Albatros D. 5, and of Fokker D. 7. Summary from L'Aérophile, L'Aéroplane, Flight and Flying. (To be continued.)

The D.H. 5 Pursuit Biplane. Aviation, vol. 5, no. 4, Sept. 15, 1918, pp. 228-229, 7 figs. Description of an English tractor biplane with a single pair of interplane struts on either side and with wings set at a negative stagger of 0.695 m. Also published in Aerial Age, vol. 8, no. 2, Sept. 23, 1918, pp. 70-71, 6 figs. Translated from Zeitschrift für Flugtechnik und Motorluftschiffahrt.

The Hannoveraner Biplane. Flight, vol. 10, no. 36, Sept. 5, 1918, pp. 987-993, 28 figs. Details of construction of captured plane. Report of Technical Department, Aircraft Production, Ministry of Munitions.

The Pfalz Single Seater Fighter—160 H.P. Mercedes Engine. Flight, vol. 10, nos. 30, 31, 32, 33, July 25, Aug. 1, Aug. 8, Aug. 15, 1918, pp. 822-827, 5 figs., pp. 855-856, 3 figs., pp. 885-888, 7 figs., pp. 905-908, 5 figs. July 25: Official data; diagrams showing method of covering body with ply-wood; wing roots. Aug. 1: Mounting of the tail-plane root; details of runner. Aug. 8: Safety-belt attachment; control handle; undercarriage. Aug. 15: Wiring diagram; wing structure and arrangement. Also published in Automotive Ind., vol. 39, no. 10, Sept. 5, 1918, pp. 406-409, 7 figs.

Giant Zeppelin Airships (Les avions géants Zeppelin). L'Aérophile, year 26, nos. 15-16, Aug. 1-15, 1918, pp. 225-242, 33 figs. Plans and details of captured machine, 22 m. long, 41 m. wide. Also published in Aerial Age, vol. 8, no. 3, Sept. 30, 1918, pp. 122-125, 6 figs.

Materials of Construction

Tests of Materials Used in Aeroplane Construction (L'essai des matériaux servant à la construction des aéroplanes). Génie Civil, vol. 73, no. 10, Sept. 7, 1918, pp. 188-191, 13 figs. Machines used for verifying equilibrium of parts; details and operation of Avery elongation and rupture-testing machine; tests made on textile fabrics.

Meteorology

Some Meteorological Conditions Which Increase the Danger of Flying, C. J. P. Cave. Aerial Age, vol. 8, no. 2, Sept. 23, 1918, p. 64, 2 figs. Rain, hail and snow; lightning; fog. (Concluded.)

Model Aeroplanes

Model Aeronautical Building as a Step to Aeronautic Engineering. Aerial Age, vol. 7, nos. 23, 24, 25, 26, Aug. 19, Aug. 26, Sept. 2, Sept. 9, 1918, p. 1127, 1 fig., p. 1183, 1 fig., p. 1231, 16 figs., p. 1283, 1 fig., vol. 8, nos. 2 and 3, Sept. 23 and Sept. 30, 1918, p. 77, 3 figs., and p. 135, 10 figs. Aug. 19: Method of fastening and rigging main planes. Aug. 26: Construction of tail, rudder, fin and propeller. Sept. 2: Compressed-air motor. Sept. 9: Details of motor; tank construction. Sept. 23: Steam-engine construction. Sept. 30: Gasoline-engine principle and construction.

Ornithopter

The Ornithopter, Herbert Chatley. Aviation, vol. 5, no. 4, Sept. 15, 1918, p. 237. Possibilities and requirements of the real bird machine.

Propellers

Notes on Airscrew Analysis, M. A. S. Riach, Aerial Age, vol. 7, no. 24, Aug. 26, 1918, pp. 1173-1179, 3 figs. Analysis of changes likely to be brought about by variation in one or more of the parameters involved in hypothesis upon which is based the theory of airscrew previously outlined by writer.

U. S. Aircraft Production

Aircraft Production in the United States. Flying, vol. 7, no. 8, Sept. 1918, pp. 721-726, 738 and 744. Complete report of the Senate Subcommittee on Military Affairs.

See also Metallurgy (Aircraft); Physics (Air); Woodworking Machinery (Propeller-Shaping Machines).

AIR MACHINERY

Air Compressors

Lubrication of Air Compressors, W. H. Callan. Am. Mach., vol. 49, no. 13, Sept. 26, 1918, pp. 575-577. Shows that most oil experts figure on heat conditions which do not exist and recommend the wrong oil.

NOTE. The abbreviations used in indexing are as follows: Academy (Acad.); And (&); American (Am.); Associated (Assoc.); Association (Assn.); Bulletin (Bul.); Bureau (Bur.); Canadian (Can.); Chemical or Chemistry (Chem.); Electrical or Electric (Elec.); Electrician (Elecn.); Engineer [s] (Engr. [s]); Engineering (Eng.); Gazette (Gaz.); General (Gen.); Geological (Geol.); Heating (Heat.); Industrial (Indus.); Institute (Inst.); Institution (Instn.); International (Int.); Journal (Jl.); London (Lond.); Machinery (Machy.); Machinist (Mach.); Magazine (Mag.); Marine (Mar.); Materials (Matls.); Mechanical (Mech.); Mining (Min.); Municipal (Mun.); National (Nat.); New England (N. E.); New York (N. Y.); Record (Rec.); Refrigerating or Refrigeration (Refrig.); Review (Rev.); Railway (Ry.); Scientific or Science (Sci.); Society (Soc.); United States (U. S.); Ventilating (Vent.); Western (West.); State names (Ill., Minn., etc.); Proceedings (Proc.); Transactions (Trans.); Supplement (Supp.).

Persberg Installation of Hydraulic Air Compressors (Hydraulisk luftkompressoranläggning vid Persberg), Gust. Anderson. Biuang till Jern-Kontorets Annaler, vol. 19, no. 7, July 15, 1918, pp. 271-296, 23 figs.

Blowers

Installation and Care of Sturtevant V D-5 Turbo-Blower, F. W. Sterling. Jl. Am. Soc. Naval Engrs., vol. 30, no. 3, Aug. 1918, pp. 480-489, 5 figs. Operating rules; enumeration of parts; emergency governor mechanism; packing; bearings; lubrication.

Test of Sturtevant Forced Draft Blower, M. C. Stuart. Jl. Am. Soc. Naval Engrs., vol. 30, no. 3, Aug. 1918, pp. 453-479, 19 figs. Performance at various speeds, steam pressures and back pressures of non-condensing vertical turbine with cone-type fan mounted on shaft directly above turbine; performance of fan at various speeds and capacities; performance of combined unit.

Compressed-Air Applications

Uses of Compressed Air in the Modern Shop, P. C. Frank. Can. Machy., vol. 20, no. 11, Sept. 12, 1918, pp. 309-313, 20 figs. Considerations on amount of clearance, cooling of air in cylinders and action of valve, in reference to efficient operation.

Flow of Air

The Flow of Air Through Small Coal and Other Broken Material: Report to the Doncaster Coal Owners' Committee, John T. Storrow. Trans. Instn. Min. Engrs., vol. 55, part 4, Aug.-Sept. 1918, pp. 313-317, 1 fig. and (discussion) pp. 317-323. Experiments to ascertain under what conditions the rate of flow of air through a porous material varies directly as the ventilating pressure, and not with the square root of it, as in the case in ordinary pipes.

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See Lubrication (Viscosity); Safety Engineering (Dust Inhalation); Varia (Automobile Insurance).

BRIDGES

Bridge Reconstruction

Strengthening Poughkeepsie Bridge Superstructure. Ry. Age, vol. 65, no. 11, Sept. 13, 1918, pp. 473-476, 9 figs. Engineering features of efforts to increase capacity by changing from double track to single gauntlet track accommodations.

Reinforced-Concrete Bridges

A New Type of Iron-Concrete Arch, M. Frontard. Eng. & Cement World, vol. 13, no. 4, Aug. 15, 1918, p. 37. Structure built by bridging gap with rails bent to curvature of arch and finishing with concrete.

The Canadian Pacific Railway's Second Track Work Between Leaside Junction and North Toronto. Can. Ry. & Marine World, no. 247, Sept. 1918, pp. 378-380, 5 figs. Features of design of 386-ft. reinforced concrete bridge over reservoir ravine; structure supported on two abutments and five towers.

Steel Arch Bridges

The Economics of Steel Arch Bridges, Indian Eng., vol. 64, nos. 3 and 4, July 20 and 27, 1918, pp. 39-41 and 53-54. Formulæ for weights of metal in arches per linear foot of span, based on designing specifications. (Continuation of serial.)

BUILDING AND CONSTRUCTION

Camp Model Towns

Construction Camps Model Towns on Miami Flood Works. Eng. News-Rec., vol. 81, no. 13, Sept. 26, 1918, pp. 575-578, 8 figs. Details of plan of village and floor plans of houses; village comprises houses, schools, community halls, markets, water mains, lights and sewers.

Concrete Culverts

Standard Practice in Concrete Culvert Construction, H. Colin Campbell. Eng. & Cement World, vol. 13, no. 4, Aug. 15, 1918, pp. 19-20. Tables giving relation between area drained and area of waterway, and data on reinforced-concrete box culverts.

Foundations

Foundation Construction for New Station at Kansas City. Elec. Rev., vol. 73, no. 13, Sept. 28, 1918, pp. 492-493, 7 figs. Problems encountered in the work on 150,000-kw. plant on Missouri River.

House Construction

House Construction and Design. Contract Rec., vol. 32, no. 35, Aug. 28, 1918, pp. 677-679, 7 figs. Various types and sizes of concrete houses adopted for work of reconstruction of Halifax.

Mill Buildings

Reconstruction of Consumers' Cordage Plant at Dartmouth. Contract Rec., vol. 32, no. 35, Aug. 28, 1918, pp. 687-688, 4 figs. Description of repair and reconstruction of buildings severely damaged by Halifax explosion.

Office Building

The Office Building of the Department of the Interior, Charles Butler. Architectural Rec., vol. 44, no. 3, Sept. 1918, pp. 199-213, 17 figs. Plans and elevations.

Piles

Carrying Capacity for Various Types of Piles, H. W. Young. Eng. & Cement World, vol. 13, no. 7, Oct. 1, 1918, pp. 28-29. Strengths computed by Patton's formula for a 30-ft. pile under average soil conditions.

See also Power Plants (Vibration).

CEMENT AND CONCRETE

By-Products

Conserving the By-Products of the Cement Mills, W. G. Clark. Eng. & Cement World, vol. 13, no. 7, Oct. 1, 1918, pp. 61-62, 1 fig. Opportunities in increasing efficiency by recovery of potash dust.

Concrete Proportioning

Methods of Proportioning Concrete Based on Recent Experimental Work, D. A. Abrams, Jl. Eng. Inst. of Can., vol. 1, no. 5, Sept. 1918, pp. 206-207. Notes based on author's work at Lewis Institute.

Concrete, Shock-Resisting

A New Shock Resisting Concrete. Can. Machy., vol. 20, no. 9, Sept. 5, 1918, pp. 297-298. Proportions of ingredients in concrete composed of portland cement with particles of moss, turf, or wood (pulverized or pulped), and metallic ores, with a binding liquid consisting of a soluble salt of alumina, lime and water.

Deterioration

Causes of the Disintegration of Concrete, A. G. Blackie. Jl. Eng. Inst. of Can., vol. 1, no. 5, Sept. 1918, pp. 200-203. Comparison of theories advanced by Montana Experimental Station, Bul. 81, Feb. 1911, and by Bureau of Standards, Tech. Paper 95, 1917, with results of work developed at Univ. of Wyoming Experimental Station, Bul. 113, Mar. 1917; account of author's tests made by determining action of various alkali solutions upon sands used locally in composition of concrete.

Chemistry of Concrete, Arch. Blackie. Can. Engr., vol. 35, no. 10, Sept. 5, 1918, pp. 231-233. Former and present theories explaining the disintegration of concrete; rules for making tile; distintegrated sewers; alkali action on sands; Winnipeg water district tests. Paper before Sasketoon Section, Eng. Inst. of Can.

Observations of Concrete Failures, H. McD. Weir. Jl. Eng. Inst. of Can., vol. 1, no. 5, Sept. 1918, pp. 203-206. Report of investigating committee appointed by Calgary Branch, particularly in relation to alkali conditions.

Reinforced Concrete v. Salt, Brine, and Sea-Water, H. J. M. Creighton. Page's Eng. Weekly, vol. 33, no. 726, Aug. 9, 1918, pp. 66-67. Corrosion of iron reinforcement due to action of brine; probable reactions which occur when metal comes in contact with a salt solution. Paper before Faraday Soc. (To be continued.) Also published in Min. Jl., vol. 122, no. 4329, Aug. 10, 1918, pp. 473-475.

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Effect of Oil on Concrete, C. P. Bowie. Practical Engr., vol. 58, no. 1642, Aug. 15, 1918, pp. 79-80. Reports on experiments performed under auspices of So. Pac. RR. Abstracted from Oil Storage Tanks and Reservoirs, Bul. 155, Bureau of Mines, Washington.

Portland Cement

Government Specifications for Portland Cement. Eng. & Cement World, vol. 13, no. 7, Oct. 1, 1918, p. 17. Definition, chemical limits, specific gravity, fineness, soundness, time of setting, tensile strength, packages and marking, storage, inspection, rejection, and treatment of samples.

See also Bridges (Reinforced-Concrete Bridges); Building and Construction (Concrete Culverts); Roads and Pavements (Concrete Roads).

CHEMICAL TECHNOLOGY

Flames

Residual and Extinctive Atmospheres of Flames, T. F. Eric Rhead. Jl. Soc. Chem. Ind., vol. 37, no. 16, Aug. 31, 1918, pp. 274T-278T, 2 figs. Experimental determination of oxygen contents for flames of various gases, the inert gas employed for the extinctive atmosphere being nitrogen.

Gasoline

The Recovery of Gasoline from Natural Gas, W. P. Dykema. Petroleum Rev., vol. 39, no. 841, pp. 138-140. Considerations to be made before designing a compression plant to treat natural gas from a given area. (To be continued.)

High-Temperature Processes

High Temperature Processes and Products, Chas. R. Darling. Jl. Royal Soc. of Arts, vol. 66, no. 3432, Aug. 30, 1918, pp. 635-642, 8 figs. Thermit processes and application of thermit to welding of iron and steel; electric steel smelting; fixation of atmospheric nitrogen; formation of calcium carbide; carborundum and allied substances.

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The Chemical Possibilities of Natural Gas, J. B. Garner. Chem. Engr., vol. 26, no. 7, June 1918, pp. 245-254. Uses of nitrogen contained in discharge gases from gas engines in production of compounds of industrial importance. Paper before Nat Gas Assn. of America.

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Studies on the Absorption of Light Oils from Gases, Harold S. Davis and Mary Davidson Davis, Jl. of Ind. & Eng. Chem., vol. 10, no. 9, Sept. 1918, pp. 718-725, 5 figs. Theory of washing process for the absorption of benzene vapor; determination of vapor pressure of benzene from its solution in high-boiling American petroleum oil; determination of average molecular weight of oil when dissolved in benzene by lowering freezing point; theory of washing processes for the absorption of light oil vapors.

Potash

The Recovery of Potash as a By-Product in the Manufacture of Portland Cement, John J. Porter. Am. Fertilizer, vol. 49, no. 5, Aug. 31, 1918, pp. 58-72. Possibilities of industry; problem of liberation; solubility of potash; electrical precipitation; estimating recovery; cost calculations.

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Comparative Methods for Determining the State of Cure of Rubber, H. P. Stevens. Jl. Soc. Chem. Ind., vol. 37, no. 16, Aug. 31, 1918, pp. 280T-284T, 5 figs. Formulation of degree of vulcanization in reference to (1) percentage of combined sulphur calculated in rubber present, (2) physical properties of vulcanizate, particularly load supported per unit cross sectional area at a given elongation, or vice-versa.

Moisture in Raw Rubber, G. Stafford Whitby. Jl. Soc. Chem. Ind., vol. 37, no. 16, Aug. 31, 1918, pp. 278T-280T, 1 fig. Records of observations made under tropical conditions on variations of water content of raw rubber and its relation to humidity of atmosphere, form of the rubber, and pressure of serum solids.

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Sulphur from Coal. Gas. Jl., vol. 143, no. 2880, July 23, 1918, p. 159, 1 fig. German feld process for simultaneous recovery of sulphur and ammonia by washing coal gas with a solution of ammonium tetrathionate.

Sulphuric Acid

Some Observations on Sulphuric Acid Plants, New and Old (IV). Gas World, vol. 49, no. 1776, Aug. 3, 1918, pp. 18-19. Spent oxide as a source of sulphur; purification of coke-oven gas.

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Increasing the Capacity of a Water Softener, C. R. Knowles. Ry. Maintenance Engr.,

vol. 14, no. 9, Sept. 1918, pp. 297-298, 4 figs. How railroad plant increased its capacity from 12,000 to 14,000 gal. per hr. by utilizing 100,000 gal. reservoir for storage of untreated water.

See also Cement and Concrete (By Products); Coal Industry (Coke); Engineering Materials (Rubber); Furnaces (Nitrogen-Fixation Furnaces); Refractories (High-Temperature Research), (Volatilization).

COAL INDUSTRY

By-Products

Liquid Fuel From Coal, W. R. Ormandy. Autocar, vol. 41, no. 1195, Sept. 14, 1918, pp. 257-258, 1 fig. The interrelation of pig iron, coke and benzol; report of Coal-Conservation Committee as affecting supply of fuel to motorists.

Coke

Pressure Regulation on By-Product Coke Ovens, Frederick H. Smoot. Gas World, vol 49, no. 1776, Aug. 3, 1918, pp. 19-20, 2 figs Valve arrangement and exhauster regulation. (From Iron Age, July 1, 1918.)

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Low-Temperature Distillation of Illinois and Indiana Coals, G. W. Traer. Bul. Am. Inst. Min. Engrs., no. 141, Sept. 1918, pp. 1463-1470, 1 fig. Account of practical work directed toward commercial adaptation of principle demonstrated by Parr, namely, the caking bituminous coal when subjected to temperature less than 1000 deg. fahr. in a retort from which air has been excluded, will yield light tar of about 1.06 sp. gr. and high value; also, this yield with a given coal will depend upon percentage of hydrocarbons in coal, maximum temperature used, and promptness with which distillate gases are removed.

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CONCRETE

(See Cement and Concrete)

CONVEYING

(See Hoisting and Conveying)

ELECTRICAL ENGINEERING

Alternators

The Behavior of Alternators with Zero Power-Factor Leading Current, F. D. Newbury. Elec. Jl., vol. 15, no. 9, Sept. 1918, pp 363-365, 3 figs. Curves showing excitation characteristics and saturation conditions required for stable self-excitation.

Cables

Aerial Cable Construction for Electric Power Transmission, E. B. Meyer. Elec. News, vol. 27, no. 17, Sept. 1, 1918, pp. 25-27, 4 figs. Design, construction and suspension of special cable used by company supplying light and power to 170 manufacturing plants. Paper before Am. Inst. Elec. Engrs.

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Automatically Remote Controlled Synchronous Motor Generator Substation, William Thomas Snyder. Elec. Rev., vol. 73, no. 11, Sept. 14, 1918, pp 407-409, 5 figs. Relative cost of automatic and manually-operated substation and mode of operating such a station of 100 kw. capacity.

Control System for Groups of Motors in a Cement Mill, William H. Easton. Eng. & Cement World, vol. 13, no. 5, Sept. 1, 1918, pp. 61-62, 3 figs. Group of eleven motors—nine 150 H.P. 2200 volt, Westinghouse squirrel-cage motors, driving 5½ by 22 ft. tube mills, and two 250 H.P., 2200-volt Westinghouse vertical squirrel-cage motors, cement-mill type, driving Bradley grinders, controlled by system recently installed.

Electromagnets

D. C. Lifting Magnets (Electro-aimants de levage à courant continu), J. A. Montpellier. L'Industrie Electrique, year 27, no. 628, Aug. 25, 1918, pp. 305-307, 3 figs. Characteristics of each one of the five types built by the Société l'Eclairage Electrique.

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The Protection of Electrical Apparatus, P. M. Lincoln. Elec Jl., vol. 15, no. 9, Sept. 1918, pp. 316-318 Brief review of various methods by which integrity of electrical insulation may be secured and permanently assured.

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Change of Specific Inductive Capacity with Temperature and Impregnation of Paper, H. C. P. Weber and T. C. MacKay. Jl. Franklin Inst., vol. 186, no. 3, Sept. 1918, pp. 374-377, 2 figs. Curves showing results obtained for various substances alone and in conjunction with impregnated paper, at Westinghouse Elec. & Mfg. Co.'s laboratory.

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Electric Lighting from Three-Phase Circuits, Terrell Croft. Southern Engr., vol. 30, no. 2, Oct. 1918, pp. 44-48, 14 figs. Suggestions for laying out systems, transformers and auto-transformers; industrial applications.

Motors

A Large Rolling-Mill Motor. Elec. Times, vol. 54, no. 1398, Aug. 1, 1918, pp. 74-75, 3 figs. Features of electrification of Frodingham Iron and Steel Works.

Causes of Overheated Motors and Motor Noises, M. A. Saller. Southern Engr., vol. 30, no. 2, Oct 1918, p. 49. Improperly fitted or tight bearings, defective oil rings, unequal air gap, small brushes.

High-Power Factor Induction Motors, Marius Latour. Elec. World, vol. 72, no. 11, Sept. 14, 1918, pp. 484-489, 19 figs. Summary of various arrangements for variable-speed motors of above description proposed in last 15 years, with particular reference to French developments.

How to Buy Direct-Current General-Utility Motors, A. Brunt. Am. Mach., vol. 49, no. 12, Sept. 19, 1918, pp. 532-534, 6 figs. Suggestions for Buyers.

Low Over-All Cost and Continuous Production, A. F. Lewis. Elec. World, vol. 72, no. 13, Sept. 28, 1918, pp. 592-595, 5 figs. Factors that must be considered in purchasing, installing and maintaining induction motors designed to assist in these objects.

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Recording Instruments

The Use of Graphic Instruments in Improving the Operation of Electrical Apparatus and Reducing Cost of Maintenance, J. H. Overpeck. Elec. Jl., vol. 15, no. 9, Sept. 1918, pp. 354-357, 3 figs. Forms for keeping records of motor failures.

Safety Measures

Installation and Care of Large Electrical Apparatus for Steel Mills, O. Needham. Elec. Jl., vol. 15, no. 9, Sept. 1918, pp. 333-336 2 figs. Insulation protection; handling, storing, erecting and starting; operation and care.

Substations

Large Underground Synchronous Substation, R. P. Hines. Coal Age, vol. 14, no. 10, Sept. 5, 1918, pp. 434-436, 4 figs. Description of substation in bituminous coal mine and its equipment.

Largest Portable Substation Yet Produced, B. H. Lytle. Elec. Ry. Jl., vol. 52, no. 11, Sept. 14, 1918, pp. 467-468, 6 figs. Long Island Railroad's portable substation used in parallel with permanent substations to help with excessive loads or as a separate substation.

Transformers

The Essentials of Transformer Practice (XIV), E. G. Reed. Elec. Jl., vol. 15, no. 9, Sept. 1918, pp. 365-367, 3 figs. Formulæ for calculations of electrical quantities in reactors with magnetic circuit either of air or iron.

Transformer Connections, Waldo Bennett. Southern Engr., vol. 30, no. 2, Oct. 1918, pp. 52-53, 9 figs. Relations of windings in single, two- and three-phase; special connections.

Transient Phenomena

Some Transient Phenomena in Electrical Supply Systems, E. W. Marchant. Jl. Instn. E. E., vol. 56, no. 276, July 1918, pp. 445-455, 17 figs. and (discussion), pp. 455-471, 7 figs. Records oscillograms taken on Liverpool Corporation electric supply system. Also tests of similar phenomena under laboratory conditions.

Turbo-Generators

High Speed Turbo-Generators. Practical Engr., vol. 58, no. 1645, Sept. 5, 1918, pp. 114-116, 6 figs. Details of construction of rotors and stators. (Continued.)

Voltage Regulation

Improving Power Factor and Voltage Regulation, J. T. Peyton. Elec. World, vol. 72, no. 11, Sept. 14, 1918, pp. 492-493, 3 figs. By using synchronous condensers, a Pennsylvania company has met increased demand without additional generating equipment and has reduced transmission losses.

See also Furnaces (Electric Brass Furnaces), (Induction Furnaces), (Resistance Furnaces); Heating and Ventilation (Electric Heating Units), (Turbo-Generator Ventilation); Machine Shop (Welding); Marine Engineering (Electrical Machinery); Military Engineering (Electrical Machinery), (Sub-stations); Steel and Iron (Electric Steel).

ENGINEERING MATERIALS

Aluminum

The Alterability of Aluminum and the Properties of Its Various Alloys, Jean Escard. Sci. Am. Supp., vol. 86, no. 2225, pp. 127-128. Factors affecting alterability; properties of commercial aluminum; alteration as determined by Le Chatelier; uses and requirements; aluminum bronzes; other alloys. From Revue Scientifique.

Asphalt

Standardization of Required Consistency for Asphalt, J. R. Draney. Good Roads, vol. 16, no. 14, Oct. 5, 1918, p. 131. Reviews present practice and suggests standardization. (Am. Soc. Mun. Improvements.)

Boiler Plates

A Cause of Failure in Boiler Plates, Walter Rosenhain and D. Hanson. Iron Age, vol. 102, no. 11, Sept. 12, 1918, pp. 632-636, 15 figs. Effect of grain growth; alteration of crystalline structure by mechanical deformation; some remedies. (Iron & Steel Inst., London, May 1918.)

Are There Advantages in Welding Boiler Plate? Howard L. Boyd. Power, vol. 48, no. 14, Oct. 1, 1918, pp. 504-506, 7 figs. Dangers of using metal for welding boiler plate which is of a chemical composition different from that of metal in plates. From California Safety News of Industrial Accident Commission of Cal.

Causes of Failure in Boiler Plates, Walter Rosenhain and D. Heinsen. Marine Eng. of Can., vol. 8, no. 9, Sept. 1918, pp. 225-228, 15 figs. Effect of grain growth; alteration of crystalline structure by mechanical deformation; suggested remedies. Iron & Steel Inst. paper.

Bronze

The Microstructure and Value of Manganese Bronze. Shipbuilding & Shipping Rec., vol. 12, no. 10, Sept. 5, 1918, pp. 232-234, 1 fig. Values of alloy in each of two sources of introducing manganese into bronze, copper and manganese, and ferromanganese.

Copper

The Action of Reducing Gases on Hot Solid Copper, Norman B. Pilling. Jl. Franklin Inst., vol. 186, no. 3, Sept. 1918, pp. 373-374. Report of results obtained at research laboratory of Westinghouse Elec. & Mfg. Co.

Hardness

Hardness of Soft Iron and Copper Compared, F. C. Kelley. Gen. Meeting Am. Electrochem. Soc., Oct. 2, 1918, Advance Copy, Paper 3, pp. 45-48. Results of hardness tests applied by Brinell method on samples of American "ingot iron" and ordinary commercial cold-rolled copper after being similarly treated in an electrically heated vacuum furnace.

Rubber

Rubber Substitutes, Andrew H. King. India's Rubber Jl., vol. 56, no. 6, Aug. 10, 1918, pp. 145-146. Factors and limitations of asphaltic materials; coal-tar and asphalt pitches; resinous substances; glue. (Concluded from preceding issue.)

Semi-Steel

Tracing the Development and Use of Semi-steel. Can. Machy., vol. 20, no. 11, Sept. 12, 1918, p. 319. Uses in munition manufacture in France, and in auto and truck trade.

See also Aeronautics (Materials of Construction); Refractories.

FACTORY MANAGEMENT

Compensation

Forms for Use in Recording Compensation, Coal Age, vol. 14, no. 11, Sept. 12, 1918, pp. 506-508. How to keep records which will stimulate foremen and others and make it possible to ascertain the probable effect, in cost of self-insurance, of any change in legislation.

Cost Systems

Cost System for a Medium Size Foundry, D. O. Barrett. Iron Age, vol. 102, no. 14, Oct. 3, 1918, pp. 810-813, 11 figs. Various forms which have proved their usefulness after several years' experience following a period of financial loss.

Proper Factory Cost Accounting Methods, Joseph Mack. Am. Industry, vol. 19, no. 2, Sept. 1918, pp. 17-18. How to distribute overhead expenses. Address before International Assn. of Mfg. Photo-Engravers.

Drafting Department

Drawing-Room System in the Engineering Department, G. F. Hamilton. Am. Mach., vol. 49, no. 11, Sept. 12, 1918, pp. 485-487, 10 figs. Method for recording drawings and insuring correction of copies sent into shop.

Organization and Wage Payment for the Drafting Department, J. B. Conway. Am. Mach., vol. 49, no. 13, Sept. 26, 1918, pp. 555-558, 4 figs. Description of plan in practical operation under conditions similar to those set forth in the article.

Production

Graphic Production Control, C. E. Knoeppel. Indus. Management, vol. 56, no. 3, Sept. 1918, pp. 177-180, 2 figs. First of series. Underlying and basic principles.

Keeping Track of Production, H. A. Russell. Indus. Management, vol. 56, no. 3, Sept. 1918, pp. 231-234, 4 figs. Key to methods described is a summary card, the production-operation cost record, upon which are entered all vital facts in regard to progress of every manufacturing order, and upon which is also kept a running inventory of all parts in stock.

Production Comparisons, Walter D. Fuller. Gas Industry, vol. 18, no. 7, July 1918, p. 241. Methods employed for determining actual and possible production.

Rents

Overhead Rent. Gas Industry, vol. 18, no. 7, July 1918, p. 239. Plan for distributing all expenses incident to occupying buildings and grounds for manufacturing, storage and office purposes.

Salvage

Salvage at the Winchester Plant, Charles M. Horton. Indus. Management, vol. 56, no. 3, Sept. 1918, pp. 201-204, 8 figs. How scrap and spare material to annual value of millions of dollars is reclaimed and utilized.

Small Jobs

Reducing the Time Occupied in Doing the Small Job. Ry. Maintenance Engr., vol. 14, no. 9, Sept. 1918, pp. 299-302. Five discussions of work done by bridge and building departments of different railroads.

Stores

Efficiency in the Handling of Railway Supplies, Charles E. Parks. Ry. Age, vol. 65, nos. 10 and 11, Sept. 6 and Sept. 13, 1918, pp. 423-427, 3 figs., pp. 491-493. Sept. 6: Methods employed by Santa Fe in storing, handling, distributing and accounting for material. Sept. 13: Line stock; ordering material; surplus and obsolete material; inventories.

Railway Stores Methods and Problems, W. H. Jarvis. Ry. Gaz., vol. 29, nos. 6 and 7, Aug. 9 and Aug. 16, 1918, pp. 155-158, and pp. 181-184, Aug. 9: Method of dealing with invoices; four-weekly balance sheets; issuing prices. Aug. 16: Stock inventories; stores sold accounts; auditing and verification of stocks.

Waste

The Elimination of Waste. Cassier's Eng. Monthly, vol. 54, no. 3, Sept. 1918, pp. 143-149. Suggestions as to how industrial waste can be cut down and scrap material reclaimed.

See also Lighting (Factory Lighting).

FORGING

Drop Forging

Drop Forging in Automobile and Aircraft work. Automobile Engr., vol. 8, nos. 116 and 118, July and Sept. 1918, pp. 190-192, 16 figs., pp. 261-263, 10 figs. Details of typical plant, with description of modern tools necessary for drop forging and methods.

Forging Machine

Possibilities of the Forging Machine, E. R. Hagen. Am. Drop Forger, vol. 4, no. 8, Aug. 1918, pp. 304-305, 2 figs. Uses of the upsetter machine in railroad and locomotive shops.

Fuel

Fuel Analysis of a Drop Forge Plant (1), B. K. Read. Am. Drop Forger, vol. 4, no. 8, Aug. 1918, pp. 307-312, 3 figs. Charts showing daily fuel and power consumption, results of installing new heating equipment, steam consumption on hammers and cost of steam in dollars per hammer-hour. From paper before Am. Drop Forge Assn.

Hammer Foundations

Question of Correct Hammer Foundations, Terrell Croft. Am. Drop Forger, vol. 4, no. 8, Aug. 1918, pp. 300-304, 4 figs. Discussion of functions of hammer foundation; results of poor installation; designs and data for different types.

Piston Rods

The Care and Maintenance of Piston Rods, G. C. Stebbins. Am. Drop Forger, vol. 4, no. 8, Aug. 1918, pp. 298-299, 1 fig. Information regarding treating of piston rods; explanation of central oiling system and its relation to maintenance of hammers. Before Am. Drop Forge Assn.

FOUNDRY

Brass Castings

How Brass Carburetors are Molded and Cast. Foundry, vol. 46, no. 10, Oct. 1918, pp. 465-469, 10 figs. Molding machines of jar-ram squeeze type extensively employed; workmen held responsible for quality of product.

Centrifugal Casting

Casting Rings in Centrifugal Machine, E. P. Cone. Iron Age, vol. 102, no. 14, Oct. 3, 1918, pp. 801-807, 8 figs. Large quantity production by De Lavaud process; unusual properties of metal.

Core Sand

Suggestions on Mixing Foundry Core Sand, Robert Crimshaw. Iron Age, vol. 102, no. 14, Oct. 3, 1918, pp. 807. Analysis of method for securing best porosity and strength in cores.

Die Castings

The Design of Die Castings, M. Stern. Am. Mach., vol. 49, no. 13, Sept. 26, 1918, pp. 549-551, 3 figs. Practical suggestions for designer.

Fluidity of Iron

The Fluidity of Molten Cast Iron, Matthew Riddell. Foundry Trade Jl., vol. 20, no. 199, July 1918, pp. 364-366, 1 fig. Attempt to explain peculiarity of cupola observed by author, which consists in greater fluidity being obtained when the bed coke is not well lighted above the tuyeres before the blast is put on and the first iron takes long to come down. Paper before British Foundrymen's Assn.

Foreign Methods

American and Foreign Steel Foundries. Iron Age, vol. 102, no. 14, Oct. 3, 1918, pp. 808-809. A British comparison of French, Belgian and American steel castings; our molding and annealing called inferior.

Foundry Industry

Foundry Industry Makes Big Gain in Two Years. Foundry, vol. 46, no. 10, Oct. 1918, pp. 455-460, 7 figs. Statistics on growth of foundries.

Foundry Losses

How the Engineer Stops Foundry Losses, Stephen B. Phelps. Indus. Management, vol. 56, no. 3, Sept. 1918, pp. 209-211, 6 figs. Defective castings, a total loss of foundry labor and supplies, can be prevented by proper design.

Man Power

Your Biggest Foundry Problem—Man-power, H. Cole Estep. Foundry, vol. 46, no. 10, Oct. 1918, pp. 443-450, 13 figs. War demands more castings with less labor; machines must do work of men.

Patterns

Mounting Patterns on Plates an Aid to Molding, R. R. Clarke. Foundry, vol. 46, no. 10, Oct. 1918, pp. 451-454, 3 figs. Various methods described and their advantages and disadvantages discussed from standpoint of both foundryman and patternmaker.

Taking the Pattern Shop Out of the Attic, F. L. Prentiss. Iron Age, vol. 102, no. 11, Sept. 12, 1918, pp. 640-641, 2 figs. Cleveland patternmaker believes business should be banished from dingy quarters and puts his ideas into practice.

The Making of Better Patterns, Ellsworth Sheldon. Am. Mach., vol. 49, no. 14, Oct. 3, 1918, pp. 617-629, 10 figs. Requirements of a good patternmaker.

Steel Castings

Steel Castings Design and Manufacture. Foundry Trade Jl., vol. 20, no. 199, July 1918, pp. 375-378. Discussion of paper presented before British Foundrymen's Assn., published in June issue.

The Manufacture of Steel Castings, E. F. Lange. Foundry Trade Jl., vol. 20, no. 199, July 1918, pp. 372-374. Comparison of American with European standards and practice. (Sequel to Development in the Manufacture of Steel Castings, Feb. 1917.)

Vents

Venting Moulds and Cores, S. G. Smith. Foundry Trade Jl., vol. 20, no. 199, July 1918, pp. 367-371, 18 figs. Suggestions to apprentices on proper manner of providing passages for free escape of expanded air and gases.

See also Steel and Iron (Semi-Steel).

FUELS AND FIRING

Air Proportions

Calculating the Excess of Air Used in Combustion, V. Hassreidter. Gas Jl., vol. 143, no. 2881, July 30, 1918, p. 206. States that when volume, G, of producer gas is burned, volume of air required is not $R-G$, but $R-g-c-d$ where R is volume of products of combustion, c contraction and d expansion due to combustion. (Jl. Soc. Chem. Ind.)

Alcohol

Alcohol as Power Fuel. Gas & Oil Power, vol. 13, no. 155, Aug. 1, 1918, pp. 159-160. Account of research in production and adaptation of alcohol for power-fuel purposes carried out in Australia by a special committee under Commonwealth Advisory Council of Science and Industry.

Bituminous Coal

Burning Bituminous Coal in House-Heating Boilers, W. A. Pittsford. Heat. & Vent. Mag., vol. 15, no. 9, Sept. 1918, pp. 23-27, 15 figs. From address before Smoke Prevention Assn., Newark, Aug. 1918.

Method of Fixing Prices of Bituminous Coal Adopted by the United States Fuel Administration, C. Garnsey, R. V. Norris, and J. H. Allport. Bul. Am. Inst. Min. Engrs., no. 141, Sept. 1918, pp. 1411-1433, 6 figs. Discussion of four methods considered by Engineers' Committee: namely, actual cost at colliery plus fixed sum or percentage; actual cost at colliery plus graduated profit decreasing as costs increase; prices fixed on average cost in each district; all coal sold at average cost of district plus profit, and return to colliery adjusted through clearing house at price proportioned to cost of production.

Carbon Dioxide

Placing CO₂ on Financial Basis. Eng. & Cement World, vol. 13, no. 4, Aug. 15, 1918, pp. 62-64. Chart to estimate money lost up the stack due to low carbon dioxide, prepared for use of central-station engineers.

Coal Storage

Coal Storage in Large Quantities, Henry J. Edsall. Indus. Management, vol. 56, no. 3, Sept. 1918, pp. 193-200, 20 figs. Methods, equipment and typical installations, diagrams of arrangements of tracks and piles.

Handling Roundhouse Coal. Power, vol. 48, no. 11, Sept. 10, 1918, pp. 372-375, 10 figs. Describes modern coal-handling system of belt conveyors for stocking and conveying coal to bins for locomotive and boiler-room use, installed at new Croxton roundhouse of Erie R. R.; capacity, 100 tons per hr.

Physical and Chemical Changes in Stored Coal. Gas Age, vol. 42, no. 6, Sept. 16, 1918, pp. 245-247, 5 figs. Results of tests. Translated from Revue Générale de l'Electricité.

Public Utility Experience in Coal Storage. Gas Age, vol. 42, no. 5, Sept. 2, 1918, pp. 193-196, 6 figs. Reports from various companies, secured by Univ. of Ill.

Reinforced Concrete Coal Storage Plant, H. C. Campbell. Eng. & Cement World, vol. 13, no. 5, Sept. 1, 1918, pp. 13-15, 5 figs. Description of pockets or storage bins especially designed for requirements, capacity and location.

Spontaneous Combustion of Stored Coal, S. H. Katz. Gas Age, vol. 42, no. 5, Sept. 2, 1918, p. 200. Results of experiments showing importance of proportion of voids in a mass of stored coal exposed to air. From Tech. Rep. 170, U. S. Bureau of Mines.

Storage and Handling of Gas Coal, H. H. Stock. Gas Age, vol. 42, nos. 5 and 6, Sept. 2, and Sept. 16, 1918, pp. 207-210, 9 figs., and pp. 255-258, 10 figs. Review of investigations by Experiment Station of Univ. of Ill. Deals with locomotive crane storage; circular storage; steeple towers; Hunt System; bridge storage; swivel bridge; expense of storing.

The Storage of Bituminous Coal, John H. Anderson. Power, vol. 48, no. 9, Aug. 27, 1918, pp. 321-322. Suggestions based on author's examination of piles on fire. Paper before Inst. of Marine Engrs.

Coal Valuations

An Alinement Chart for the Evaluation of Coal, A. F. Blake. La. Planter & Sugar Manufacturer, vol. 61, no. 10, Sept. 7, 1918, pp. 156-157. Designed to determine relative values of different coals, given price per ton and chemical analysis, by calculating the relative costs of a million heat units in accordance with the methods established by U. S. Bureau of Mines.

Combustion Losses

Combustion Losses and Their Minimization (III), Robert June. Brick & Clay Record, vol. 53, no. 6, Sept. 10, 1916, pp. 465-468, 2 figs. Heat losses in burning coal; in the dry chimney gases; due to incomplete combustion; in fuel through grate; due to superheating moisture in air and to moisture in fuel; due to visible smoke and to radiation.

Losses in the Boiler Room From Incomplete Combustion and High Stack Temperature, George H. Diman. Textile World Jl., vol. 54, no. 14, Oct. 5, 1918, pp. 82 and 87, 2 figs. Tables calculated from average conditions in New England textile mills.

Danish Fuels

Concerning Our (Danish) Fuels (Om vore Brændselsstoffer), Gunnar Jergensen. Ingenioren, vol. 27, no. 66, Aug. 17, 1918, pp. 451-459.

Fuel Changes

Problems Involved in Fuel Changes, A. Bement. Power, vol. 48, no. 11, Sept. 10, 1918, pp. 380-382. Ash, not coal, the trouble maker; operatives do not change method of firing with coal. Some concrete instances and the remedies.

Fuel Conservation

Bulletin for Firemen and Engineers. Textile World Jl., vol. 54, no. 14, Oct. 5, 1918, pp. 81-82. Bul. no. 3 of Mass. Fuel Administration prepared by a committee of operating engineers and firemen.

Coal Conservation Committee, Final Report. Colliery Guardian, vol. 116, no. 3008, Aug. 23, 1918, pp. 385-388, 1 fig. Final report of committee appointed in 1916 by Mr. Asquith issued by Ministry of Reconstruction.

Coal Saving Suggestions and a Few Don'ts. Aera, vol. 7, no. 2, Sept. 1918, pp. 179-180, 1 fig. Suggestions based on experience of Westinghouse Elec. & Mfg. Co.'s combustion engineers.

Conservation of Fuel Used by Public Utilities, L. R. Nash, E. B. Powell and H. Vittinghoff. Stone & Webster Jl., vol. 23, no. 3, Sept. 1918, pp. 163-177. Considers load ing and operation improvements for reducing fuel consumption to minimum by gas, electric light and power companies and railroads.

Fuel Saving in Massachusetts. Aera, vol. 7, no. 2, Sept. 1918, pp. 107-118. Method in vogue which, it is assured, will save 260,000 tons of coal during present year.

Practical Fuel Conservation, F. C. Wagner. Nat. Engr., vol. 22, no. 9, Sept. 1918, pp. 401-404. Stationary engineer's part in campaign to conserve coal; suggestions regarding equipment and operation. Paper before Ind. State Convention, Nat. Assn. Stationary Engrs.

Report of Coal Conservation Committee. Engineer, vol. 126, no. 3269, Aug. 23, 1918, p. 158, 2 maps.

Fuel Supplies

Is Our Fuel Supply Nearing Exhaustion? R. H. Fernald. Ry. Rev., vol. 63, no. 8, Aug. 24, 1918, pp. 271-275. Digest of fuel resources of the world and particularly of United States, giving statistical data as to rates of production, rates of depletion, and prospects of exhaustion. From Gen. Elec. Rev.

Furnaces

Combustion and Smokeless Furnaces, Joseph W. Hays. Steam, vol. 22, no. 3, Sept. 1918, pp. 65-70. Discussion based on nature and properties of heat and on Berthelot's Second Law regarding heat produced in a furnace. (To be continued.)

Gas Firing

Gas Firing for Boilers, T. M. Hunter. Elec. Times, vol. 54, no. 1398, Aug. 1, 1918, pp. 73-74. Remarks on advisability of firing boilers with gas. Paper before South Wales Inst. of Engrs.

Low-Grade Fuels

Experience with the Combustion of Lignites, R. A. Ross. Jl. Eng. Inst. of Can., vol. 1, no. 5, Sept. 1918, pp. 208-210. Experiments at Saskatoon plant.

Method for the Combustion of Brown Coal. Marine Eng. of Can., vol. 8, no. 9, Sept. 1918, p. 241. Brief note on process based on applying conditions in water-gas producer to boiler furnace and using exhaust steam for gas production.

Suggestions for Efficiently Burning Lignites in a Domestic Furnace, R. G. McLaurin. Jl. Eng. Inst. of Can., vol. 1, no. 5, Sept. 1918, pp. 210-213, 1 fig. Prerequisites for efficient combustion of western coal are new furnace design, and control of combustible and air.

The Use of Lignite, Bagasse and Wood Waste for Power Generation and Other Purposes, John B. C. Kershaw. Engineer, vol. 126, no. 3268, Aug. 16, 1918, pp. 133-134. (Second article.)

Low-Rate Combustion

Getting Fuel Economy Under Difficulty. Black Diamond, vol. 61, no. 13, Sept. 28, 1918, p. 249. Suggestions to save coal while under low-rate combustion in hand-fired plants. From Tech. Paper No. 139, Low-Rate Combustion in Fuel Beds of Hand Fired Furnaces, Bureau of Mines.

New England

The Fuel Situation in New England, Charles T. Main. Power, vol. 48, no. 14, Oct. 1, 1918, p. 508. From paper before New England Water Works Convention, Sept. 1918.

Oil Storage

Losses of Oil in Storage, C. P. Bowie. Jl. Soc. Automotive Engrs., vol. 3, no. 3, Sept. 1918, pp. 235-237. Data of losses by evaporator and from wooden and steel rod tanks; devices for lessening losses. From Oil Storage Tanks and Reservoirs, Bul. 155 (Petroleum Technology 11) of the Bureau of Mines.

Peat

Coal Conservation, Gas Producer Economies. Gas & Oil Power, vol. 13, no. 156, Sept. 5, 1918, pp. 167-168. Utilization of peat fuels in production of gas for suction engines.

The Value of Peat Fuel for the Generation of Steam. Engineer, vol. 126, nos. 3269 and 3270, Aug. 23 and Aug. 30, 1918, pp. 163-166, 6 figs., and pp. 178-180, 4 figs.

The Utilization of the Peat Resources of Canada, B. F. Haanel. Jl. Soc. Chem. Industry, vol. 37, no. 15, Aug. 15, 1918, pp. 258T-261T. Canadian peat deposits; description of peat; cost of manufacture; utilization for industrial purposes; peat as a source of oil and retort gas.

Pulverized Coal

A Diversified Application of Powdered Coal, Charles Longnecker. Iron Age, vol. 102, no. 11, Sept. 12, 1918, pp. 619-623, 8 figs. Pulverized fuel, distributed by compressed air to substations, used in open-hearth, annealing and other furnaces.

Fuels, E. R. Knowles. Steam, vol. 22, no. 3, Sept. 1918, p. 76. Four requirements in burning of pulverized coal and attainable with it. (Concluded from August issue.)

Powdered Coal Cuts Coal Consumption in Annealing Ovens Thirty Per Cent. Can. Machy., vol. 20, no. 9, Sept. 5, 1918, p. 300, 1 fig. Brief account of recent work done at malleable-iron plant of Am. Radiator Co., Buffalo.

Pulverized Coal Firing. Iron & Coal Trades Rev., vol. 97, no. 2636, Sept. 6, 1918, p. 265, 1 fig. Particulars of system developed by Fuller Engineering Co.

The Possibilities of Powdered Coal as Shown by Its Combustion Characteristics, W. G. Wilcox. Steam, vol. 22, no. 3, Sept. 1918, pp. 70-75. Requirements necessary in perfect combustion, weaknesses of present methods; conclusions regarding powdered coal. Paper before N. Y. Section, Am. Chem. Soc.

Soft Coal

Burning Soft Coal in Heaters Designed for Hard Coal. Heat. & Vent. Mag., vol. 15, no. 9, Sept. 1918, pp. 21-23. Suggestions for selecting and using coal for house-heating equipment.

Stokers

Handling Jones Under-Feed Stokers, "Receiver." Power Plant Eng., vol. 22, no. 18, Sept. 15, 1918, pp. 743-744, 4 figs. Building and banking fires; precautions to observe in handling fires.

Smokeless Combustion with Chain-Grate Stokers, Thomas A. Marsh. Elec. Rev., vol. 73, no. 12, Sept. 21, 1918, pp. 448-449, 2 figs. Discussion of furnace chambers, boiler settings and baffling as affecting efficiency and smokeless combustion of high-volatile coals. Paper before Annual Smoke Prevention Convention, Newark, N. J.

The Stoker of the Future, Joseph Harrington. Elec. Rev., vol. 73, no. 12, Sept. 21, 1918, pp. 442-443. Analysis of mechanical-stoker evolution as influenced by coal characteristics, clinker, efficiency and rate of combustion.

Wood

Wood Fuel, A. Barbey. Domestic Eng., no. 277, Sept. 1918, pp. 1-3. Present situation in Switzerland. Paper before Vaudoise Soc. of Nat. Sci. From Bulletin Technique.

See also Forging (Fuel); Coal Industry (Fuel Conservation); Hoisting and Conveying (Coal Handling); Mines and Mining (Shale Oil); Motor-Car Engineering (Fuels).

FURNACES

Electric Brass Furnace

A Rocking Electric Brass Furnace, H. W. Gillett and A. E. Rhoads. Brass World, vol. 14, no. 9, Sept. 1918, pp. 264-268. Description of furnace at plant of Michigan Smelting & Refining Co., with results of tests and bibliography of electric-furnace literature.

Gas Heat-Treating Furnace

Automatic Shell Heat Treating Furnaces, W. J. Harris, Jr., Iron Age, vol. 102, no. 10, Sept. 5, 1918, pp. 565-568, 8 figs. Human element superseded by mechanical devices in a new gas-fired installation at Pawtucket.

Induction Furnaces

Production of High Temperature and Its Measurement, E. F. Northrup. Trans. Faraday Soc., vol. 13, part 3, June 1918, pp. 212-221, 6 figs. Principle of operation and details of a 20-kw. electric induction simple crucible furnace.

Nitrogen-Fixation Furnaces

Nitrogen Fixation Furnaces, E. Kilburn Scott. Gen. Meeting Am. Electrochem. Soc., Oct. 2, 1918, Advanced Copy, Paper 8, pp. 103-134, 17 figs. Review and comparison of various types of electrical furnaces; description of author's three-phase furnace and discussion of its details in comparison with other types.

Resistance Furnaces

Tests on a Resistance Electric Furnace for High Temperatures (Försök med en elektrisk motstandsugn för höga temperaturer), Jakob Forssell. Teknisk Tidskrift,

vol. 48, no. 66, July 24, 1918, pp. 93-98, 4 figs.

HEATING AND VENTILATION

Electric Heating Units

Electricity as a Substitute for Gas, Frank Thornton. Am. Drop Forger, vol. 4, no. 8, Aug. 1918, pp. 324-325. Comparison of electricity as heating unit with natural gas and coal; conditions which have developed electrical heating. From paper before Engrs.' Soc. of Western Pa. (To be Continued.)

Equipment

Care of Heating and Ventilating Equipment, Harold L. Alt. Power, vol. 48, no. 11, Sept. 10, 1918, pp. 383-384. First of series on economical operation.

Factories

Difficult Problems of Paper Manufacturers Solved by the Sturtevant Absorption System. Paper Mill, vol. 41, no. 40, Oct. 5, 1918, pp. 16 and 44-46, 3 figs. Heating and ventilating system of large mill.

Factory Heating, Chas. L. Hubbard. Steam, vol. 22, no. 3, Sept. 1918, pp. 63-65. Methods of computing available exhaust-and live-steam requirements. (To be continued.)

Heating and Ventilating Are Very Important (II), M. H. Potter. Can. Machy., vol. 20, no. 8, Aug. 22, 1918, pp. 225-227, 6 figs. Systems of heating buildings; machine-shop arrangements; suitable temperatures; artificial lighting.

Heating Systems

Fuel Saving Heating Systems, Alfred G. King. Domestic Eng., vol. 84, no. 8, pp. 272-274, 5 figs. How the vapor-vacuum system is installed; how it operates and how fuel is conserved.

Heating and Piping Systems. Contract Rec., vol. 32, no. 37, Sept. 11, 1918, p. 740. Points to be considered in design of a heating system.

Pressure Regulation

Pressure Regulating Devices, Chas. L. Hubbard. Domestic Eng., vol. 84, no. 9, Aug. 31, 1918, pp. 312-314, 7 figs. Notes on construction and operation of pressure-reducing valves for modern heating systems. (To be continued.)

School Buildings

School Building Heating and Ventilation, Samuel R. Lewis. Heat. & Vent. Mag., vol. 15, no. 9, Sept. 1918, pp. 33-43, 14 figs. Second article.

Turbo-Generator Ventilation

The Ventilation of Turbo-Generators, J. Humphrey. Iron & Coal Trades Rev., vol. 97, no. 2636, Sept. 6, 1918, pp. 260-261, 1 fig. Deal chiefly with question of dust removal from air.

See also Fuels and Firing (Low-Grade Fuels).

HOISTING AND CONVEYING

Chains

Safe Chain Loads, A. Black. Machy., vol. 25, no. 1, Sept. 1918, pp. 37-39. Factors that determine safe loads and effects obtained by annealing chains.

The Manufacture and Testing of Cast Steel Chain Cables. Page's Eng. Weekly, vol. 33, no. 728, 1918, pp. 88-90. Memorandum issued by Lloyd's register of shipping.

Coal Handling

A New Design for Engine Coaling Facilities. Ry. Age, vol. 65, no. 14, Oct. 4, 1918, pp. 615-616, 2 figs. Economies effected in track capacity and car supply on Erie R. R.

Coal and Shipping. Transport from Collieries to Ports, F. J. Warden-Stevens. Colliery Guardian, vol. 116, no. 3009, Aug. 30, 1918, pp. 439-440. Description of means and equipment for shipping coal from mines to ports in the United Kingdom.

Concrete Coal Bins Prove Profitable, C. W. Hull. Eng. & Cement World, vol. 13, no. 7, Oct. 1, 1918, pp. 23-24, 2 figs. Record of successful operation and methods of unloading from cars and loading trucks.

Coal Tipples

Simpson Creek Coal Company's Tipples, R. G. Read. Coal Age, vol. 14, no. 11, Sept. 5, 1918, pp. 430-433, 5 figs. Features of design described and illustrated.

Conveyors

Conveyor at the Wellpark Brewery, Glasgow. G. F. Zimmer. Engineering, vol. 106, no. 2746, Aug. 16, 1918, pp. 165-168, 15 figs. Illustrated description of a combination push-bar or drag link conveyor and the roller runway.

Conveyors for Chemical Works, William H. Atherton. Conveying (Supp. to Cassier's Eng. Monthly), vol. 1, no. 4, Sept. 1918, pp. xxix-xxxiv, 9 figs. General arrangement of plant for handling granulated niter cake. (Continuation of serial.)

Conveyors, Robert S. Lewis. Min. & Sci. Press, vol. 117, no. 11, Sept. 14, 1918, pp. 349-355, 8 figs. Data for designing and calculating belt-conveyor systems.

Portable Automatic Trimming Conveyor, Geo. F. Zimmer. Conveying (Supp. to Cassier's Eng. Monthly), vol. 1, no. 4, Sept. 1918, pp. xxxv-xl, 6 figs. Device to handle coal with minimum expenditure of manual labor to trim it uniformly over the available bunker space provided in naval, mail and cargo steamers.

Cranes

Industrial Controllers (XXI), H. D. James. Elec. Jl., vol. 15, no. 9, Sept. 1918, pp. 368-371, 12 figs. Electrical operation of cranes; diagrams of connections; design features of various types.

Elevators

Development of V-Groove Elevator, Charles Reedy. Nat. Engr., vol. 22, no. 9, Sept. 1918, pp. 410-413. History of experiments; discussion of various makes of traction drives; features of operating costs and details. Abstract of paper before convention of Elevator Mfrs.' Assn.

Mine Locomotives

A New Type of Mine Locomotive Controller, L. W. Webb. Gen. Elec. Rev., vol. 21, no. 9, Sept. 1918, pp. 620-622, 8 figs. Pneumatic hand-operated control for electric power equipments.

Ore Cars

Ore Car Designed at Hecla Mine, C. T. Rice. Eng. & Min. Jl., vol. 106, no. 12, Sept. 21, 1918, pp. 522-525, 4 figs. Detailed description of a car having a capacity of 82 cu. ft., to be let down a shaft 4 by 5 ft. and pass around a 28-ft. curve on a 24-in. track.

Safety Appliances

Safety in Winding Operations (II), J. A. Vaughan. South African Jl. & Eng. Rec., vol. 27, nos. 1400 and 1401, July 27, and Aug. 3, 1918, p. 318 and pp 296-297. July 27: Discussion of several faults or omissions of winding engine drivers, suggestions to prevent them. Aug. 3: Considerations on movement of reversing levers and automatic application of brakes. Before S. A. A. A. S. (Continuation of serial.)

Winding Mechanism

Automatic Cable Winding Mechanism, Donald A. Baker. Machy., vol. 25, no. 1, Sept. 1918, pp. 44-45, 3 figs. Arrangement for winding cable used for making lead balls for shrapnel shells.

Wire Ropes

The Factor of Safety of Wire Ropes (II). South African Mining Jl., vol. 27, part 2, no. 1394, June 15, 1918, pp. 171-172. Author's reply to criticisms of his previous discussion, offered by other members of the Inst. Paper before S. A. I. of E.

See also Railroad Engineering, Steam (Cranes); Safety Engineering (Winding Engines).

HYDRAULICS

Dams

Calaveras Dam Slide—Report on Failure of Hydraulic Fill Dam During Construction, D. C. Henny and C. H. Swigart. Reclamation Rec., vol. 9, no. 9, Sept. 1918, pp. 433-435, 2 figs. Report of investigation ordered by chief of construction, U. S. Reclamation Service, giving original construction, tests of materials and subsequent design amendments.

Method of Keying Sections of Concrete Dam, Frank P. Fifer. Can. Engr., vol. 35, no. 9, Aug. 29, 1918, p. 210, 1 fig. Method employed in construction of lock and dam on Hudson River at Troy, N. Y.

Sixty-One-Foot Hydraulic-Fill Dam Rests on Earth Foundation, William G. Fargo. Eng. News-Rec., vol. 81, no. 11, Sept. 12, 1918, pp. 491-495, 9 figs. Junction hydroelectric development in southern Michigan notable for winter placing of earth fill and for extreme height of concrete retaining walls, which hold 90 ft. of fill.

Weighing Materials Saved Cement on Three Big Dams, H. H. Hunt. Contract Record, vol. 32, no. 37, Sept. 11, 1918, pp. 738-740. How concrete proportioned by weighing the cement, sand and gravel reduced the volume of cement used on three hydroelectric developments completed recently in Michigan and Minnesota.

Hydroelectric Plants

New Hydroelectric Plant of Montana Power Company, W. A. Scott. Eng. & Cement World, vol. 13, no. 7, Oct. 1, 1918, pp. 18-22, 2 figs. Details of hydraulic equipment of project adding 48,000 kva. to system.

Mysore Irrigation Project

A Great Mysore Irrigation Project. The Waste Weir of the Krishnarajasagara, B. Bubba Rao. Indian & Eastern Engr., vol. 42, no. 5, May 1918, pp. 157-158, 2 figs. Program for completing war work; protection works; calculations for stability of waste weir section. Paper before Mysore Engrs.' Assn. (Continued from preceding issue.)

Tasmania Hydroelectric Development

The Great Lake Hydro-Electric Development of Tasmania, Ludwig W. Schmidt. Power, vol. 48, no. 10, Sept. 3, 1918, pp. 328-330, 7 figs. Description of some features of a 100,000-hp. hydroelectric development undertaken by private enterprise and completed with financial aid of government of Tasmania.

Water Power

Water Power Development to Conserve Coal. Ry. Rev., vol. 63, no. 8, Aug. 24, 1918, pp. 268-270. Outline of legislation proposed by administration to conserve country's fuel supply and man power through resort to hydroelectric development on an extensive scale for railway purposes.

Water Power in Industry: Its Place and Value, A. Newlands. Ry. News, vol. 110, no. 2854, Sept. 14, 1918, pp. 195-196. Estimated extent to which water power has been utilized the world over. (British Science Guild.)

Water Works

War Burdens of Water-Works in the United States, Am. City, vol. 19, no. 3, Sept. 1918, pp. 193-194. Summary of findings and conclusions of Executive Committee of Am. Water Works Assn.

Water Works Operation. Mun. Jl., vol. 45, no. 9, Aug. 31, 1918, pp. 170-171, 1 fig. Selection of service pipe—galvanized lead, lead-lined and cement-lined.

See also Air Machinery (Air Compressors); Sanitary Engineering (Water Supply).

INDUSTRIAL ORGANIZATION

Depreciation

Depreciation and Rate Making, L. R. Nash. Elec. Ry. Jl., vol. 52, no. 12, Sept. 21, 1918, pp. 511-513. States that use of an undepreciated value with sinking-fund accruals for depreciation is not only justified by precedent and correct accounting principles but is desirable on ground of public policy.

Industrial Census

What an Industrial Census Can Do, Dale Wolf. Indus. Management, vol. 56, no. 3, Sept. 1918, pp. 213-216. Results of an experiment of Miller Lock Co.

Industrial Organization

New Developments in Industrial Organization, W. G. Cass. Cassier's Eng. Monthly, vol. 54, no. 3, Sept. 1918, pp. 131-142. Methods followed at Port Sunlight Works. (To be continued.)

See also Marine Engineering (Industrial Management); Railroad Engineering, Steam (Salvage).

INTERNAL-COMBUSTION ENGINEERING

Alcohol Engines

Power-Alcohol and Alcohol Engines. Automobile Engr., vol. 8, no. 116, July 1918, pp. 188-189. Notes on report of Committee of Advisory Council of Science and Industry of Australia.

Diesel Engines

Coal Tar Oil for Diesel Engines, A. W. H. Griepe. Gas Eng., vol. 20, no. 10, Oct. 1918, pp. 465-473, 11 figs. Physical and chemical characteristics of suitable coal-tar oils.

Conserving Our Natural Resources by the More Extended Use of the Diesel Engine, P. L. Scott. Sibley Jl. of Eng., vol. 32, no. 12, Sept. 1918, pp. 178-180. Shows position author believes Diesel and surface-ignition engines will occupy in conservation of

present source and in use of fuels not yet widely recognized. From The Pacific Marine Review. (First of a series of six articles.)

Gas Turbines

The Gas Turbine, Georges Funck. Automobile Engr., vol. 8, no. 118, Sept. 1918, pp. 249-254, 20 figs. Two possible methods of operation of a steam turbine; illustrations of two proposed methods for gas turbine combustion of mixture at constant pressure, and at constant volume. Efficiency obtainable in gas turbine. Paper before Graduates' Section, Instn. Automobile Engrs.

High-Speed Engines

High Speed Internal Combustion Engines, H. R. Ricardo. Mech. World, vol. 64, no. 1648, Aug. 2, 1918, p. 57. Range of mixture strength available with petrol; volumetric efficiency. Paper before Northeast Coast Instn. of Engrs. & Shipbuilders. (Continuation of serial.) Also published in Automobile Engr., vol. 8, no. 116, July 1918, pp. 184-188, 18 figs.

Low-Compression Oil Engines

Some Features of Low Compression Oil Engines, L. H. Morrison. Power, vol. 48, no. 13, Sept. 24, 1918, pp. 455-458, 8 figs. Several forms of fuel injection pumps and nozzles described and information given concerning their care and repair. (Fifth article.)

Offset Cylinders

Offset Cylinders, A. Johnson. Automobile Engr., vol. 8, no. 118, Sept. 1918, pp. 244-245, 3 figs. Mathematical investigation of desaxe setting.

Rotary Engines

Augustine Rotary Two-Cycle Super-Induction Gas Engine. Gas Eng., vol. 20, no. 10, Oct. 1918, pp. 481-487, 14 figs. Description with drawings of new design of rotary air-cooled engine developed by Augustine Automatic Rotary Engine Co., Buffalo, N. Y.

Thermodynamic Cycles

Thermodynamic Cycles in Internal Combustion Engines, Wm. J. Walker. Aerial Age, vol. 8, no. 3, Sept. 30, 1918, pp. 126-127, 12 figs. Discussion of increasing power of engine by increasing m.e.p. of cycle.

Tractor Engines

Oil Burning Tractor Engines, H. H. Sward. Jl. Soc. Automotive Engrs., vol. 3, no. 3, Sept. 1918, pp. 209-210, and discussion 210-211. Considerations regarding fuel selection.

See also Aeronautics (Engines).

LABOR

Contract System

Labor Shortage Made Good by Station Contract System, F. P. Kemon. Eng. News-Rec., vol. 81, no. 12, Sept. 19, 1918, pp. 542-544, 4 figs. How Winnipeg aqueduct workers speeded completion of work at contract prices which netted 30 to 40 per cent increase in wages.

Coöperative Plants

Philadelphia Coöperative Plan Extended. Elec. Ry. Jl., vol. 52, no. 11, Sept. 14, 1918, pp. 459-462. Success of the plan for producing cordial relations between labor and capital demonstrated by eight years of experience; wages now raised to equal of the highest established by War Labor Board; several changes in original plan.

Solving Labor Relationship Problems. Am. Drop Forger, vol. 4, no. 8, Aug. 1918, pp. 320-322. Account of work done by directors of a company who have asked their employees to coöperate with them and to help decide what their mutual relation should be. (To be continued.)

Cost of Living

How to Determine Cost of Living in an Industrial Community, Ray M. Hudson. Indus. Management, vol. 56, no. 3, Sept. 1918, pp. 185-192. Gives in complete detail results and basis of a cost study made for the H. H. Franklin Mfg. Co.

Cripples

Rehabilitating Cripples at Ford Plant, J. E. Mead. Iron Age, vol. 102, no. 13, Sept. 26, 1918, pp. 739-742, 8 figs. Full efficiency obtained by 85 per cent; light handwork in hospital speeds recovery.

Employee Representation

Midvale Plan of Employee Representation. Iron Age, vol. 102, no. 14, Oct. 3, 1918, pp. 834-835. Delegate for each 300; about one-tenth of these form plant committee; general committee for all plants; arbitration provided for if necessary.

Housing

Engineering Possibilities of Circular Housing Plan, G. J. Lamb. Can. Engr., vol. 35, no. 9, Aug. 29, 1918, pp. 193-196, 3 figs. Layout of block of 21 houses; particulars of water mains, sewers and maintenance.

Labor Plans

Beginnings of Labor Maintenance Service in a Small Plant, Mary L. Morris. Indus. Management, vol. 56, no. 3, Sept. 1918, pp. 205-208, 3 figs. How this work was started in a textile mill employing 500 workers; work divided into medical, employment and social divisions.

Conservation of Our Human Equipment, Earl B. Morgan. Am. Drop Forger, vol. 4, no. 8, Aug. 1918, pp. 316-318. Methods of selecting men for job; organizing methods for taking care of workmen; how to conduct investigations; centralizing control of shop activities. (Concluded from June issue.)

How a Medium-Sized Plant Solves Its Labor Problems, H. E. Sloan. Machy., vol. 25, no. 1, Sept. 1918, pp. 11. Proper working conditions; hourly wages and bonus payments; American citizenship desirable.

Mine Labor

The Coal Shortage, F. W. Gray. Can. Min. Jl., vol. 39, no. 17, Sept. 1, 1918, pp. 291-293. True aspects of situation as seen by writer who suggests return of enlisted miners.

Training

Experience in Training Mechanical Operators. Iron Age, vol. 102, no. 10, Sept. 5, 1918, pp. 551-553, 8 figs. Machine-tool plant of medium size succeeds in effort to develop efficient workers from unskilled men and women.

How to Start Training in a Factory, Frank L. Glynn. Am. Industry, vol. 19, no. 2, Sept. 1918, pp. 22-25, 4 figs. Plan developed in Curtiss Aeroplane Co., Buffalo, and suggestions to manufacturers.

Industrial Training A War Measure, C. S. Coler. Elec. Jl., vol. 15, no. 9, Sept. 1918, pp. 352-353, 4 figs. Vestibule school of Westinghouse Elec. and Mfg. Co.

Training Men and Boys in a Shop School, A. N. Hook. Am. Mach., vol. 49, no. 13, Sept. 26, 1918, pp. 567-569. Successful methods of graduating a large number of workmen and at the same time lessening the financial burden of the school's maintenance.

Training School at Hog Island, W. H. Blood. Stone & Webster Jl., vol. 23, no. 3, Sept. 1918, pp. 178-181, 9 figs. System followed and results being obtained.

Turnover

Computing Labor Turnover. Indus. Management, vol. 56, no. 3, Sept. 1918, pp. 239-246. Results of a questionnaire to determine definition of labor turnover and how it is computed in various plants.

Wages

Living Costs and Wage Standardization, W. B. Wilson. Aera, vol. 7, no. 2, Sept. 1918, pp. 145-146. Secretary of Labor in New York address says differences as between communities may have to be disregarded and uniform rates provided for entire country.

New Wage Increase. Ry. Rev., vol. 63, no. 10, Sept. 7, 1918, pp. 335-339. Text of two supplements stabilizing wages and removing inequalities occurring in general order No. 27, United States Railroad Administration.

Women Workers

The Employment of Women in Munition Factories, O. E. Monkhouse. Jl. Instn. Mech. Engrs., no. 4, April 1918, pp. 213-221. Unskilled types of women educated, domestic, ordinary, training of women; how they have reached their present skill; hours of work.

Training the Woman War Worker, Edward K. Hammond. Machy., vol. 25, no. 1, Sept. 1918, pp. 15-17, 3 figs. Methods used in the plant of Taft-Pierce Company, Woonsocket, R. I., in training of women machine operators by means of a "vestibule" school.

Women on Kansas City Railways, J. E. Gibson. Aera, vol. 7, no. 2, Sept. 1918, pp. 93-102, 6 figs. What has been done to make their employment attractive and to secure the best class.

Women Substation Operators a Notable Success. Elec. World, vol. 72, no. 12, Sept. 21, 1918, pp. 545-548, 6 figs. Pioneer work of Boston Edison Co. in training women for electrical service; synopsis of course of instruction.

See also Foundry (Man Power); Marine Engineering (Man Power); Mines and Mining (Man Power).

LIGHTING

Daylight, Artificial

Artificial Daylight in the Industries, M. Luckiesh. Elec. World, vol. 72, no. 13, Sept. 28, 1918, pp. 596-598. Qualifications of light required for color discrimination, with examples of industrial use of daylight lamps installed in many varied establishments.

Factory Lighting

Laws Relating to Factory Lighting, W. T. Blackwell. Am. Drop Forger, vol. 4, no. 8, Aug. 1918, pp. 312-313. Discussion on proper application of light in shops.

Some Important Phases of Industrial Lighting, W. T. Blackwell. Elec. Rev., vol. 73, no. 10, Sept. 7, 1918, pp. 360-362, 3 figs. Conservation of labor through improved lighting; proper lighting layout a simple problem; typical example; commonly neglected features of factory lighting.

Lighting Methods

The Lighting Art; Its Practice and Possibilities in Interiors. M. Luckiesh. Trans. Illuminating Eng. Soc., vol. 13, no. 6, Aug. 30, 1918, p. 354. Abstract of paper before Chicago Section of society.

Selection of Lighting Units, Davis H. Tuck. Elec. World, vol. 72, no. 12, Sept. 21, 1918, pp. 552-554, 5 figs. Simple method of analyzing distribution curves explained; efficiency of reflectors.

Paint Works

Improvement of Lighting of Paint and Varnish Works, F. H. Bernhard. Elec. Rev., vol. 73, no. 13, Sept. 28, 1918, pp. 481-486, 6 figs. Seventh article on improvement of lighting in the industries.

Woodworking Plants

Need of Improved Lighting of Woodworking Plants, F. H. Bernhard. Elec. Rev., vol. 73, no. 11, Sept. 14, 1918, pp. 401-408, 8 figs. Sixth of series of articles on lighting in the industries. Present article shows how better lighting speeds up production, improves quality and reduces accidents; low cost; common faults; some suggestions for betterment.

See also Electrical Engineering (Lighting); Municipal Engineering (Street Lighting); Railroad Engineering, Steam (Car Lighting).

LUBRICATION

Dredges and Shovels

Lubrication of Steam Shovels and Dredges. Eng. & Cement World, vol. 13, no. 5, Sept. 1, 1918, p. 74. Recommendation made by the Texas Co.

Lubricating Oils

Lubrication and Lubricating Oils, N. C. Brunn. Ry. Gaz., vol. 29, no. 8, Aug. 23, 1918, pp. 205-206. Abstract of results obtained on neutral, animal and vegetable oils. From paper before Soc. of Engrs., Tokio.

Viscosity

Relation Between Viscosity and the Chemical Constitution of Lubricating Oils, A. E. Dunstan and F. B. Thole. Jl. Instn. Petroleum Technologists, vol. 4, no. 16, June, 1918, pp. 191-216, 5 figs., and (discussion) pp. 216-229. Theoretical discussion on measurement of absolute viscosity; review of experimental data on American, Russian and Scotch oils, obtained by various authors; condensed bibliography.

See also Air Machinery (Air Compressors); Machine Shop (Oil Reclamation); Marine Engineering (Oil Coolers).

MACHINE DESIGN

Nomography

Nomography in Engine Design, F. Leigh Martineau. Jl. Soc. Automotive Engrs., vol. 3, no. 3, Sept. 1918, pp. 224-234, 23 figs. Practical study of graphic representation of formulæ and construction of various diagrams. Paper before Instn. Automotive Engrs., London.

MACHINE PARTS

Bearings

Ball Bearings for Machine Shop Equipment, Edward K. Hammond. Machy., vol. 25, no. 1, Sept. 1918, pp. 50-58, 22 figs. Second of a series.

Refitting Engine Bearings, C. H. Willey. Mech. World, vol. 64, no. 1648, Aug. 2, 1918.

pp. 56-57, 6 figs. Oil-flood method to locate knocks that develop during a run on a peak load; rebabbitting bearings. From National Engineer. (To be continued).

Using Ball Bearings in Marine Machinery. Can. Machy., vol. 20, no. 11, Sept. 12, 1918, pp. 322-323, 6 figs. Work done in Sweden; progress made in Canada.

Belts

Belting Problems Discussed at Chicago Meeting. Eng. & Cement World, vol. 13, no. 4, Aug. 15, 1918, pp. 56-60. Account of meeting of belt manufacturers, sales representatives and engineers at which data concerning belt performance in varied industrial plants were presented.

Bolts

Big End Bolts. Gas & Oil Power, vol. 13, no. 156, Sept. 5, 1918, pp. 173-174, 1 fig. Discussion of their fracture and failure.

Pulleys

Saving Coal by Efficient Pulleys, Charles H. Machen. Am. Mach., vol. 49, no. 12, Sept. 19, 1918, pp. 536-538, 4 figs.

Springs

Helical Springs, M. H. Sabine. Mech. World, vol. 64, no. 1648, Aug. 2, 1918, p. 55, 6 figs. Layout and formulæ to determine number of coils and free length.

See also Aeronautics (Bolts); Forging (Piston Rods).

MACHINE SHOP

Balancing

Methods of Balancing Rotors, C. C. Brinton. Elec. Jl., vol. 15, no. 9, Sept. 1918, pp. 349-352, 9 figs. Static and dynamic balancing systems and machines.

Bulldozer Operations

Bulldozer Operations with One and Two-Motion Dies, J. V. Hunter. Am. Mach., vol. 49, no. 11, Sept. 12, 1918, pp. 465-470, 20 figs. A variety of work that can be done in a bulldozer with properly designed dies.

Case-Hardening Materials

Case Hardening, S. S. Amdursky. Gas Industry, vol. 18, no. 8, Aug. 1918, pp. 259-261, 3 figs. Result of investigations by a gas and electric company into possibilities of converting both coal and oil-fired case-hardening furnaces to use gas.

Testing the Relative Merits of Case-Hardening Materials, Clarence N. Underwood. Am. Mach., vol. 49, no. 13, Sept. 26, 1918, pp. 569-571, 3 figs. Method consists in case-hardening test pieces with various materials to be tested and in measuring the results.

Cutting Metals

The Cutting of Iron and Steel by Oxygen (XVIII), M. R. Amadeo (Translated from original French by D. Richardson). Acetylene & Welding Jl., vol. 15, no. 179, Aug. 1918, pp. 140-141, 1 fig. Peculiarities of carburized metal found in cuts made with central-jet blowpipes; formation of heating flame.

Gage Making

Elements of Gage Making, C. A. Macready. Am. Mach., vol. 49, no. 12, Sept. 19, 1918, pp. 511-519, 21 figs. Amount and trend of distortion due to heating by grinding wheels. Fourth of series.

Heat Treatment

Correct Heat Treatment of Die Blocks, G. Peterson. Am. Drop Forger, vol. 4, no. 8, Aug. 1918, pp. 295-297, 1 fig. Theory of crystallization and influence of mass in relation to temperature; bearing of these theories on subject.

Heat-Treating Gears for Army Trucks in the Electric Furnace, Dwight D. Miller. Am. Mach., vol. 49, no. 11, Sept. 12, 1918, p. 461, 1 fig. Benefits derived from proper heat treatment of gears; use of electric furnace for heat treatment of gears; use of electric furnace for heat treatment.

Using Electrical Furnaces for Annealing, Wirt S. Scott. Am. Drop Forger, vol. 4, no. 8, Aug. 1918, p. 323. Control equipment used; conditions for which furnace is adapted. (Concluded from June issue.)

Milling

Milling Practice in Railway Shops, Frank A. Stanley. Ry. Mech. Eng., vol. 92, no. 9, Sept. 1918, pp. 521-524, 9 figs. Examples of cutters used with success in Southern Pacific Shops in Sacramento, Cal.

Navy Repairs

War-Time Repairs in the Navy, Frank A. Stanley. Am. Mach., vol. 49, no. 14, Oct. 3, 1918, pp. 621-624, 12 figs. Describes a miscellaneous line of work and special cutters, hobs and other tools. Fourth article.

Oil Reclamation

Reclaiming Oil from Metal Turnings, C. L. Smith. Iron Age, vol. 102, no. 10, Sept. 5, 1918, pp. 558-559, 3 figs. Scheme employed by Cincinnati Milling Machine Co. makes use of a special collecting truck and a separator set flush with floor.

Plating

Effecting War Economies in the Plating Room, E. P. Later. Foundry, vol. 46, no. 10, Oct. 1918, pp. 461-463. How waste may be eliminated and metals, acids and other materials conserved by exercising greater care in operation.

Radiator Manufacture

The Manufacture of the Sperry-Type Automobile Radiator. Am. Mach., vol. 49, no. 12, Sept. 19, 1918, pp. 522-524, 8 figs. Description of the sheet-metal work in making this type of radiator.

Welding

The Autogenous Welding of Lead (III), P. Rosenberg. Acetylene & Welding Jl., vol. 15, no. 179, Aug. 1918, pp. 134-135, 8 figs. Hydrogen and oxy-acetylene installations.

Electric Arc Welding. Domestic Eng., no. 277, Sept. 1918, p. 5. Formula to calculate approximate heat quantities involved in welding. Paper before Cleveland Eng. Soc.

Fusion Welding Fallacies, S. W. Miller. Machy., vol. 25, no. 1, Sept. 1918, pp. 12-13, 5 figs. Third of a series.

Selection and Application of Electric Arc Welding Apparatus, A. M. Candy. Elec. Jl., vol. 15, no. 9, Sept. 1918, pp. 337-346, 25 figs. Chief requisites for electric arc welding both with alternating and direct current; constant-current vs. constant-potential generators; protective equipment and accessories; selection of electrodes; gas vs. arc.

Wheel Hubs

Machining Front Wheel Hubs, A. Thomas. Automobile Engr., vol. 8, no. 118, Sept. 1918, pp. 264-266, 12 figs. Operations in manufacturing front-wheel hub from drop forging of 3 per cent nickel steel.

See also Air Machinery (Compressed-Air Applications); Marine Engineering (Welded Ships); Mechanics (Balancing); Millwrighting; Safety Engineering (Machinery Movements).

MACHINE TOOLS

Dies

Construction and Operation of Temporary Dies, Hugo F. Pusep. Am. Machy., vol. 49, no. 11, Sept. 12, 1918, pp. 488-489, 6 figs. Method outlined shows how dies can be built for small output at little expense.

Double-Movement Dies for Bulldozer Work, J. V. Hunter. Am. Mach., vol. 49, no. 12, Sept. 19, 1918, pp. 508-510, 9 figs. Illustrations of cheaply made double-movement dies for use in a bulldozer

Presses

Dies for Tape-Measure Winder. Machy., vol. 25, no. 1, Sept. 1918, pp. 46-48, 6 figs. Set of dies for performing sequence of operations under power press.

Mechanical Presses, Métanx, Alliages et Machines, year 11, no. 7, July 1918, pp. 10-13, 9 figs. Their utilization after the war. (Concluded from May issne.)

Wright Dieing Machine. Machy., vol. 25, no. 1, Sept. 1918, pp. 73-75, 3 figs. Machine adapted for performance of those classes of operations usnally handled in dies operated by power presses.

See also Metal-Working Tools

MACHINERY, SPECIAL

Hosiery Machinery

Drilling Jigs Used in the Manufacture of Hosiery Machines, Robert Mawson. Am. Mach., vol. 49, no. 13, Sept. 26, 1918, pp. 563-565, 10 figs. Many of the jigs described are simple in design but produce as equally accurate results as more complicated tools.

Sand-Blast Machinery

Automatic Positive Pressure Sand Blast Apparatus. Compressed Air Mag., vol. 23, no. 9, Sept. 1918, pp. 8884-8886, 1 fig. Machine controlled by specially designed manifold valve.

MARINE ENGINEERING

Barges

Upper Mississippi River Barge Fleet, B. L. Brown. Jl. Engrs. Club of St. Louis, vol. 3, no. 4, July-Aug. 1918, pp. 199-202. Data on construction and equipment of 19 steel barges, with double bottoms and four towing steamers, designed to handle up-stream tonnage against rapid currents.

Cargo Steamers

The Most Suitable Sizes and Speeds for General Cargo Steamers, John Anderson. Int. Mar. Eng., vol. 23, no. 9, Sept. 1918, pp. 505-511, 13 figs. Method of determining most economical dimensions of cargo vessels for any length of voyage, condition of loading and speed. Paper before Instn. of Naval Architects, London, March 1918.

Concrete Ships

Concrete Barge Specifications Show Many Unusual Features. Marine News, vol. 5, no. 3, Aug. 1918, pp. 70-71 and 122. Details of 21 vessels to be used on New York state barge canal system.

Concrete Ships, Harvey S. Owen. Jl. Engrs. Club of St. Louis, vol. 3, no. 4, July-Aug. 1918, pp. 243-255. Concrete ship designing problems; light aggregate and protective coating recently developed; opinions regarding durability of concrete ships.

Construction Features of Concrete Ships. Eng. & Contracting, vol. 50, no. 13, Sept. 25, 1918, pp. 303-304. The concrete; reinforcing steel; mixing and placing concrete; durability of a concrete ship. Abstract of paper by Rudolph J. Wig and S. C. Hollister before Amer. Concrete Inst.

Construction of Concrete Ships for Emergency Fleet Corporation, R. J. Wig. Can. Engr., vol. 35, no. 9, Aug. 29, 1918, pp. 212 and 214. Principal characteristics of 3500-ton concrete ship. From special report to U. S. Shipping Board.

Developments in Concrete Barges and Ships, J. E. Freeman. Int. Mar. Eng., vol. 23, no. 9, Sept. 1918, pp. 520-522. Brief résumé of history of concrete shipbuilding; what has been accomplished in United States and abroad. From paper before Am. Concrete Inst., June 1918.

Ferro-Concrete Ships. Ferro-Concrete, vol. 10, no. 1, July 1918, pp. 7-17. Discussion of paper by T. J. Gueritte before North-East Coast Instn. of Engrs. & Shipbuilders, published in Apr. issue.

Method of Concrete Ship Construction, Theodore Ahlborn. Int. Mar. Eng., vol. 23, no. 9, Sept. 1918, pp. 517-520, 6 figs. Reinforcing diagrams of parts of the hull; methods of construction.

Reinforced Concrete Vessels, Walter Pollock. Int. Mar. Eng., vol. 23, no. 9, Sept. 1918, pp. 512-517, 9 figs. Discussion of factors involved in designing small coastwise concrete motorship. From paper before Instn. of Naval Architects, London, March 1918.

Eagles

Manufacturing Eagles at Ford Shipyard, Chas. Lundberg. Iron Age, vol. 102, no. 12, Sept. 19, 1918, pp. 679-684, 13 figs. Submarine chasers assembled on wheels and dropped into water; a launching a day the aim; general description of operation and plant.

Electrical Machinery

Electrical Applications to Merchant Vessels, H. A. Hornor. Jl. Am. Soc. Naval Engrs., vol. 30, no. 3, Aug. 1918, pp. 490-503. General methods of installation in present practice; distribution, generating sets, switchboards, lighting fixtures, searchlights and interior communication.

Fabricated Ships

Assembling and Regulating Ship's Structure, T. L. Cohee. Int. Mar. Eng., vol. 23, no. 9, Sept. 1918, pp. 534-536. Rigid supervision and strict check and recheck system necessary to eliminate errors in assembling fabricated ships.

Control of Hull Construction of 5000-Ton Deadweight Fabricated Steel Vessel, "Fabricator." Int. Mar. Eng., vol. 23, no. 9, Sept. 1918, pp. 536-538. System employed at yard where straight work was produced at outside shops and furnaced work turned out at yard.

Industrial Management

Putting Our Merchant Ships on Schedule, L. P. Alford. Indus. Management, vol. 56, no. 3, Sept. 1918, pp. 227-230, 7 figs. How principles of industrial management have been applied in controlling ship movements.

Man Power

Manning the New Merchant Marine, Henry Howard. Int. Mar. Eng., vol. 23, no. 9, Sept. 1918, pp. 499-501. Free schools established for training deck and engine-room

crews for American ships; details of system explained.

Training Workers for Wooden Shipyards. Int. Mar. Eng., vol. 23, no. 9, Sept. 1918, pp. 526-528, 4 figs. New course of instruction organized at Pratt Institute, Brooklyn, N. Y., for woodworkers in shipyards.

Oil Coolers

Multiwhirl Oil Cooler. Power, vol. 48, no. 14, Oct. 1, 1918, p. 489, 2 figs. Description of a watercooled oil-cooler through which oil to be cooled is pumped in a helical path so as to strike the water-filled tubes at right angles.

Passenger Steamers

Twin Screw Passenger Steamer "Stavangerfjord." Engineering, vol. 106, no. 2746, Aug. 16, 1918, pp. 170-172, 21 figs. Deck plans, elevation, photographs and detailed description of features of the new 13,000-ton steamer built by Cammell, Laird & Co., Ltd., Birkenhead.

Shallow-Water Boats

Solving the Shallow Water Problem, W. V. Kidder. Motor Boat, vol. 15, no. 18, Sept. 25, 1918, pp. 13-14, 4 figs. Boat with flat "shovel" nose set in motion by air propeller in stern.

Standard Vessels

Further German Views on Standard Cargo Vessels, E. Goos. Shipbuilding & Shipping Rec., vol. 12, no. 10, Sept. 5, 1918, pp. 231-232, 1 fig. Considers that German yards, with possible exception of new yards recently built, have little to gain and much to lose by adopting policy of standard shipbuilding. From Schiffbau (Hamburg).

Welded Ships

Electrically Welded Cargo Ships. Jl. Engrs. Club of St. Louis, vol. 3, no. 4, July-Aug. 1918, pp. 203-210. Review of problems of welding in their application to marine construction and of work being done by U. S. Shipping Board, Emergency Fleet Corporation. From Nauticus.

Evolution of Electric Welding Processes as Applied to Shipbuilding, H. A. Hornor. Jl. Engrs. Club of St. Louis, vol. 3, no. 4, July-Aug. 1918, pp. 256-263. Electric welding in railway shops; application to steel shipbuilding; British Admiralty investigation; experiments under way in the U. S.; electric welding methods. From Nauticus (special supplement).

Application of Electric Welding to Shipbuilding. Engineering, vol. 106, no. 2747, Aug. 23, 1918, pp. 197-199. Results of a six-months' series of tests and experiments carried out by Lloyd's. Also published in Shipbuilding & Shipping Rec., vol. 12, no. 8, Aug. 22, 1918, pp. 186-188.

Electric Welding as Applied to Steel Ship Construction. Eng. & Contracting, vol. 50, no. 13, Sept. 25, 1918, pp. 308-309. Description of work of Electric Welding Committee of Emergency Fleet Corporation. General features of steamer; type of joints; method of assembly; amount of welding required. Also published in Jl. Engrs. Club of Phila., vol. 35-39, no. 166, Sept. 1918, pp. 427-428, and discussion pp. 428-439, 16 figs.

Welding

The Application of Electric Welding to Ship Construction and Repair. Elecn., vol. 81, no. 2102, Aug. 30, 1918, p. 379. A résumé of present practice.

See also Machine Shop (Navy Repairs); Mechanics (Specific Speed Method).

METAL-WORKING TOOLS

Boring Machines

Defiance No. 5, Horizontal Boring, Milling, Drilling and Tapping Machine. Am. Mach., vol. 49, no. 11, Sept. 12, 1918, pp. 499-500, 1 fig. Description, with principal dimensions.

Overhead Flexible Boring Machine. Ry. Gaz., vol. 29, no. 6, Aug. 9, 1918, p. 160, 2 figs. Illustration of machine designed to meet demand for means of applying the Russell patent screwdriver to pieces of work which cannot be handled under spindle of an ordinary fixed drilling press. Also published in Practical Engr., vol. 58, no. 1640, Aug. 1, 1918, p. 51, 2 figs.

Gear-Cutting Machinery

The Works of the Moss Gear Co. Automobile Engr., vol. 8, no. 116, July 1918, pp. 203-210, 22 figs. Machines used and employed in factory specializing in manufacture of toothed gearing.

Millers

The Kempsmith "Maximiller." Am. Mach., vol. 49, no. 14, Oct. 3, 1918, pp. 595-600, 8 figs. Description of all-geared milling machine built by Kempsmith Mfg. Co., Milwaukee, Wis.

Milling Cutters

Grinding Relief of Milling Cutters. Machy., vol. 25, no. 1, Sept. 1918, pp. 9-10, 7 figs. Comparison of use of disk wheels and cup wheels for grinding milling cutters and an analysis of results obtained.

Nut-Forging Machine

Hollings Indenting Type of Nut-Forging Machine. Machy., vol. 25, no. 1, Sept. 1918, pp. 33-35, 5 figs. Machine which in conjunction with the special bar stock used makes it possible to produce well-formed blanks without excessive pressure and with a relatively small amount of scrap.

Pitch-Measuring Machine

Pitch Measuring Machine for Screw Gauges. Can. Machy., vol. 20, no. 11, Sept. 12, 1918, pp. 320-321, 2 figs. Features of Bingham Powell type.

Shell-Boring Lathe

"Galloway" Shell-Boring Lathe. Am. Mach., vol. 49, no. 12, Sept. 19, 1918, pp. 544-545, 1 fig. Illustration and principal dimensions.

Taps and Dies

Taps and Dies for Production Work, G. Doorakkers. Engineer, vol. 126, nos. 3269 and 3270, Aug. 23 and Aug. 30, 1918, pp. 151-152 and 186-187, 1 fig. (first and second articles), 5 figs.

Wrigglers

Wrigglers and Their Uses, Hugo F. Pusep. Am. Mach., vol. 49, no. 13, Sept. 26, 1918, pp. 559-560, 5 figs. Use of wrigglers in locating points on work to be drilled or milled when a fairly liberal tolerance is allowed.

See also Machine Tools.

MECHANICS

Balancing

The Balancing of Heavy Rotors, M. W. Torbet. Jl. Am. Soc. Naval Engrs., vol. 30, no. 3, Aug. 1918, pp. 518-533, 6 figs. Mathematical discussion of forces and couples based on six typical equations of motion.

Beams, Offset

The Design of Offset Beams, Victor M. Summa. Ry. Mech. Eng., vol. 92, no. 9, Sept. 1918, pp. 514-517, 9 figs. Discussion of formulæ used.

Rotation, Rapid

On the Determination of the Resistance to Motion of Rapidly Rotating Machines (Om bestämmande af wastigt roterande maskiners rörelsemotstand), Erik Aug. Fursberg. Teknisk Tidskrift, vol. 48, no. 31, Aug. 3, 1918, pp. 385-389. (To be continued.)

Specific-Speed Method

Design of Water Propellers by the Specific Speed Method, Chas. F. Gross. Jl. Am. Soc. Naval Engrs., vol. 30, no. 3, Aug. 1918, pp. 534-546, 5 figs. Presents to draftsmen method of propeller design when given power propeller is to absorb and the speed of advance of propeller through water, items to be determined being diameter, pitch, mean width ratio and blade thickness.

Speed, Critical

Critical Speed in Tapered Shaft Design, Alfred Musso. Machy., vol. 25, no. 1, Sept. 1918, pp. 59-60, 1 fig. Derivation of formulæ and examples illustrating their use.

See also Railroad Engineering, Steam (Shocks in Trains).

METAL ORES

Chromite

Chromite, J. C. Williams. Colo. School of Mines, vol. 8, no. 9, Sept. 1918, pp. 157-159. Foreign and domestic deposits; uses of chromium; alloys; description of chromite; its occurrence and concentration.

Manganese

Manganese Deposits of East Tennessee. The Resources of Tennessee, vol. 8, no. 3, July 1918, pp. 153-207, 10 figs. Report of results of field work by geologists of U. S. Geol. Survey in coöperation with the State Geol. Survey of Tennessee; geography of region; manganese minerals; rocks with which ore is associated; types of deposits; description of typical mines and prospects.

Pyrolusite from Virginia, Thomas L. Watson and Edgar T. Wherry. Jl. Wash. Acad. of Sci., vol. 8, no. 16, Oct. 4, 1918, pp. 550-560, 1 fig. Geology of manganese deposits and crystallography of ore.

Tungsten

Molybdenum, Tungsten and Bismuth. Ind. Australian & Min. Standard, vol. 60, nos. 1552, 1553, 1554, Aug. 8, 15 and 22, pp. 210-211, 245-247, and 284. Treatise on these minerals. Aug. 8: Molybdenite occurrences in Northern Europe, South America, and South Africa; geographical distribution of wulfenite. Aug. 15: list of wulfenite occurrences in United States. Aug. 22: occurrences of wulfenite in Central and Southern Europe, and Australasia.

See also Steel and Iron (Iron-Titanium Ores), (Ore Resources).

METALLURGY

Aircraft

The Metallurgist and the Aircraft Program (III), H. F. Wood. Am. Drop Forger, vol. 4, no. 8, Aug. 1918, pp. 318-319. Suggestions on selection and testing of engine parts; responsibility of metallurgist on success of an airplane engine. From paper before Steel Treating Research Soc.

Tin

The Taylor Concentrator for Tin Slime, J. Waring Partington. Queensland Government Min. Jl. vol. 19, no. 219, Aug. 15, 1918, pp. 352-353 and 359-360, 3 figs. Consists of 24 rectangular concentrating surfaces attached to, and revolving with, a central vertical shaft, the latter being provided at its upper extremity with a worm gearing by means of which motion is imparted to frame. Machine designed in effort to eliminate disadvantages of usual type of revolving wooden round frame.

Wastes

Recuperation and Utilization of Wastes in the Manufacture of Copper, Zinc, Lead, Tin, Aluminum and Their Alloys (La récupération et l'utilisation des déchets de cuivre, zinc, plomb, étain, aluminum et de leurs alliages), Paul Razons. Génie Civil, vol. 73, nos. 9 and 10, Aug. 31 and Sept. 7, 1918, pp. 171-174, 8 figs., and pp. 184-188, 1 fig. Aug. 31: Apparatus for recuperating copper vapors in copper works; method of washing copper filings. Sept. 7: usage of copper waste in the manufacture of cupric sulphate; remelting of bronze filings; by-products of zinc works and recuperation of zinc from refuse of galvanized iron. (To be continued.)

Zinc

Electrothermal Metallurgy of Zinc (La métallurgie électrothermique du zinc), J. Escard. Génie Civil, vol. 73, nos. 7, 8 and 9, Aug. 17, 24 and 31, 1918, pp. 124-127, 3 figs., pp. 141-146, 9 figs., and pp. 168-171, 5 figs. Aug. 17: Coal-reduction methods, De Laval and Johnson furnaces. Aug. 24: Condensation of zinc vapors; decomposition of zinc sulphide by iron; industrial furnaces. Aug. 31: Results obtained with Côte and Pierron furnaces; Peterson's process; Thomson-Gerald furnace; Snyder furnace.

MILLWRIGHTING

Belt Clearances

Belt Clearances for Oblique Drives, F. R. Parsons. Nat. Engr., vol. 22, no. 9, Sept. 1918, pp. 419-420, 3 figs. Description of setting out floor clearances and difficulties encountered; hints on how to do such work correctly. From Mech. World.

Shafting

Aligning and Erecting Shafting (I). Ironmonger, vol. 164, no. 2338, Sept. 7, 1918, p. 42, 4 figs. Supplementing information in series on belt-driving practice published June 29, July 6, and Aug. 10.

MILITARY ENGINEERING

Artillery

Calculation of a Long Range Gun (Note sur le calcul d'un canon à longue portée). Génie Civil, vol. 73, no. 10, Sept. 7, 1918, pp. 191-192, 1 fig. Calculation of characteristics of trajectory for 100 km. range; mechanical requirements of projectile.

Contract Organization

Contract Organization Vitally Important for War Work, Francis Donaldson. Eng. News-Rec., vol. 81, no. 12, Sept. 19, 1918, pp. 535-538. Large-scale government construction demands most careful coördination of forces; charts setting forth organization of two typical contracts.

Electrical Machinery

Electrical Developments for American Army, R. K. Tomlin, Jr. Elec. World, vol. 72, no. 12, Sept. 21, 1918, pp. 532-536, 8 figs. Present plans for troops in France provide for 50,000 kw.; technical board controls supplies and coördinates work of design

and construction; electrical machinery difficult to get.

Mine Safety Appliances

Mine Safety Appliances in Warfare. F. H. Trego. Coal Age, vol. 14, no. 11, Sept. 12, 1918, pp. 504-505. Account of mine safety appliances which have been adapted by War Department for use in war.

Railways, Military

Operation of the U. S. Military Railways in France, J. G. Porter. Ry. Age, vol. 65, no. 12, Sept. 20, 1918, pp. 549-551. How Americans adapted themselves to new transportation conditions encountered overseas.

Rifles

Temporary Small-Arms Repair Shop in France, R. K. Tomlin, Jr. Am. Mach., vol. 49, no. 12, Sept. 19, 1918, pp. 535-536, 3 figs. Description of repair shop for salvaging rifles.

The Science of the Rifle, F. H. Kelly. Arms & Explosives, vol. 26, no. 312, Sept. 2, 1918, pp. 117-120, 2 figs. Action of bolt magazine and trigger parts. From writer's book under same title.

Sanitary Engineering

Water Supply Fire Protection, Roads and Waste Disposal of a Large Training Camp, Murray Warner. Am. City, vol. 19, no. 3, Sept. 1918, pp. 174-176, 1 fig. Distribution system of water supply based on standard daily allowance of 55 gal. per man; machines used in the five fire stations; sewage and garbage disposal.

Small Arms

Revolvers and Automatic Pistols (Les revolvers et les pistolets automatiques), L. Cabanès. Génie Civil, vol. 73, nos. 8 and 9, Aug. 24 and 31, 1918, pp. 146-150, 7 figs., and pp. 165-167. Aug. 24: English Gabbett-Fairfax model; American Colt 38: characteristics of Colt 45. Aug. 31: Classification of various types in order of merit; choice of pocket pistol for personal defense in peace times; choice for war service; automatic Colt 45.

Substations

The Outdoor Substation in War Service, E. B. Meyer. Elec. World, vol. 72, no. 12, Sept. 21, 1918, pp. 537-541, 9 figs. Through its use the sudden demand for power to supply war industries has been promptly met with a resulting conservation of material and labor.

Supply Bases

Army Intermediate Depot in France Problem in Getting Labor and Supplies, Robert K. Tomlin, Jr. Eng. News-Rec., vol. 81, no. 11, Sept. 12, 1918, pp. 478-483, 11 figs. Project covers site six miles long; three types of warehouses being built; Chinese labor used on railroad grading; installation completed for storing 5000 tons of beef at zero temperature.

Boston Army Supply Base Will Be Valuable Permanent Port Terminal. Eng. News-Rec., vol. 81, no. 12, Sept. 19, 1918, pp. 522-526, 5 figs. Description of storage warehouse in Boston having 60 acres of storage space.

Troop Transportation

A Novel Scheme for Carrying Troops by Rail, Frederick C. Coleman. Ry. Age, vol. 65, no. 11, Sept. 13, 1918, pp. 509-511, 5 figs. The Great India Peninsula Railway of India's military cars, holding 66 soldiers each, described.

Military Trains in India. Ry. Gaz., vol. 29, no. 9, Aug. 30, 1918, pp. 232-236, 13 figs. Plans and interior arrangement of carriages.

See also Mines and Mining (Explosives); Munitions.

MINES AND MINING

Asphalt

Asphalt Deposits and Oil Conditions in Southwestern Arkansas, Hugh D. Miser and A. H. Purdue. U. S. Geol. Survey, Bul. 691-J, Contributions to Economic Geology Part II, Aug. 16, 1918, pp. 271-292, 1 fig. Geography and geology; general features and local details of asphalt deposits; drilling for oil; well records.

Blackdamp

Outbursts of Gas in Crowsnest Field, James Ashworth. Coal Age, vol. 14, no. 10, Sept. 5, 1918, pp. 443-446, 3 figs. Description of violent gas outbursts which have caused coal fields to be shut down; theories advanced to account for outbursts; suggestions for proceeding with work. Abstract of pamphlet entitled Outbursts of Explosive Gases in the Crowsnest Pass Coalfield, British Columbia.

The Origin of Blackdamp, J. I. Graham. Trans. Instn. Min. Engrs., vol. 55, part 4, Aug.-Sept. 1918, pp. 303-312. Experiments from which author formulates four ordinary compositions of blackdamp resulting from different contributory causes.

Briquetting of Ores

Briquetting of Powdery Ores and of Blast Furnace Dust (Le briquetage des minerals pulvérulents et des poussières de hauts fourneaux). Génie Civil, vol. 73, no. 7, Aug. 17, 1918, pp. 131-134, 10 figs. Schumacher process; Fawcet, Sutcliffe and Speakman presses; nodulation and agglomeration processes.

Cementation

The François Cementation Process, A. H. Krynauw. Min. Mag., vol. 19, no. 2, Aug. 1918, pp. 68-77, 10 figs. Cases in which cement grout under pressure has been successfully applied and manner in which this has been done. From paper before Chem., Metallurgical, and Min. Soc. of So. Africa.

Explosives

Some Notes on Experiments Made with a View to Reducing the Consumption of Explosives, and Increasing the Fathoms Broken per Machine Shift in Machine Stoping, T. H. Bayldon. Jl. So. African Instn. Engrs., vol. 16, no. 12, July 1918, pp. 226-233, 2 figs. Tables comparing two methods: (1) drilling alternately on two stope faces and doubling size of benches, (2) cutting four three-hole benches for each machine on each face.

Man Power

Mechanical Equipment and the Conservation of Miners, R. L. Herrick. Compressed Air Mag., vol. 23, no. 9, Sept. 1918, pp. 8876-8881, 7 figs. Typical examples of man-power savings observed by writer on a 450-mile automobile trip about the mines in the anthracite district.

Salt

Salt Mining and Dressing, J. B. Calkins. Eng. & Min. Jl., vol. 106, no. 10, Sept. 7, 1918, pp. 431-435, 7 figs. Brief history of salt industry, with detailed account of mining and milling operations at a property in New York State having an output of 2000 tons of prepared salt in a 10-hr. day; details as to haulage, dressing and mechanical treatment.

Shale Oil

The Extraction of Oils from Shales and Coal. Petroleum Rev., vol. 39, no. 836, July 27, 1918, p. 59. New English patented process consisting in mixing powdered shale or coal both with some finely ground material (such as limestone, dolomite, carbonate of magnesium or barium carbonate), which, under the action of heat, will give off carbonic acid gas, and with small iron scrap (such as iron turnings) or its chemical equivalent for the purpose of causing the release of increased quantities of hydrogen.

See also Safety Engineering (Mine Accidents).

MOTOR-CAR ENGINEERING

Chassis

Military Transport Chassis (VII). Automobile Engr., vol. 8, no. 118, Sept. 1918, pp. 267-270, 4 figs. Details of F. W. D. (Model B) 3-ton chassis.

Fuels

The Valuation of Motor Fuels, Harold Moore. Automobile Engr., vol. 8, no. 118, Sept. 1918, pp. 245-248. Relative value of tests: specific gravity, viscosity, cold test, coke test, fractional distillation, specific heat, iodine and bromine values, ultimate analysis, temperature of spontaneous ignition, explosive range, calorific power.

Use of Gas for Automobiles. Gas Age, vol. 42, no. 5, Sept. 2, 1918, pp. 199-200. French discussion upon intensive trials both in England and France made with automobiles driven with illuminating gas.

Gear Changing

A Mechanism for Changing Gears Automatically. Automotive Ind., vol. 39, no. 10, Sept. 5, 1918, pp. 416-417, 4 figs. Gears shifted and clutch operated by engine power.

The Problem of the Gear Box. Auto, vol. 23, no. 35, Aug. 30, 1918, pp. 625-626. Inquiry of conditions limiting possibilities in design. (To be continued.)

Racing Cars

The 300 H.P. Fiat Racer. Autocar, vol. 41, no. 1189, Aug. 3, 1918, pp. 117-118, 1 fig. Dimensions and history.

Spark Plugs

How Automobile Spark Plugs Are Made. Commercial America, vol. 15, no. 3, Sept. 1918, pp. 33-37, 7 figs. Cold-drawing and automatic machine process; making porcelain; experimenting; testing and assembling.

Steering

Problems in Steering of Motor Cars Discussed from the Point of View of Projective Geometry (Anwendung eines Satzes der projektiven Geometrie auf die Lenkung von Automobilen), C. Veithen. Dingler's Polytechnisches Journal, vol. 333, no. 2, Jan. 26, 1918, pp. 9-10, 3 figs.

Three-Wheel Cars

The Morgan Runabout. Autocar, vol. 41, no. 1189, Aug. 3, 1918, pp. 123-124, 4 figs. Brief description of a three-wheeled light car.

Trailers

Development of the Trailer. Sibley Jl. of Eng., vol. 32, no. 12, Sept. 1918, pp. 180-185, 2 figs. Experimental basic trailing laws; steering.

Valve Design

Four Valves Per Cylinder. Autocar, vol. 41, no. 1195, Sept. 14, 1918, p. 264. Six-cylinder Pierce-Arrow engine with 12 inlet and 12 exhaust valves in side pockets.

See also Internal-Combustion Engineering; Machine Shop (Radiator Manufacture), (Wheel Hubs); Safety Engineering (Headlights, Automobile).

MUNICIPAL ENGINEERING

Catch-Basin Cleaning

Catch-Basin Cleaning in Chicago. Mun. Jl., vol. 45, no. 11, Sept. 14, 1918, pp. 199-200. Itemized costs of work done by hand and by auto-eductor, time of cleaning different basins.

City Planning

The Planning of the New Halifax, Thos. Adams. Contract Rec., vol. 32, no. 35, Aug. 28, 1918, pp. 680-683, 3 figs. Plans and details of six schemes, two for city and four for county.

The St. Louis Zone Plan, Harland Bartholomew. Jl. Engrs. Club of St. Louis, vol. 3, no. 4, July-Aug. 1918, pp. 214-240, 5 figs. Provisions of city building zone plan passed by Board of Aldermen.

Salvage

Municipal Salvage, J. C. Dawes. Surveyor, vol. 54, no. 1390, Sept. 6, 1918, pp. 111-112. Possibilities of utilizing ordinary house refuse. Inst. of Cleansing Superintendents. (To be concluded.)

Street Lighting

The Aesthetics of Street Lighting, M. Luckiesh. Trans. Illuminating Eng. Soc., vol. 13, no. 6, Aug. 30, 1918, pp. 355-356. Abstract of paper before Phila. Section of the Soc.

MUNITIONS

Canada

Canada's Production of Munitions of War. Can. Min. Jl., vol. 39, no. 17, Sept. 1, 1918, pp. 295-296. Summary of work of Imperial Munitions Board, with a few details regarding most important departments.

Explosives

Sengite: A New Explosive, J. P. Udal. South African Min. Jl., vol. 27, part 2, no. 1401, Aug. 3, 1918, p. 307. Process of manufacturing explosive made of gun coton impregnated with nitrate of soda.

Fuses

Making the Mark III Detonating Fuse. Edward K. Hammond. Machy., vol. 25, no. 1, Sept. 1918, pp. 27-32, 9 figs. First of a series describing operations involved.

Guns

Lathes for the Present Gun Program, A. L. De Leeuw. Am. Mach., vol. 49, no. 11, Sept. 12, 1918, pp. 491-493. Suggestions for obtaining at once required lathes for manufacture of guns.

The British 6-Inch Howitzer, I. W. Chubb. Am. Mach., vol. 49, no. 14, Oct. 3, 1918, pp. 605-612, 16 figs. Body and breach mechanism; various turning, boring, rifling and planing operations are described. (Third article.)

Helmets

Ancient Helmet Making, H. H. Manchester. Am. Mach., vol. 49, no. 12, Sept. 19,

1918, pp. 503-507, 28 figs. A résumé of art of making helmets from earliest times.

Machine Guns

The Manufacture of the Lewis Machine Gun Frank A. Stanley. Am. Mach., vol. 49, no. 12, Sept. 19, 1918, pp. 529-531, 9 figs. Thirteenth article describing manufacture of Lewis machine fun. Second article on the barrel, describing chambering, lapping and inspection.

Shells

Government Requires Millions of Gas Shells. Foundry, vol. 46, no. 10, Oct. 1918, pp. 441-442. Program of Government for next twelve months.

Rectifying Rough Bored 155-mm. Shells, M. P. Potter. Can. Machy., vol. 20, no. 9, Sept. 5, 1918, p. 297, 5 figs. Type of head developed after Government requirements.

Making the U. S. 8-in. Shell, M. E. Hoag. Am. Mach., vol. 49, nos. 11 and 12, Sept. 12 and 19, 1918, 9 figs, and 457-460, 11 figs. Describes turning and boring. (Serial.)

Labor-Saving Washing Device Used on Shell Work, J. H. Rodgers. Can. Machy., vol. 20, no. 9, Sept. 5, 1918, p. 299. Arrangement by which shells are subjected to a spray wash of soda solution, followed by a rinsing with clear hot water.

See also Military Engineering (Rifles), (Small Arms).

PHYSICS

Air

Physics of the Air, W. J. Humphreys. Jl. Franklin Inst., vol. 186, no. 3, Sept. 1918, pp. 341-370, 6 figs. Discussion of crushing of hollow conductors by lightning discharges; quantity of electricity in discharge; general rules for construction of an efficient system of lightning protection; electrical field of the earth; electrical conductivity of the atmosphere; ionic content of the air. (Continuation of serial.)

Luminous Materials

On the Luminescence Due to Radio-Activity, Enoch Karrer and D. H. Kabakjian. Jl. Franklin Inst., vol. 186, no. 3, Sept. 1918, pp. 317-340, 17 figs. Quantitative data on rejuvenation of self-luminous materials, and in particular of radium bromide.

PIPE

Corrosion Prevention

The Deactivator System for Elimination of Corrosion in Hot Water Supply Pipes. Eng. & Contracting, vol. 50, no. 13, Sept. 25, 1918, pp. 297-299, 1 fig. Description of an experimental plant installed in an apartment house in Boston and results obtained. Installation made by Research Laboratory of Applied Chemistry, Massachusetts Institute of Technology in coöperation with Research Department of National Tube Co.

Discussion Concerning the Destruction of Gas and Water Piping in Clayey Soils Containing Gypsum (Zur Zerstörung der Gas- und Wasserleitungen in gipshaltigem Lehmboden), P. Medinger. Journal für Gasbeleuchtung year 61, nos. 7 and 8, Feb. 16 and 23, 1918, pp. 73-76, 1 fig., and pp. 89-91, 3 figs. Extensive discussion of the underlying chemical phenomena.

Wood

Redwood Pipe and Its Uses. Eng. & Cement World, vol. 13, no. 7, Oct. 1, 1918, p. 32, 1 fig. Processes of making three principal types in present use.

See also Wood (Pipes).

POWER GENERATION AND SELECTION

Coal Mining

Electricity in Coal-Mining Operations, Frank Huskinson. Elec. World, vol. 73, no. 13, Sept. 28, 1918, pp. 494-495. Mine signaling and telephone systems; data on rope haulage; miscellaneous applications.

The Electrification of a Durham Colliery. Engineer, vol. 126, no. 3268, Aug. 16, 1918, pp. 136-138, 4 figs. Description of electrical equipment of a British colliery.

Combined Power

Economic Proportion of Hydroelectric and Steam Power, Frank G. Baum. Elec. Rev., vol. 73, no. 12, Sept. 21, 1918, pp. 450-451, 2 figs. New method of determining economical proportion of hydroelectric to steam power. From paper before Am. Inst. of Elec. Engrs.

Efficiency

Efficiency in Power Production, M. T. Berja. Aera, vol. 7, no. 2, Sept. 1918, pp. 175-177, and (discussion) pp. 177-178. Suggestions to engineers. (Manila Elec. Ry. & Light Co.)

Electricity

Industrial Applications of Electricity, Dwight D. Miller. Elec. Contractor-Dealer, vol. 17, no. 12, Oct. 1918, pp. 123-128, 2 figs. Examples of uses of electric heat; advantages of electric drive-friction losses, greater output for a given time, flexibility of operation, lighter building construction, safety.

Exhaust Steam

Utilization of Exhaust Steam in Collieries for the Production of Electrical Energy. (Considérations sur l'utilisation des vapeurs déchappement dans les houillères en vue de la production d'énergie électrique), A. Barjou. L'Industrie Electrique, year 27, no. 628, Aug. 25, 1918, pp. 308-312, 5 figs. Diagram and formula to determine steam consumption of low-pressure turbines; scheme of connections for a turbo-alternator group, 625 kva. 5000 volts. (Continuation of serial; former installments in no. 621, p. 166, no. 623, p. 212, and no. 627, p. 287.

Mining

Electricity in Mining, L. Fokes. Sci. & Art of Min., vol. 29, no. 2, Aug. 24, 1918, pp. 18-20, 5 figs. Safe operation of signaling apparatus; signaling circuits. (Continuation of serial.)

Motor Selection

Applying Engineering Principles Properly in Motor Selection, C. W. Squier. Elec. Ry. Jl., vol. 52, no. 12, Sept. 21, 1918, pp. 505-508, 14 figs. How to compare electric motors which appear to have the necessary characteristics for service designated and to select the one best adapted to meet given requirements.

Oil Fields

The Application of Electrical Power to Oilfield Requirements, J. Wilfred Burford. Jl. Instn. Petroleum Technologists, vol. 4, no. 16, June 1918, pp. 229-262, 4 figs., and (discussion) pp. 262-276. Economics gained by installation of electrical machinery; requirements of petroleum-producing industry; field this industry offers to manufacturers of electrical machines.

Printing

Electrically-Driven Printing Presses. Engineer, vol. 126, no. 3268, Aug. 16, 1918, 9 figs. Illustrations of arrangements and controllers; wiring diagrams.

Power Industry

Conditions in the Power Industry, L. W. Schmidt. Power, vol. 48, no. 14, Oct. 1, 1918, pp. 486-488. Digest of reports of United States consuls on power situation in various parts of world and influence of war upon this industry.

Water Works

Electric Drive for Water Works (Der elektrische Antrieb von Wasserversorgungsanlagen), Wintermeyer. Journal für Gasbeleuchtung, year 61, nos. 11 and 12, Mar. 16 and 23, pp. 126-128, 6 figs, and pp. 137-142, 10 figs. Discussion with diagrams of motor-generator connections.

Wind Power

The Use of Wind Power (Om udnyttlese af vindkraften), H. C. Vogt. Ingeniøren, vol. 27, no. 65, Aug. 14, 1918, pp. 451-452, 2 figs. (Continued from June 8.)

POWER PLANTS

Auxiliaries

Motor-Driven Auxiliaries, C. Grant. Mech. World, vol. 64, nos. 1648 and 1651, Aug. 2, and Aug. 23, 1918, pp. 52-53, and p. 88. Aug. 2: Rotary air pumps; circulating pumps. Aug. 23: Remarks on operation of feed pumps; chimney draft fans; generator cooling fans.

Cedar Rapids, Steam

Cedar Rapids Big Steam Plant. Power, vol. 48, no. 14, Oct. 1, 1918, pp. 478-485, 13 figs. Description of 16,000-kw. steam-turbine plant, with list of principal equipment.

Chimneys

Graphic Method of Chimney Design, H. M. Brayton. Power, vol. 48, no. 10, Sept. 3, 1918, pp. 349-350, 3 figs. Method of designing chimneys without calculations by use of charts and curves.

Rusting Steel Chimneys Coated with Concrete by Cement Gun. Eng. News-Rec., vol. 81, no. 13, Sept. 26, 1918, pp. 596-597, 3 figs. Reinforced-concrete shell is applied to outside of steel stacks.

Cincinnati, Steam

Cincinnati's New 100,000-Kilowatt Power Station. Elec. Rev., vol. 73, nos. 11 and 12, Sept. 14 and 21, 1918, pp. 397-400, 5 figs., and pp. 439-441, 5 figs. First installment describing station layout and mechanical equipment of Union Gas & Electric Company's new station with initial capacity of 50,000 kilowatts. Also published in Power, vol. 48, no. 10, Sept. 3, 1918, pp. 337-344, 14 figs.

Engine House

Rectangular Engine House Avoids Use of Turntable. Eng. News-Rec., vol. 81, no. 13, Sept. 26, 1918, pp. 593-594, 3 figs. Reinforced-concrete building has arched roof on timber lattice trusses; engine stalls have swinging doors.

Feedwater Heater

The Swartwout Feed-Water Heater and Receiver. Steam, vol. 22, no. 3, Sept. 1918, p. 80, 1 fig. Automatic apparatus designed to heat feedwater by use of exhaust steam.

Flexibility

Flexibility of Industrial Power Plants. Southern Engr., vol. 30, no. 2, Oct. 1918, p. 57, 1 fig. Typical connection diagram utilizing rotary converters for tying alternating and direct-current generators together.

Indicating Instruments

Management of the Power Plant, Robert June. Textile World Jl., vol. 54, no. 14, Oct. 5, 1918, pp. 77-81, 5 figs. Use and purpose of indicating instruments. Fourth of series.

Inspection

Need and Value of Boiler Inspection, A. L. G. Taylor. Power, vol. 48, no. 11, Sept. 10, 1918, pp. 389-390. Some instances of unsafe equipment revealed by inspection.

The Massachusetts Plan of Power-Plant Inspection and Coal Conservation, Thomas Hawley. Power, vol. 48, no. 9, Aug. 27, 1918, pp. 302-304. An exposition of plan to be followed in Massachusetts.

Mansfield, Coal and Natural Gas

More Energy for Mansfield District. Power Plant Eng., vol. 22, no. 18, Sept. 15, 1918, pp. 733-738, 12 figs. Description of new plant of Mansfield Electric Light & Power Co. at Melco, Ohio, using both natural gas and coal.

Montana, Hydroelectric

New Hydroelectric Plant of Montana Power Company, W. A. Scott. Elec. Rev., vol. 73, no. 13, Sept. 28, 1918, pp. 487-490, 2 figs. Details of recently completed Holter project.

Pennsylvania Salt Co., Steam

New Plant of the Pennsylvania Salt Manufacturing Company. Power, vol. 48, no. 12, Sept. 17, 1918, pp. 406-413, 10 figs. Description of a modern steam-turbine alternating-current plant with rotary-converter transformation to direct-current for electrolytic work.

Records

Power Plant Records of Operation, Ralph E. Turner. Power Plant Eng., vol. 22, no. 19, Oct. 1, 1918, pp. 799-803, 4 figs. Report sheets designed to aid engineer in obtaining and maintaining highest efficiency.

Rochester, Hydroelectric

Hydroelectric Development at Rochester. Power Plant Eng., vol. 22, no. 19, Oct. 1, 1918, pp. 779-782, 8 figs. Description of features of an hydroelectric plant.

Vibration

Prevention of Vibration in Power and Ventilation Plants, Charles L. Hubbard. Power Plant Eng., vol. 22, no. 19, Oct. 1, 1918, pp. 782-785, 11 figs. Causes of vibration and forms of foundations, supports, hangers and connections to prevent communication to building structure.

See also Chemical Technology (Water Softening); Hoisting and Conveying (Coal Handling).

PUMPS

Motor-Driven Pumps

Motor-Driven Pumps, Chas. Lawson. Southern Engr., vol. 30, no. 2, Oct. 1918, pp. 66-73, 6 figs. Pumping data; lift of pumps and pump control.

Triplex Pumps

Triplex Pumps, John H. Perry. Domestic Eng., vol. 84, no. 8, pp. 275-276, and 306, 4 figs. A few of the different kinds and how they work.

RAILROAD ENGINEERING, ELECTRIC

Circuit Breakers

High-Speed Circuit Breakers for Chicago, Milwaukee & St. Paul Electrification. C. H. Hill. Gen. Elec. Rev., vol. 21, no. 9, Sept. 1918, pp. 623-626, 5 figs. Details of construction.

Cripples

The Disabled Soldier in Electric Railway Service. Electric Ry. Jl., vol. 52, no. 13, Sept. 28, 1918, pp. 579-582, 10 figs. Reclaiming the disabled soldier; blind men winding coils; one-armed men doing shop work.

Freight Transportation

The Problem of Freight Haulage, Harlow C. Clark. Aera, vol. 7, no. 2, Sept. 1918, pp. 103-106. Summary of electric railway freight situation in its connection with national transportation; causes preventing use of many miles of available track.

Locomotives

Advantages of Storage-Battery Locomotives, C. W. Chappelle. Coal Age, vol. 14, no. 10, Sept. 5, 1918, pp. 437-442, 3 figs. Paper read before Illinois Min. Inst., Peoria, Ill., May 1918, and discussion which followed.

Determination of the Proper Size of Storage-Battery Locomotive, Dever C. Ashmead. Coal Age, vol. 14, no. 12, Sept. 19, 1918, pp. 548-552, 2 figs. Explaining calculations of draw-bar pull and battery capacity.

Electric Shunting Locomotive, Lancashire & Yorkshire Ry. Ry. Gaz., vol. 29, no. 9, Aug. 30, 1918, p. 237, 1 fig. Particulars of an electric locomotive designed for shunting service at Clifton power station.

Rewinding and Testing Direct-Current Locomotive Armatures, Frank Huskinson. Coal Age, vol. 14, no. 12, Sept. 19, 1918, pp. 541-544, 16 figs. How mine-locomotive armatures may be rewound.

RAILROAD ENGINEERING, STEAM

Ballasting

A Typical Rock Ballasting Organization, F. H. C. Graves. Ry. Maintenance Engr., vol. 14, no. 9, Sept. 1918, pp. 310-311, 1 fig. Account of work done recently on a double-track eastern road with dense traffic.

Bolsters

Effect of Holes in the Sides of Box Bolsters, L. E. Endsley. Ry. Mech. Eng., vol. 92, no. 9, Sept. 1918, pp. 507-508, 3 figs. Results of a series of tests made on a box bolster with and without holes in the sides.

Brakes

Brake Performance with Heavy Trains. Ry. Gaz., vol. 29, no. 10, Sept. 6, 1918, p. 254. Remarks upon requirements of an efficient brake system based upon results obtained by the Virginian Ry. and described in same issue.

Car Cleaning

Passenger Car Cleaning on the Canadian Pacific Railway, E. Eley. Can. Ry. & Marine World, no. 248, Oct. 1918, p. 432. Description of process. Paper before Can. Ry Club, Montreal.

Car Lighting

Lighting of Railroad Cars by Coal Gas (Die Beleuchtung der Eisenbahnwagen mit Steinkohlengas), O. Hübner. Dingler's Polytechnisches Journal, vol. 333, no. 2, Jan. 26, 1918, pp. 10-12. From Journal für Gasbeleuchtung, year 59, pp. 417-425 and 435-439. Abstract of an extensive paper.

Cars, Passenger

New Cars for Special and Excursion Traffic. Ry. Gaz., vol. 29, no. 6, Aug. 9, 1918, pp. 159-160, 3 figs. General design of 26-ton, 82-passenger car prepared for Victorian Railways.

Cars, Standard

Railroad Administration's Standard Baggage Cars. Ry. Age, vol. 65, no. 13, Sept. 27, 1918, pp. 584-586, 3 figs. Details of designs for 60-ft. and 70-ft. cars of all-steel construction.

Steel Baggage Car for the United States Railroad Administration. Ry. Rev., vol. 63, no. 10, Sept. 7, 1918, pp. 341-343, 4 figs. General description of design adopted for all-steel 70-ft. baggage cars.

Cars, Wooden

Large Capacity Wooden Hopper Car. Ry. Mech. Eng., vol. 92, no. 9, Sept. 1918, pp. 509-512, 3 figs. Drawings and general data with description of wooden hopper car built by the N. & W.

Cranes

Gasoline Traveling Crane for Railroad Ash Pits. Ry. & Locomotive Eng., vol. 31, no. 10, Oct. 1918, pp. 305-307, 4 figs. General features of machines used by New York Central.

Draft Gear

Proper Draft Gear Maintenance, L. T. Canfield. Ry. Rev., vol. 63, no. 13, Sept. 28, 1918, pp. 460-462, 2 figs. Report of five tests of gears; recommendations as to inspection and repair. Paper read before Car Foreman's Assn. of Chicago, Sept. 1918.

Firing

Mechanical Stoking of Locomotives as Related to Smoke, W. S. Bartholomew. Ry. Rev., vol. 63, no. 10, Sept. 7, 1918, pp. 339-341. Résumé of stoker firing practice citing general points of advantage over hand firing, as well as specific instances in support of these claims. Read before Smoke Prevention Assn. at Newark, N. J., Aug. 22.

Freight Handling

The Mechanical Handling of Goods on Railways. Ry. Gaz., vol. 29, no. 10, Sept. 6, 1918, pp. 258-261, 14 figs. Handicaps imposed by wartime conditions on handling railway goods to rail truck from trader or Government consignee and vice versa.

Locomotives

Locomotive Stokers and Smoke Prevention, W. S. Bartholomew. Ry. Age, vol. 65, no. 10, Sept. 6, 1918, pp. 451-453. Résumé of stoker firing practice citing general points of advantage over hand firing, as well as specific instances in support of these claims. Read before Smoke Prevention Assn., Newark, N. J., Aug. 22.

Locomotive Terminal Detention Records. Ry. Gaz., vol. 29, no. 9, Aug. 30, 1918, pp. 241-242. Forms used by the Pennsylvania for gathering information regarding locomotive delays at terminals.

Making Good Engines Better on the Delaware, Lackawanna and Western. Ry. & Locomotive Eng., vol. 31, no. 10, Oct. 1918, p. 319, 3 figs. Results obtained from engines fitted with "Universal" steam chests and valves.

Renewable Stayheads for Locomotive Fireboxes. Engineer, vol. 126, no. 3270, Aug. 30, 1918, pp. 176-177, 5 figs. Description of a new renewable staybolt head and report of experiments and tests made upon it.

Results of Road Tests of N. & W. Mallet Locomotive, H. W. Reynolds. Ry. Mech. Eng., vol. 92, no. 9, Sept. 1918, pp. 502-503, 3 figs. General data on boiler, engine and locomotive performance, and results of tests.

Superheater Locomotive Performance. Ry. Age, vol. 65, no. 11, Sept. 13, 1918, pp. 498-499, 1 fig. Importance of maintenance; clean flues; dampers; effects of high water; lubrication and drifting.

Ten-Wheel and Mikado Type Locomotives for the Paris-Orleans Ry., F. C. Coleman. Ry. Rev., vol. 63, no. 8, Aug. 24, 1918, pp. 267-268, 2 figs. Description of two designs of locomotives recently introduced into heavy freight and passenger service in France.

Terminal Handling of Locomotives, H. C. Pickard. Can. Ry. & Marine World, no. 248, Oct. 1918, pp. 421-424, 11 figs. Suggestions regarding conservation of man power in cleaning fires in locomotives.

The Design and Uses of Tank Locomotives. Ry. Gaz., vol. 29, no. 6, Aug. 9, 1918, pp. 161-164, 6 figs. Claimed advantages of tank locomotives. Diagram drawings of the 0-6-4, 2-6-4, 4-6-2, 4-4-4 and 4-6-4 types.

Locomotives, Standard

Heavy Mikado Type Locomotive, United States Railroad Administration. Ry. Rev., vol. 63, no. 10, Sept. 7, 1918, pp. 331-334, 5 figs. Descriptive reference to first of heavy Mikado type locomotives to be constructed for U. S. R. R. Administration. Comparison with leading details of light Mikado type.

Heavy Standard Mikado Locomotive. Ry. Mech. Eng., vol. 92, no. 9, Sept. 1918, pp. 491-494, 7 figs. General description and principal data, with drawings.

Tonnage Rating of the Standard Locomotives, H. S. Vincent. Ry. Age, vol. 65, no. 14, Oct. 4, 1918, pp. 627-631, 3 charts. Charts of tonnage rating for U. S. Standard light Mikado, heavy Mikado and 8-wheel switching locomotives, with tables of frictional resistances of freight and passenger cars.

The U. S. Standard Heavy Mikado Type Locomotive. Ry. Age, vol. 65, no. 9, Aug. 30, 1918, pp. 375-376, 4 figs. General description, with drawings and principal data.

Rails

On the Stiffness and Relative Strength of Rails, E. W. Stoney. Indian Eng., vol. 63, no. 22, June 1, 1918, p. 304, 6 figs. Diagrams showing plots of results of experiments on deflection of rails in various positions by central dead loads.

Transverse Rail Fissues and the Derailment at Juniper, Ga. Ry. Rev., vol. 63, no. 9, Aug. 31, 1918, pp. 305-309, 9 figs. From report of engineer-physicist of Bureau of Safety, Interstate Commerce Commission, on failure by breaking in several places of a 12-year old 80-lb. A. S. C. E. section rail.

Salvage

Reclamation on the Southern Pacific, Frank A. Stanley. Ry. Mech. Eng., vol. 92, no. 9, Sept. 1918, pp. 505-506, 5 figs. Second installment. Description of extensive salvage work.

Shocks in Trains

Shocks in Long Passenger Trains, Robert Burgess. Southern & Southwestern Ry. Club, vol. 14, no. 10, July 1918, pp. 4-20 and (discussion) pp. 20-31. Causes producing them; suggestions to engine men.

Signals

Train Operation by Signal Indication on the Erie Railroad, Henry M. Sperry. Ry. Gaz., vol. 29, no. 9, Aug. 30, 1918, pp. 227-231, 4 figs. Summary of disadvantages experienced under manual block and improvement in train operation under automatic block. From the Railway Age.

Sleepers

The Green-Moore Patent Resilient Reinforced Concrete Sleepers. Ry. Gaz., vol. 29, no. 10, Sept 6, 1918, pp. 262-264, 10 figs. Figures and illustrations. Other concrete sleepers have been described in issues of May 13 and July 19, 1918.

Snow

Maintaining a Railroad Above the Clouds. Ry. Maintenance Engrs., vol. 14, no. 9, Sept. 1918, pp. 291-295, 9 figs. Problems encountered in handling snow and ice to keep open the Moffatt line reaching an elevation of over 11,000 ft.

The Southern Pacific's Snow Shed Problem, Geo. W. Rear. Ry. Gaz., vol. 29, no. 6, Aug. 9, 1918, pp. 158-159. Brief history of development of 29 miles of snow sheds and of problems involved in their maintenance. From Proc. Am. Ry. Bridge & Building Assn., 1917.

Superheaters

Superheater Unit Maintenance. Ry. Rev., vol. 63, no. 13, Sept. 28, 1918, pp. 479-482, 9 figs. Instructions for installation and care of superheater units. From Bulletin No. 4, by Locomotive Superheater Co., New York.

Terminals

Unit Operation of Railroad Terminals. Ry. Rev., vol. 63, no. 13, Sept. 28, 1918, pp. 455-458. From Preliminary Report of Committee on Yards and Terminals, Am. Railway Eng. Assn., issued in Bulletin 208.

Yards, Gravitation

Colwick Gravitation Yards, Great Northern Ry. Ry. Gaz., vol. 29, no. 7, Aug. 16, 1918, pp. 185-188, 5 figs. Plan and views of yard instituted for concentrating and remarshalling coal traffic to and from Notts and Derby mines.

See also *Factory Management (Stores)*; *Safety Engineering (Railroad Administration Safety Work)*; *Testing and Measurements (Track Scales)*.

REFRACTORIES

Brick, Inspection

Inspecting Refractory Brick, C. E. Nesbitt and M. L. Bell. Iron Age, vol. 102, no. 11, Sept 12, 1918, p. 630. Standard specification a necessity; results of some tests. From a paper before Am. Soc. for Testing Materials, June 1918.

Brick, Silica

The Manufacture of Silica Brick, H. Le Chatelier and B. Bogitch. Bul. Am. Inst. Min. Engrs., no. 141, Sept 1918, pp 1435-1462, 14 figs. Experiments on samples of a few grams conducted at the Sorbonne, Paris, for the purpose of determining necessary conditions in manufacture of high-grade brick.

High-Temperature Research

High Temperature Processes and Products (III), Chas. A. Darling. Jl. Royal Society of Arts, vol. 66, no. 3433, Sept. 6, 1918, pp. 649-656, 2 figs. Alundum and aloxite; artificial graphite; British processes; high-temperature research.

Structure

The Importance of Structure in Refractories, J. H. Kirkpatrick. Clay Worker, vol. 70, no. 2, Aug. 1918, pp. 137-139, 6 figs. Effect of structure on the ultimate quality of manufactured product. From the Effect of Size of Grog in Fire Clay Bodies, tech paper 104, Bureau of Standards.

Volatilization

Relative Volatilities of Refractory Materials, Wm. Roy Mott. Gen. Meeting Am. Electrochem. Soc., Oct. 2, 1918, Advanced Copy, Paper 1, pp. 1-34, 6 figs. Experimental study of order in which substances volatize in electric arc, distances at which their vapors condense from arc, and time to volatilize equal atomic quantities of elements or molecular quantities of compounds; theoretical considerations concerning ratios of absolute boiling points to melting points, and upon a universal vapor pressure curve applicable to all substances.

REFRIGERATION

Ice Making

Modern Raw Water Ice Making Plant. Ice & Refrigeration, vol. 55, no. 1, July 1, 1918, pp. 1-6, 9 figs. Details of motor-driven 100 ton plant with complete equipment.

Multiple-Effect Compression

Multiple-Effect Compression Ice Making and Refrigerating Machines. Engineering, vol. 106, no. 2747, Aug. 23, 1918, pp. 201, 7 figs. Diagram showing working cycle, indicator cards, and general description of a CO_2 multiple-effect compression refrigerating machine built by Seagers, Ltd., Dartford, Kent.

Storage-Room Refrigeration

Efficiency in Engineering, Eric H. Peterson. Ice & Refrigeration, vol. 55, no. 1, July 1, 1918, pp. 9-11, 5 figs. Charts showing refrigeration required for various temperatures in well-ventilated rooms and amount of pipe required for storage rooms.

ROADS AND PAVEMENTS

Concrete Roads

A Road Finisher That Produces Denser Concrete. Eng. & Cement World, vol. 13, no. 4, Aug. 15, 1918, p. 33, 1 fig. Device designed in 1913 by E. G. Carr, said to eliminate voids in concrete, and to have been used in construction of 400 miles of California's highways.

Pavement Planer Method of Finishing Concrete Roads, E. Earl Glass. Eng. & Contracting, vol. 50, no. 14, Oct. 2, 1918, pp. 318-319, 4 figs. Description of tools and methods used in making a concrete road in California.

Corners

Width of Roadway and Corner Cut Off, R. H. Whitten. Mun. Jl., vol. 45, no. 9, Aug. 31, 1918, pp. 166-167, 3 figs. Plans made by City Plan Commission of Cleveland for increasing corner radii and angle of vision.

Earth Roads

Method of Handling Materials for Concrete Roads. Eng. & Cement World, vol. 13, no. 7, Oct. 1, 1918, p. 31, 2 figs. Advantages of eliminating stock piles along route.

The Location, Construction and Maintenance of Earth Roads, H. R. MacKenzie. Jl. Eng. Inst. of Can., vol. 1, no. 5, Sept. 1918, pp. 181-186. Emphasizes engineering supervision of construction and constant attention to maintenance as principal factors necessary to make of an earth road a satisfactory highway.

Furnace-Slag Sub-Crust

Roads During and After the War, E. Purnell Hooley. Surveyor, vol. 54, no. 1385, Aug. 2, 1918, pp. 59-60. Use of furnace slag as sub-crust in macadam and telford roads. Paper before Instn. Mun. and County Engrs.

Highways

State-Aid Highway Work in Illinois, C. M. Hathaway. Am. City, vol. 19, no. 3, Sept. 1918, pp. 176-182, 3 figs. Widths, drainage, alignment and design of state-aid roads; discussion of construction materials: concrete, brick, bituminous, macadam and oiled earth; state-aid bridge work; grade-crossing problems. (Concluded.)

The Planning of a System of Rural Highways Under Conditions Existing in Province of Saskatchewan, W. M. Stewart. Jl. Eng. Inst. of Can., vol. 1, no. 5, Sept. 1918, pp. 189-192 and (discussion) 192-193. Classification of roads and determination of satisfactory type of surface to be used on a certain road from an estimate of volume and class of traffic to be provided for. Also published in Can. Engr., vol. 35, no. 10, Sept. 5, 1918, pp. 217-218.

Typical Specifications for Non-Bituminous Road Materials, Prevost Hubbard and Frank H. Jackson. U. S. Department of Agriculture, Bul. no. 704, professional paper, Aug. 30, 1918, 38 pp., 3 figs. For 19 common materials used in the construction and maintenance of various types of highways; descriptions of methods of testing to which reference is made in specifications.

Wood-Block Pavements

Proper Method of Application of Bituminous Filler for Creosoted Wood Block Pavements and Floors, Lambert T. Ericson. Eng. & Contracting, vol. 50, no. 14, Oct. 2, 1918, pp. 320-321, 2 figs. To prevent an excess of tar on pavement in hot weather, joints should be filled with tar or other substance at very high temperature so that joint will be well penetrated; details of proper application given.

SAFETY ENGINEERING

Acetylene, Dissolved, Cylinders for

Report of the Departmental Committee on Cylinders for Dissolved Acetylene (VI). Acetylene & Welding Jl., vol. 15, no. 179, Aug. 1918, pp. 146-150, 2 figs. Report on two samples of charcoal and on alternating pressure tests made on two dissolved acetylene cylinders. (Concluded.)

Blow-Off Tanks

Explosion of a Blow-off Tank. Travelers Standard, vol. 6, no. 9, Sept. 1918, pp. 177-181, 3 figs. Suggestions on construction and installation of blow-off tanks derived from an account of a recent explosion at a Cleveland manufacturing plant.

Construction Work

Benefit of Accident Prevention in Contracting, F. S. Robinson. Eng. & Contracting, vol. 50, no. 13, Sept. 25, 1918, pp. 311-312. Abstract of paper before Construction Section of National Safety Council, Sept. 1918.

Safety Engineering and Accident Prevention in Construction Work, Leo D. Woedtke. Eng. & Contracting, vol. 50, no. 13, Sept. 25, 1918, pp. 299-303. Accident prevention methods of Fred T. Ley & Co., Inc. Abstract from address before Construction Section Meeting of National Safety Council, Sept. 1918.

Dust Inhalation

Effects of Mine-Dust Inhalation, J. S. Haldane. Eng. & Min. Jl., vol. 106, no. 11, Sept. 14, 1918, pp. 475-477. Effects of various kinds of dusts when breathed by mine or mill workers. From paper submitted to Chem. Metallurgical & Min. Soc. of South Africa, and Instn. of Min. Engrs., London. Published also in Trans. Instn. Min. Engrs., vol. 55, part 4, Aug.-Sept. 1918, pp. 264-273 and (discussion) pp. 273-293.

A Short List of References on the Dust Hazard in Industry. Library of the National Workmen's Compensation Service Bureau, Reference List No. 3. A short bibliography.

Dust Explosions

Considerations Respecting Causes of Dust Explosions (Einiges über Staubexplosionem), G. Bauer. Zeitschrift für angewandte Chemie, year 30, no. 79, Oct. 2, 1917, pp. 239-240, 4 figs.

Explosives

Safety in the Use of Explosives, Arthur La Motte. Coal Age, vol. 14, no. 11, Sept. 12, 1918, pp. 490-496. Paper before Nat. Safety Council.

Fire Hazards

The Factory Fire Brigade (I), Paul Mason. Am. Indus., vol. 19, no. 2, Sept. 1918, pp. 14-16. Organization, equipment and discipline.

First Aid

Elementary First Aid for the Miner, W. A. Lynott and D. Harrington. Sci. & Art of Min., vol. 29, no. 2, Aug. 24, 1918, pp. 22-23. What to do at once when a fellow miner is hurt; general directions for caring for bleeding; miscellaneous precautions; dressing for broken bones; electric shock. From Miner's Circular 23, U. S. Bureau of Mines.

Flying Objects

Injury from Flying Objects, Chesla C. Sherlock. Am. Mach., vol. 49, no. 14, Oct. 3, 1918, pp. 625-627. Legal aspects of injuries received from flying objects discussed.

Headlights, Automobile

Automobile Headlights and Glare Reducing Devices, L. C. Porter. Gen. Elec. Rev., vol. 21, no. 9, Sept. 1918, pp. 627-632, 13 figs. General discussion showing set of curves indicating candlepower necessary to "pick up" a man at various distances.

Dazzling Head Lamps. Autocar, vol. 41, no. 1192, Aug. 24, 1918, p. 188. Tests and standard specifications adopted in New York State.

Lightning Arresters

The Oxide Film Lightning Arrester, Crosby Field. Gen. Elec. Rev., vol. 21, no. 9, Sept. 1918, pp. 597-601, 6 figs. Principle, construction and operation of instrument which consists essentially of an insulating film placed between a conductor and lead peroxide.

Machinery Movements

Abnormal Movement of Machinery, Chesla C. Sherlock. Am. Mach., vol. 49, no. 13, Sept. 26, 1918, pp. 578-580. Discussion of accidents due to a sudden and abnormal movement of machinery, taking operator by surprise, and legal aspects.

Mine Accidents

Who Gets Hurt and Why. Coal Age, vol. 14, no. 11, Sept. 12, 1918, pp. 480-482, 7 figs. Details relating to total distribution of mine accidents, from records of Ellsworth Collieries.

Quarrying

Safe Practices in the Quarry and Mill, William H. Baker. Eng. & Cement World, vol. 13, no. 4, Aug. 15, 1918, pp. 53-54. Precautions taken at Hannibal, Mo., mills of Atlas Portland Cement Co. Abstract of paper before Nat. Safety Council.

Railroad Administration, Safety Work

Safety Program of Railroad Administration, Hiram W. Belnap. Ry. Rev., vol. 63, no. 12, Sept. 21, 1918, pp. 426-428. What it expects of different organizations in promotion of safety work. Abstract from paper before Nat. Safety Council, St. Louis.

Scaffolds

Safe Construction of Scaffolds and Falsework, T. F. Foltz. Eng. & Contracting, vol. 50, no. 12, Sept. 18, 1918, pp. 285-288. Abstract of paper before National Safety Council.

Small Shops

How Accident Prevention Work May Be Carried On in Small Companies, Wills Machlachlan. Am. Gas Eng. Jl., vol. 109, no. 14, Oct. 5, 1918, pp. 319-322. Suggestions in regard to equipment and organization. Paper before National Safety Congress.

Winding Engines

Safety in Winding Operations, J. A. Vaughan. South African Mining Jl., vol. 27, part 2, no. 1399, July 20, 1918, pp. 269-270. Remarks on safe handling of winding engine based on author's experience and compiled statistics of winding accidents in the Witwatersrand. Paper before the S. A. A. A. S.

See also Electrical Engineering (Excessive Voltages), (Safety Measures); Hoisting and Conveying (Safety Appliances), (Wire Ropes); Military Engineering (Mine Safety Appliances); Roads and Pavements (Corners).

SANITARY ENGINEERING

Plumbing

The Why and Wherefore of Sanitary Engineering, Arthur Bateman. Domestic Eng., vol. 84, no. 9, Aug. 31, 1918, pp. 315-317 and 344, 7 figs. Technical and scientific plumbing and sanitation. (Continuation of serial, preceding installment appeared July 13.)

Sewage Disposal

Sewage Disposal, Edward Willcox. Surveyor, vol. 54, no. 1385, Aug. 2, 1918, pp. 55-56. Camp sewage disposal; fertilizers from sewage; design of plants; Wolverhampton experiments; American research work. Assn. Mgrs. Sewage Disposal. (To be concluded.) Published also in Can. Engr., vol. 35, no. 10, Sept. 5, 1918, pp. 224-225.

Water Supply

Experience with Artesian Water Supply in Savannah, E. R. Conant. Am. City, vol. 19, no. 3, Sept. 1918, pp. 182-192, 1 fig. From paper before Am. Water Works Assn.

STANDARDS AND STANDARDIZATION

Gas-Meter Threads

Standardization of Gas Meter Threads and Connections in Germany (Die Vereinheitlichung der Gasmesser-Verschraubungen und

Verbindungen), D. Eisele. Journal für Gasbeleuchtung, year 61, no. 16, Apr. 20, 1918, pp. 181-183, 2 figs.

Pyrometers

Pyrometer Standardization. Ezer Griffiths and F. H. Schofield. Trans. Faraday Soc., vol. 13, part 3, June 1918, pp. 222-237, 6 figs. Indicates temperature-scale basis of practical types and errors to which pyrometric observations are liable.

Screw Thread

The Relation of Screw-Thread Angles to Other Functions, H. J. Bingham Powell. Am. Mach., vol. 49, no. 13, Sept. 26, 1918, pp. 571-573, 1 fig. Author sets forth his reasons for advocating adoption as an international standard the Whitworth thread.

Tubes, Seamless

International Aircraft Standards. Flight, vol. 10, no. 33, Aug. 15, 1918, p. 919. Specifications for alloy-steel seamless tubes of 200,000 lb. per sq. in. tensile strength. (Continued.)

See also Cement and Concrete (Portland Cement); Engineering Materials (Asphalt); Marine Engineering (Fabricated Ships), (Standard Vessels); Railroad Engineering, Steam (Locomotives, Standard).

STEAM ENGINEERING

Boiler Gage Glass

The Boiler Gage Glass. Wm. L. De Baufre. Jl. Am. Soc. Naval Engrs., vol. 30, no. 3, Aug. 1918, pp. 547-556, 2 figs. Explains how to determine actual weight of water contained in boiler, and gives corrections to be applied in tests where the gage-glass reading, the steam pressure and the rate of steaming at the end of a run are different from those obtaining at the beginning.

Boilers

Examination of Steam Boilers at Collieries. Edward Ingham. Colliery Guardian, vol. 116, no. 3007, Aug. 16, 1918, pp. 336-337, 9 figs. Typical defects found in inspection of boilers explained.

Steam-Boiler Regulation and Control. Albert A. Straub. Power, vol. 48, no. 13, Sept. 24, 1918, pp. 442-446, 6 figs. Brings out point that proper handling of damper for controlling draft for steam-boiler furnaces is of importance, and presents charts showing variation of temperature of escaping gases and of steam pressure.

Pressure Losses

Pressure Losses in Steam Plants. R. S. Hawley. Power Plant Eng., vol. 22, no. 18, Sept. 15, 1918, pp. 739-741, 2 figs. Causes: distinction between losses due to throttling and radiation.

Scale, Boiler-Tube

Boiler-Tube Scale; Its Removal with Kerosene as Practised at the Fuel-Oil Testing Plant, Albert M. Penn. Jl. Am. Soc. Naval Engrs., vol. 30, no. 3, Aug. 1918, pp. 512-517, 2 figs. 15 gal. of kerosene were poured into each lower drum with tin funnel, 100-lb. steam allowed to flow in and condense until water glass was three-quarters full. Photographs showing results and precautions advised.

Soot Removal

Soot Removal from Fire-Tube Boilers. Power, vol. 48, no. 9, Aug. 27, 1918, pp. 305-308, 13 figs. Rear-end and front-end blowers for return tubular boilers, rocking elements for internally fired boilers and gear-turned blowers for vertical boilers.

Steam, High-Pressure

Advantages of High Pressure and Superheat as Affecting Steam Plant Efficiency. Eskil Berg. Elec. Rev., vol. 73, no. 12, Sept. 21, 1918, pp. 444-447, 3 figs. Possibilities of higher steam pressures and temperatures for reducing mechanical and thermal losses in turbines.

The Uses of High-Pressure and High-Temperature Steam in Large Power Stations, J. H. Shaw. Contract Rec., vol. 32, no. 35, Aug. 28, 1918, pp. 703-705. Comparison of costs illustrated by schedule showing coal, steam and heat consumption for a 20,000-kw. machine running at 200 lb. and 350 lb. gage pressure at varying superheats and also at 500 lb. pressure absolute and 268 deg. fahr. superheat. Paper before Instn. Civ. Engrs. Also published in Elec. News, vol. 27, no. 17, Sept. 1, 1918, pp. 29-31, and in Elecn., vol. 81, no. 2100, Aug. 16, 1918, pp. 330-332, 5 figs.

Superheaters

General Construction and Maintenance of Superheater Units. Ry. & Locomotive Eng., vol. 31, no. 10, Oct. 1918, pp. 315-316, 4 figs. Device especially designed to prevent leakage in the joints and rapid deterioration of the ends of superheater pipes.

The Value of Superheated Steam at the Colliery and at Iron Works. Iron & Coal Trades Rev., vol. 97, no. 2635, Aug. 30, 1918, pp. 238-239, 2 figs. Description of Sugden superheater, with Stirling boiler and independently fired.

Turbines

A 35,000-kw. Turbine is Wrecked in Northwest Station, Chicago. Power, vol. 48, no. 10, Sept. 3, 1918, pp. 345-348, 4 figs. Detailed description of accident to 35,000-kw. turbine at Northwest Station, Chicago. Failure of nineteenth wheel probable cause of wreck.

Additional Power at Small Cost by Exhaust Steam Turbine. Can. Machy., vol. 20, no. 11, Sept. 12, 1918, pp. 317-318, 3 figs. Saving of fuel and boiler capacity obtained in paper mill by connecting steam turbines to line shaft through reduction gear.

The Forty-five Thousand Kilowatt Compound Turbine at Providence, R. I., J. P. Rigsby. Power, vol. 48, no. 9, Aug. 27, 1918, pp. 292-298, 9 figs. Illustrated description of 45,000-kw. cross compound reaction Westinghouse turbine at Providence, R. I.

Valves, Safety

Graphic Methods of Determining Size of Safety Valve, H. F. Gauss. Power, vol. 48, no. 12, Sept. 17, 1918, pp. 414-417, 4 figs. Reasons for increasing maximum allowable lifts above those permitted in the A.S.M.E. Code. Napier's formula for the flow of steam through an orifice used as a basis for constructing capacity curves. General solution by means of logarithmic charts.

Safety and Relief Valves, M. W. Rink. Jl. Am. Soc. Naval Engrs., vol. 30, no. 3, Aug. 1918, pp. 504-511, 7 figs. Construction and use of shifting and cylinder relief valves for a mixture of steam and water. From Marine Eng.

See also Engineering Materials (Boiler Plates); Power Generation and Selection (Exhaust Steam).

STEEL AND IRON

By-Products

By-Product Recovery in Iron and Steel Works. Engineering, vol. 106, no. 2747, pp. 206-207. Utilization of gas and other by-products of iron and steel works. From paper by A. Gouvy before Congrès du Génie Civil, Paris, March 1918.

Blast Furnaces

Fuel Economy in Blast Furnaces. T. C. Hutchinson. Iron Age, vol. 102, no. 12, Sept. 19, 1918, pp. 689-691, 3 figs. Cleaning the ore and size of bell factors in larger output and lower coke consumption in British practice; long life of furnace walls. From paper before Iron & Steel Inst., London, May 1918.

Casting

Sound Steel by Lateral Compression. Benjamin Talbot. Iron Age, vol. 102, no. 14, Oct. 3, 1918, pp. 836-838, 2 figs. British results from applying this principle to tap portion of slag; cheap refractory top of slag. From paper before Iron & Steel Inst., London, May 1918.

Corrosion

Corrosion of Iron and Steel, and its Prevention (VII). Abe Winters. Can. Machy., vol. 20, no. 9, Aug. 29, 1918, pp. 257-258. Considerations on sherardizing process (covering heated iron with zinc dust) with reference to temperature and time, and its commercial application.

Electric Steel

Electric Steel Making, Arthur V. Farr. Machy., vol. 25, no. 1, Sept. 1918, pp. 40-42, 9 figs. Importance and growth of electric-steel industry; cold-melt process and structure of electric steel.

The Electric Furnace in the Steel Casting Industry, W. E. Moore. Elec. Jl., vol. 15, no. 9, Sept. 1918, pp. 331-332. Remarks on advantages and disadvantages of various processes of manufacturing steel—crucible melting, open-hearth, side-blow converter, and the electric furnace.

The New Electric Steel Plant at Toronto (La nouvelle aciérie électrique de Toronto). Génie Civil, vol. 72, no. 26, June 29, 1918, pp. 479-481, 3 figs. Plans, views and description.

Ferro-Alloys

The Manufacture of Ferro-Alloys in the Electric Furnace, R. M. Keeney. Min. Jl., vol. 122, no. 4334, Sept. 14, 1918, pp. 538-539. Ferrouranium. Paper before Am. Inst. Min. Engrs. (Continuation of serial.)

Iron, Molecular Instability

Molecular Instability Due to Magnetostriction (Instabilité moléculaire par le magnétostriction), D. Hurmuzescu. Revue Générale de l'Electricite, vol. 4, no. 7, Aug. 17, 1918, pp. 211-214, 1 fig. Results of experimental study which led author to assert that, unlike steel, iron under certain conditions possesses molecular instability.

Iron-Titanium Ores

On the Microstructure of Certain Titanium Iron Ores, Chas. H. Warren. Economic Geology, vol. 13, no. 6, Sept. 1918, pp. 419-446, 12 figs. Experimental study of titanium-iron-oxide minerals, including a number of ilmenites from different parts, carried out on large Leitz metallographic microscope, using a small 4 ampere arc as source of light.

Ore Resources

Notes on Certain Iron Ore Resources of the World, C. E. Harder, W. Lindgren, C. M. Weld, A. C. Spencer, H. P. Bain, and Sidney Paige. Bul. Am. Inst. Min. Engrs., no. 141, Sept. 1918, pp. 1471-1496. Brazil, Scandinavia, Cuba, Southern Europe, China, and Alsace-Lorraine.

Application of Optical Pyrometry in Steel Works Practice, J. N. Greenwood. Trans. Faraday Soc., vol. 13, part 3, June 1918, pp. 295-308, 4 figs. Comparison of various conditions of use of an optical pyrometer in taking temperatures of liquid steel in the open with calibration conditions; errors due to emissivity; polarization of emitted light, and lack of monochromatism; technical defects of the Cambridge type; suggestion to obtain control of steel-making process pyrometrically.

Pyrometry

Notes on Pyrometry from the Standpoint of Ferrous Metallurgy, W. H. Hatfield. Trans. Faraday Soc., vol. 13, part 3, June 1918, pp. 289-294. Account of methods to control temperature used in large armament works.

Temperature Determinations of Liquid Steel, A. McCance. Trans. Faraday Soc., vol. 13, part 3, June 1918, pp. 309-310. Work done at the Parkhead Steel Works to develop a system of controlling the temperature in an open-hearth furnace by an optical pyrometer.

The Determination of the Temperature of Liquid Steel Under Industrial Conditions, Cosmo Johns. Trans. Faraday Soc., vol. 13, part 3, June 1918, pp. 280-288. Account of author's experience; suggestion to adopt as standard an optical pyrometer using monochromatic light $\lambda = 0.65\ \mu$.

Semi-Steel

Steel Mixture Iron—The Use of Scrap Steel in Pig Iron Mixtures. Contract Rec., vol. 32, no. 37, Sept. 11, 1918, pp. 731-732. Factors involved in absorption of carbon from coke by steel during cupola melting and experiment illustrating this absorption; results obtained from melting steel borings and crop ends from smithy in a cupola together with 10 per cent ferrosilicon. From the Engineer, London.

Steel, Hardness and Tensile Strength

Tensile Strength and Hardness of Steel, H. M. Brayton. Iron Age, vol. 102, no. 11, Sept. 12, 1918, pp. 627-629, 3 figs. Their relation shown by means of graphical charts which give either variable in terms of the other.

Steel Mills

Fuel Economy in a Modern Steel Works, Benjamin Talbot. Colliery Guardian, vol. 116, no. 3010, Sept. 6, 1918, pp. 493-494. Examination of most economical fuel consumption possible to obtain in practice in a modern steel works. Appendix II to Carbonization Committee's Report, Board of Trade. Also published in Iron & Coal Trades Rev., vol. 97, no. 2634, Aug. 23, 1918, pp. 210.

Mechanical and Electrical Equipment of a Southern Steel Mill. Southern Engr., vol. 30, no. 2, Oct. 1918, pp. 36-43, 12 figs. Waste-heat boiler installation, mixed-pressure turbines, motor drive for billet mills, roughing mills and other machinery, motor control.

Tubes, Seamless

Tubes and Tubular Structures, W. W. Hackett and A. G. Hackett. Aviation, vol. 5, no. 4, Sept. 15, 1918, pp. 230-234. Review of method of manufacturing seamless steel tubing, of difficulties to be overcome, and forms of manipulation which it is possible to put upon good quality steel tubing; account of tests carried out on specimen tubes, under various conditions, and joined together in different ways. Paper before Aeronautical Soc. of Great Britain.

Wire-Rod Mills

Designing Passes for Wire Rod Mill Roll Train, W. S. Standiford. Am. Mach., vol. 49, no. 14, Oct. 14, 1918, pp. 601-604, 3 figs. Design of roll passes and difficulties encountered in manufacture of rods.

See also Engineering Materials (Semi-Steel); Foundry (Fluidity of Iron).

TESTING AND MEASUREMENTS

Calorimeters

Some Points Regarding Calorimeter Efficiency, Walter P. White. Jl. Franklin Inst., vol. 186, no. 3, Sept. 1918, pp. 279-287. Sources of calorimetric error and considerations on different types of these instruments with reference to moderately high precision demanded in commercial work.

Electrical Apparatus

The Engineering Evolution of Electrical Apparatus (XXXII), Chas R. Riker. Elec. Jl., vol. 15, no. 9, Sept. 1918, pp. 357-362, 14 figs. Synchroscopes; power-factor meters; frequency meters; ground detectors; compensated instruments.

Engine Testing

The New Duesenberg Aero Engine Test House. Aerial Age, vol. 8, no. 2, Sept. 23, 1918, pp. 66-67, 4 figs. Processes followed at laboratories of Duesenberg Motors Corporation in analyses of construction materials.

Hardness Testing

Brinell Hardness Test, J. G. Ayers, Jr. Iron Age, vol. 102, no. 10, Sept. 5, 1918, pp. 581-582, 3 figs. New method insuring quick commercial results of sufficient accuracy. From paper before Am. Soc. for Testing Materials.

High-Temperature Measurements

The Automatic Control and Measurement of High Temperatures, Richard P. Brown. Trans. Faraday Soc., vol. 13, part 3, June 1918, pp. 246-252. Operation of Brown heat meter.

Meters, Electric

Meter Installation for Determining Energy Accurately in Three-Phase Systems (Sur un montage des compteurs enregistrant l'énergie des postes triphasés permettant la détermination de l'énergie magnétisante et donnant une plus grande sécurité de bon fonctionnement), P. Bourguignon. Revue Générale de l'Electricité, vol. 4, no. 7, Aug. 17, 1918, pp. 214-217, 2 figs. Method to determine cos Φ by means of two monophase meters.

Pyrometry

Base-Metal Thermoelectric Pyrometers, Chas. R. Darling. Trans. Faraday Soc., vol. 13, part 3, June 1918, pp. 344-347, 2 figs. Couples employed: iron-constantan, two iron-nickel alloys of different composition, and two different nickel-chrome alloys known as Hoskins' alloys.

Bibliography on Pyrometers, Robert Hadfield. Trans. Faraday Soc., vol. 13, part 3, June 1918, pp. 362-372. Pamphlets, papers and cuttings; British and American patents; books.

Note on the Wiborgh Pyrometer, John G. A. Rhodin. Trans. Faraday Soc., vol. 13, part 3, June 1918, pp. 260-261, 4 figs. Description of instrument. From Jernkontorets Annaler.

Notes on the Remediable Causes of Unreliability Encountered in Thermoelectric Pyrometry, Especially in Systems of the Base-Metal Type, C. E. M. Stone. Trans. Faraday Soc., vol. 13, part 3, June 1918, pp. 348-355, 1 fig., and (discussion) pp. 355-359. Efforts of various manufacturers to construct an efficient pyrometer by using base-metal thermocouples in conjunction with pivot millivoltmeters.

Optical Pyrometry in Non-Ferrous Metallurgy, F. G. Donnan. Trans. Faraday Soc., vol. 13, part 3, June 1918, pp. 276-279, 2 figs. Corrections necessary in reading of optical pyrometers when measuring temperatures of molten metal, in the cases of gold and copper.

Pyrometers, Their Construction and Repair, J. V. Lucas. Am. Mach., vol. 49, no. 11, Sept. 12, 1918, pp. 471-477, 17 figs. Description of construction and of minor repairs which can be made without returning instrument to maker.

The Measurement of High Temperatures by Means of Pottery Materials, Henry Watkin. Trans. Faraday Soc., vol. 13, part 3, June 1918, pp. 330-340, 10 figs., and (discussion) pp. 341-343, 1 fig. Types of pyrometer based on principle of contraction of pottery materials under influence of heat.

The Relation of Optical and Radiation Pyrometry to Modern Physics, Paul D. Foote. Trans. Faraday Soc., vol. 13, part 3, June 1918, pp. 238-245, 1 fig. Study of constants in Planck's spectral distribution law and Stefan-Boltzman law of radiation in their relation with constants of other important radiation laws.

Thermocouples

The Advantage of Burying the Cold-Junction of a Thermocouple as a Means of Maintaining it at a Constant Temperature, Robert S. Whipple. Trans. Faraday Soc., vol. 13, part 3, June 1918, pp. 253-259, 5 figs. Method used in connection with experimental work at Cambridge Scientific Instrument Co.

Track Scales

War Time Standardization of Railroad Track Scales, C. A. Briggs. Scale Jl., vol. 4, no. 12, Sept. 10, 1918, pp. 9-10. Recountal of recent efforts of Bureau of Standards. Paper before Scale Mfrs.' Assn.

Working Stresses for Railroad Track Scale Design. Scale Jl., vol. 4, no. 12, Sept. 10, 1918, p. 7, 1 fig. Nat. Bureau of Standards data including allowances for import carried by moving loads.

Ultra-Violet Rays

Ultra-Violet Light, Its Application in Chemical Arts (XIV), Carleton Ellis and A. A. Wells. Chem. Engr., vol. 26, no. 7, June 1918, pp. 263-272. Testing smokeless powder and many organic compounds by effect produced on them with exposure to ultra-violet radiations.

See also Aeronautics (Materials of Construction); Electrical Engineering (Recording Instruments); Power Plants (Indicating Instruments); Steel and Iron (Pyrometry).

TRANSPORTATION

Delivery Zones

How Delivery Zones Will Reduce Freight Traffic, E. Amberg. Am. City, vol. 19, no. 3, Sept. 1918, pp. 179-180, 2 figs. Feature of plan being worked out by U. S. Railroad Administration to reduce congestion of freight traffic in New York.

Freight Handling

Reorganization of Loading and Unloading, C. H. Humphreys. Motor Traction, vol. 27, no. 705, Sept. 4, 1918, pp. 165-168, 2 figs. Suggests forms of standard chassis which can be fitted with two or three standard type bodies, and apparatus for loading and unloading certain classes of goods.

WOOD AND TIMBER

Decomposition

Durability of Untreated Piling Above Mean Low Tide, C. H. Teasdale and M. E. Thorne. Ry. Gaz., vol. 29, no. 10, Sept. 6, 1918, p. 257. Report on protection afforded to timber by saturation above water level. Prepared by questionnaire method at U. S. Forest Products Laboratory.

Fungi, the Cause of Decomposition of Timber, P. H. Dudley. Wood-Preserving, vol. 5, no. 3, July-Sept. 1918, pp. 26-35, 10 figs. Brief details of the life history of trees and fungi.

Pipes

The Possibilities of Creosoted Douglas Fir Wood Stave Pipe for Use in Irrigation and Water Supply Systems (II), O. P. M. Goss. Wood-Preserving, vol. 5, no. 3, July-Sept. 1918, pp. 37-38, 1 fig. Experimental work in perforating outer surface of staves with small holes systematically spaced.

Poles

Economics of Pole Timber, Ernest F. Hartman. Elec. World, vol. 72, no. 13, Sept. 28, 1918, pp. 590-591, 1 fig. Preservation of poles and arresting of decay in advanced stages.

Maintenance Cost of Poles, W. F. Goltra. Wood-Preserving, vol. 5, no. 3, July-Sept. 1918, pp. 35-36. Table showing discounted value of annual return of one pole, obtainable for 1 to 55 years.

Uses

The Uses of Wood. The Place of the Wooden Roof in Civilization (IV). Am. Forestry, vol. 24, nos. 296 and 297, Aug. 1918 and Sept. 1918, pp. 473-482, 15 figs., and pp. 533-541, 21 figs. Various phases of subject, from beginnings in the forests through processes of logging, lumbering, transportation and milling, considering details in field of utilization and manufacture of wood.

See also Fuels and Firing (Wood); Pipe (Wood); Roads and Pavements (Wood-Block Pavements).

WOODWORKING MACHINERY

Propeller-Shaping Machine

Aero-Propeller Shaping Machine. Can. Machy., vol. 20, no. 8, Aug. 22, 1918, pp. 227-228, 2 figs. Ransome-Kerr machine which works by copying the profile of a model blade.

VARIA

Abaci

The Construction of Abaci, A. B. Eason. Elecn., vol. 81, no. 2100, Aug. 16, 1918, pp. 339-341, 6 figs. How to draw up abaci for use in solving various common engineering problems without using tables and slide rules.

Automobile Insurance

List of References on Automobile Insurance in the Library of the National Workman's Compensation Service Bureau. Reference List No. 5. A short bibliography.

Diamonds

The Diamond, Charles Parsons. Sci. Am. Supp., vol. 86, no. 2225, Aug. 24, 1918, pp. 124-126, 12 figs. Theories and experiments in forming artificial gems. From lecture before Inst. of Metals, published in The Engineer (London).

Education

Broader Foundation Demanded for Engineering Education, Frederick Bass. Eng. News-Rec., vol. 81, no. 13, Sept. 26, 1918, pp. 582-583. Higher aims also needed; students' longings not met: vision of great practitioners should guide educators.

The Engineer and the War, M. E. Cooley. Jl. Engrs. Club of St. Louis, vol. 3, no. 4, July-Aug. 1918, pp. 211-213. Tabular presentation of output of all engineering schools of United States since 1895. From Michigan Tecanic.

Electrical Industry

Business Conditions in the Electrical Industry. Elec. Rev., vol. 73, no. 10, Sept. 7, 1918, pp. 363-384. A summary of views obtained from leading manufacturers and jobbers regarding present conditions in industry and outlook for the future.

Engineers, Legal Status

Legislation Concerning the Status of Engineers, F. H. Peters. Jl. Eng. Inst. of Can., vol. 1, no. 5, Sept. 1918, pp. 217-220 and (discussion) 220-221. Account of work done by Inst. toward establishing some legal standard and make it possible to control organization.

Foreign Markets

Testing the Buying Power of a Foreign Market, L. W. Schmidt. Am. Mach., vol. 49, no. 13, Sept. 26, 1918, pp. 581-584. Suggestions as to ways of estimating probable markets to see whether it will pay to send representatives; sources of information and how it can be judged and collated.

Latitude Determinations

Common Methods of Determining Latitude and Azimuth Useful to Engineers and Surveyors, Harry J. Wolf. Quarterly of the Colo. School of Mines, vol. 13, no. 3, July 1918, pp. 3-13. Latitude by observing altitude of sun at noon or that of polaris at culmination; azimuth by altitude of sun, or equal a. m. and p. m. altitudes of sun, by polaris at elongation culmination or any hour-angle.

Microtelescope

Optical Devices Aid Science and Industry. Can. Machy., vol. 20, no. 9, Sept. 5, 1918, p. 301, 5 figs. Recently produced microtelescope consisting of a microscope of ordinary construction carrying a short-focus telescope objective and tube below the stage.

Pole Stubs, Driving

Driving Pole Stubs with Motor Truck. Telephony, vol. 75, no. 9, Aug. 31, 1918, p. 27, 3 figs. How reinforcing piles were driven to a depth of 14 ft. alongside poles of toll line which passed through a section of silty ground.

Salesmanship

Engineering Salesmanship, Charles W. Hunt. Machy., vol. 25, no. 1, Sept. 1918, pp. 7-8. First principle of salesmanship; qualifications of a good engineering salesman; importance of personality: resourcefulness; investigation of complaints; inside support; post-war conditions. From paper before Manchester Assn. of Engrs.

BRITISH ENGINEERING STANDARDS ASSOCIATION

Papers on Standardization Work of This Important Association, with Special Reference to Screw Threads, Screw-Thread Gages and Tolerances

IN view of the standardization work in process by the Screw-Thread Commission of the United States Department of Commerce, the Machine-Shop Session of the Annual Meeting on Wednesday, December 4, will be devoted mainly to the production and testing of screw gages and standardization work in this connection. The work of the British Engineering Standards Association is reviewed in the following papers and a paper by Frank O. Wells, on the production of gages, is also given in this number. In the November issue appeared a paper by H. L. Van Keuren of the U. S. Bureau of Standards on methods of testing and standardizing gages.

SUMMARY OF THE WORK OF THE ASSOCIATION

By C. le Maistre,[1] London, England

THE insistent demand created by the war for the maximum output of manufactured material in the minimum of time has naturally brought to the fore those means by which economy in production can be effected, and in this way standardization is coming into its own. Indeed, standardization in the engineering world has become almost a word to conjure with, but like all good things, it must be taken in moderation, and the standards recommended must, by a process of periodic revision, be kept abreast of invention and progress; otherwise there is the danger of standardization becoming crystallization.

It may fairly be said that the primary objects of standardization are to secure interchangeability of parts, to cheapen manufacture by eliminating the waste of time and material entailed in producing a multiplicity of designs for one and the same purpose, and also to expedite delivery and so reduce maintenance charges and stores.

Seventeen years ago, however, neither the necessity nor the value of work of this character and still less its intimate relation to economy and speed of production was at all generally recognized, and it was to remedy the chaotic state of things then existing in the engineering industry of Great Britain that the late Sir John Wolfe Barry, K. C. B., F. R. S., in 1901 took the initial steps, when he brought the subject to the notice of the Council of the Institution of Civil Engineers, which resulted in the formation of the British Engineering Standards Committee.

From its inception certain definite principles have governed the work of the Committee, amongst which may be placed in the forefront the community of interest of producer and consumer, which is, in fact, the corner stone of the organization. It was also realized that the Committee should not be an academical body, but an industrial organization in the closest touch with practical requirements and modern scientific knowledge and discovery; that it should only undertake standardization to meet recognized wants, and then only at the request of the principal interests concerned; that it should confine itself to setting-up standards, leaving it to the user to satisfy himself by inspection and supervision that the standards were being adhered to; and, most important of all, that periodic revision of the standards should be undertaken so that improvements might be incorporated, the various industries thus being prevented from becoming stereotyped and their methods hidebound.

From the small nucleus of seven members who formed the original Committee, a far-reaching organization has developed with some 160 committees, sub-committees and panels, including in all over 900 members and dealing under one central authority with standards relating to practically the whole field of engineering. Thus for many years past, the British Engineering Standards Association, as it is now called, has provided the neutral ground upon which the producer and the consumer, including the technical officers of the large spending departments of the Government and the great classification societies, have met and considered this subject of such vital interest to the well-being of the engineering industry of the country.

To the observance of the democratic and progressive principles outlined, coupled with the devoted labor of its members freely giving their time and experience to the work, often at great personal expense and inconvenience, may be attributed the increasing success of this work of growing national importance.

A large number of British Standard Specifications and Reports have already been issued and these are constantly being added to, the most recent additions being the specifications for aircraft material and parts drawn up at the request of the Department of Aircraft Production of the Ministry of Munitions, for whom the Association acts practically as the Departmental Specifications Committee.

The standardization of steel sectional material was the first work taken up by the Committee. The British standards for this material, so important in the construction of ships, bridges and underframes for railway wagons, have had a very wide adoption. The total number of sections is some 175, and the recently formed Mercantile Section of the Admiralty, as a war measure, was able to select from this list a largely reduced number and so put into operation an exceedingly economical measure with but little delay. The testing requirements of Lloyd's Register and the other great classification societies and the Board of Trade have been unified through the work of the Committee.

It would appear from the steelmakers' returns for 1913 giving the tonnage of lengths rolled of each section that 95.7 per cent had been produced by standard rolls and only 4.3 per cent by non-standard rolls, the work thus having proved of immense utility to the steelmakers.

In the case of tramway rails, standardization has had the result of reducing to a minimum the sections required; at the present time there are only five standard sections as against over 70 sections prior to the advent of the committee. These sections are now being reduced to three, one being a special section for interurban tramways operating at a higher speed than those of the towns.

As a further instance of the benefit of the Committee's labors may be mentioned the standard specification for Portland cement, which is practically universally adopted throughout the country.

In regard to the electrical industry, the most important piece of work has been the issue of standardization rules for electrical machinery, in the drafting of which much benefit has accrued through the close and very cordial coöperation of the Standards Committee of the American Institute of Electrical Engineers.

A large amount of standardization has been effected also for the automobile industry, especially in regard to the special steels used.

From time to time Government Departments have called upon the Standards Committee to carry out work for them, as, for instance, in the case of the Ministry of Munitions in relation to the question of screw-thread tolerances and the gauging of screws generally. Then the Indian Government requested the Committee to undertake the question of standard designs for loco-

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motives, and these have proved of immense value. The Road Board also asked the Committee to draft specifications for road material. As already mentioned, at the request of the Department of Aircraft Production, the Association is dealing with the specifications for aircraft materials and parts as a war measure for the Department. To carry on this important work a large number of sub-committees have been formed, consisting of officers from the technical, supply and inspection departments, together with representatives from the various trade organizations concerned; the specifications in this case are not published by the Association in the ordinary way, but are issued to the Department of Aircraft Production, by whom they are sent to the various manufacturers of aircraft material on the Government list, in this way becoming obligatory.

In regard to the question of finance, the funds for carrying out the work of the Committee have been provided by the Government and the industries concerned. In 1903 the Government included in the estimates a substantial contribution, which was subsequently extended for the years 1904-5-6 by a grant-in-aid equal to the amount contributed by the supporting institutions, manufacturers and others. This was continued on a smaller scale down to 1916, and a further grant on the same condition is being continued to March, 1919. The Indian Government has been a generous supporter of the Committee and the Governments of other Overseas Dominions have also given financial assistance. A liberal response to the Committee's appeal for funds has been made by the engineering industry of the country and also by railway, shipping and other companies, and by some of the Local Government Boards and the tramway and electricity authorities.

The expenses of the whole organization up to the war were under £4000 a year, but, owing to the widening of the field of its labors, this amount has been very greatly exceeded.

The Committee, as many are aware, has recently become incorporated as an Association, under license of the Board of Trade, in order to enable it in the first place to continue the work carried out by the Engineering Standards Committee, viz. to coördinate the efforts of producers and users for the improvement and standardization of engineering materials, and, secondly, in order to secure undisputed legal right to its mark or brand to be attached by manufacturers to their products as a hall-mark of goods made in accordance with the British Standard Specifications.

The chairman of the Association is Sir Archibald Denny, Bart., who succeeded the late Sir John Wolfe Barry, to whose guiding hand during the many years of his chairmanship, so much of the success of the movement is due.

The Main Committee, as the governing Committee is called, consists of members nominated by the leading technical institutions, viz., the Institution of Civil Engineers, Mechanical Engineers, the Iron and Steel Institute, the Naval Architects, and the Institution of Electrical Engineers; there are also two representatives of the Federation of British Industries; and three members, not representative of any institution or association, but elected for their eminence in the profession.

The members of the Federation of British Industries give the various trade organizations connected with the work of standardization a direct channel through which to place their views before the Main or executive Committee of the Association.

Rotation of office is provided in that the chairman and vice-chairman and one-third of the group of members retire annually being eligible for reelection.

The Main Committee is the sole executive authority and all specifications and reports are presented to it for final adoption. The procedure before embarking on any new subject is to ascertain by means of a representative conference that there is a volume of opinion favorable to the work being undertaken. If such is the case, the Main Committee nominates the chairman of a sectional committee to take up the work in question, this committee being formed of technical officers representative of the various Government Departments interested, representatives of the trade organizations concerned, and lastly experts in the subject to be dealt with. The Main Committee does not dictate in any way either the number of members or the personnel of the sectional committee, only reserving to itself the right to nominate the chairman, though naturally it is guided in this matter also by the advice of the members.

Although the activities of the Association have in the main been confined to the home country, a considerable amount of work of an international character has been undertaken. At the present time the Association is coöperating with the American Institute of Electrical Engineers in several directions in regard to electrical apparatus generally. Then there is the great question of the standardization of screw threads and also of milling cutters and small tools, in connection with which The American Society of Mechanical Engineers will be able to render most valuable assistance. Indeed, there is a wide field for Anglo-American agreement on engineering standardization generally and the Association looks forward to a large measure of intimate coöperation with this object in view.

In connection also with its labors outside the home country, the Association is developing a scheme for assisting in procuring the wider dissemination of British Standards, and is undertaking the translation of its more important reports into various foreign languages, as well as setting up, with the assistance of the Overseas Department of the Board of Trade, Local Committees of British Engineers and Traders in some of the more important trading centres of the world.

That the value and utility of the work of the Association is becoming more and more recognized both at home and abroad is evidenced by the amount of new work it is continually being invited to undertake as well as by the inquiries received from all parts of the world both with reference to the standards and to the organization itself.

The most recent addition to the Association's activities is that of the standardization of the details in the construction of ships and their machinery. A conference recently convened at the instance of the Board of Trade, and representing Government Departments, shipowners, shipbuilders and engineers, classification societies and consulting and naval architects, has unanimously decided to recommend to the Main Committee the setting up of a complete section to deal with this branch of engineering, in which, in common with all others, economic production, fostered by interchangeability of detailed parts, is of such vital importance.

This brief account will, it is hoped, be sufficient to show that throughout the Empire, British Standards are receiving increased recognition as being of direct utility to the engineering industry generally. Standardization, after all, is no more and no less than proper coördination. To effect it may necessitate the sinking of much personal opinion, but, if its goal, through wideness of outlook and unity of thought and action, is the benefit of the community as a whole, standardization as a coördinated endeavor is bound increasingly to benefit humanity at large.

Technical Paper 178 of the U. S. Bureau of Mines, by S. M. Darling, which has been recently issued, deals with the characteristics and utilization of lignite. There are considerable lignite deposits in the Dakotas and Minnesota, yet the greater part of the fuel used in these states is imported from distant coal fields, involving long hauls. Mr. Darling's notes are intended to point out some of the ways in which that fuel may be used economically. It cannot be used in its raw form, except in the immediate neighborhood of the mine, because it contains 30 per cent of moisture. Instead, it must be modified so as to produce several products, each adapted to a particular commercial need, such as: Dried lignite for use with stokers or in gas producers; powdered fuel for use in furnaces, kilns and locomotives; dried briquets for large hand-fired industrial furnaces; carbonized lignite for use in suction producers; carbonized lignite briquets for use in domestic stoves and furnaces; and sulphate of ammonia and producer gas as obtained by the Mond process.

This publication gives much information as to the by-products obtainable from lignite and will be of value to those studying the problem of utilizing lignite as fuel.

THE WORK OF THE BRITISH ENGINEERING STANDARDS ASSOCIATION ON SCREW THREADS AND LIMIT GAGES

By SIR RICHARD GLAZEBROOK,[1] C.B., F.R.S., TEDDINGTON, ENGLAND

THE following notes give a résumé of the work done by the British Engineering Standards Association in connection with screw threads and limit gaging.

The importance of problems dealing with limits and gages was recognized at an early date by the Main Standards Committee, which appointed a Committee on Screw Threads and Limit Gages in February 1903. Two years later, after 23 meetings at which careful inquiries were made, and the merits of various threads, in particular of the Sellers Thread, were studied, the Committee finally decided that:

Having regard to the evidence laid before the Committee, and to the fact that the Whitworth thread is in general use throughout the country, the Committee do not recommend any departure from this form of thread.

It appeared, however, that there was a very general demand for a series of screws having finer pitches than those of the Whitworth form, and this led to the introduction of the British Standard Fine, B.S.F., series of pitches.

The Report contains tables giving the standard dimensions of these two series of screw threads, B.S.W. and B.S.F., and also of the British Association Series. It contains besides the following definitions:

Tolerance. A difference in dimensions prescribed in order to tolerate unavoidable imperfections of workmanship.

Allowance. A difference in dimensions, prescribed in order to allow of various qualities of fit.

Clearance. A difference in dimensions, or in the shape of the surface, prescribed in order that two surfaces, or parts of surfaces, may be clear of one another.

Effective Diameter of a Screw. The effective diameter of a screw having a single thread is the length of a line drawn through the axis and at right angles to it, measured between the points where the line cuts the slopes of the thread.

Core Diameter. The core diameter is twice the minimum radius of a screw, measured at right angles to the axis.

Full Diameter. The full diameter is twice the maximum radius of a screw, measured at right angles to the axis.

Crest. The crest is the prominent part of the thread, whether of the male screw or of the female screw.

Root. The root is the bottom of the groove of the thread, whether of the male screw or of the female screw.

Slope of Thread. The slope of thread is the straight part of the thread which connects the crests and roots.

Angle of Thread. The angle of thread is the angle between the slopes, measured in the axial plane.

Pitch. The pitch is the distance in inches measured along a line parallel to the axis of the screw between the point where it cuts any thread of the screw and the point at which it next meets the corresponding part of the same thread. *The reciprocal of the pitch* measures the number of turns per inch or millimetre as the case may be.

Initial Report on Screw-Thread Tolerances

The Committee next turned its attention to limits for plain cylindrical work and to limit gages for screw threads. The preparation of reports on these subjects involved a long series of experiments and measurements, many of which were carried out at the National Physical Laboratory.

The object of specifying tolerances was to secure interchangeability, and a little consideration showed the Committee that the element whose error most seriously affects interchangeability is the pitch; attention was drawn to the fact that the consequences of an error in pitch manifest themselves not only in the direction of the axis, but also at right angles to it, and it was shown that with an angular thread of angle α, a bolt and a nut of t inches in thickness, having a relative difference of pitch of p mils per inch, must have a difference of effective diameter of $pt \cot \alpha/2$ mils, in order that they may go together; pt clearly measures the total pitch difference of the screw and nut in the length engaged, so that the importance of the pitch error per length of engagement was appreciated from the commencement of the work. In the case of the Whitworth thread, $\alpha = 55$ deg., and $\cot \alpha/2$ is approximately 2, so that the rule was formed that for a screw of faulty pitch to pair with a perfect nut, the effective diameter must be reduced by twice the pitch error per length of engagement.

In the words of the report, the Committee had before them two separate matters to decide:

a To lay down tolerances on full core and effective diameters to cover the wear of tools and unavoidable imperfections of measurement, and to prescribe minimum allowances in order that bolts and nuts may be assembled freely.

b To decide what errors in pitch could be permitted in ordinary practice, having regard to the allowances in effective diameter which they entail.

The report contains the answers to these questions. Formulæ are given for the various tolerances and allowances, and a table of values worked out for the two series of threads.

Table 1 gives the tolerances for bolts $\frac{1}{4}$ in., $\frac{1}{2}$ in., 1 in., 2 in. and 3 in. in diameter for B.S.W. threads.

Further Investigations of Tolerances

No further investigations were undertaken until the comparatively recent reorganization of a Sectional Committee on Machine Parts, their Gaging and Nomenclature and a Sub-Committee on Screw Threads for all purposes and their gaging.

War conditions have increased enormously the demand for interchangeable screws, while the experience gained has enabled a clearer idea to be formed of the real essentials of interchangeability and of the difficulty of securing them. It has become increasingly clear that fit at crest and root is in most cases unimportant. Large tolerances can be given on these dimensions: some authorities think it desirable to prescribe actual clearances, i.e., to formulate such dimensions that the bolt and nut can never come into contact at these points. In any case, it is agreed that for the work, an adherence to the exact amount of rounding at crest and root specified in the Whitworth thread is not needed. The elements which do matter are the pitch and the effective diameter: i.e., the lead and pitch diameter, to use the American terms, and also, to a less degree, the angle. The conditions applicable to munitions, guns, shells, fuses, etc., are somewhat special, and for these stores the tolerances possible have to be fixed in each individual case, but there is a very large demand for bolts and nuts, studs, and the like, using in most cases the finer series of pitches, and experience soon showed that the tolerances fixed by the Committee were too small. These various factors led to a reconsideration of its decision, with the result that a new report on British Standard Fine Threads and their Tolerances, was issued in June last. Corresponding reports on the Standard Whitworth Series B.S.W. Threads, and the B.A. Threads are in course of preparation, and it is hoped will appear very shortly.

Form of Thread

The question of the form of the thread was considered with great care, and the Committee had the advantage of discussing the series of pitches and other points of importance with the American Commission on Standardization of Aircraft Parts. It was clear to all that without deciding on the merits of the case it was impossible under existing conditions to alter the B.S.F.

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series of pitches, and it also appeared that provided the pitches were the same the 5 deg. difference in angle between the English and American threads would not prevent a very considerable degree of interchangeability. This conclusion has been substantiated by measurements since made on both sides of the Atlantic.

As to the form of thread, the evidence collected showed that, provided no close limits are placed on the exact curvature at crest and root, the rounded Whitworth form had distinct advantages from the manufacturing standpoint. The alteration suggested was the flattening of the crests in accordance with the theoretical Sellers thread. Further experience and measurement show distinctly that in practice the crests of American threads are frequently rounded, while it is agreed on all sides that rounding at the roots is essential to strength. Rounding at the roots is produced naturally by the wear of a sharp-pointed tool, and it appears probable that the radius selected by Whitworth (Radius $= 0.137\ p$, where p is the pitch) represents the stable condition reached by a pointed tool after some slight use.

Much the same is true at the crest; the difficulty of making a die with sharp corners that will stand wear is well recognized.

The Committee, therefore, decided to adhere to the Whitworth form, but without insisting on the exact curvature at crest and root so far as the work is concerned. In the case of a gage, however, their conclusion is that the theoretical form must be followed and attention given to the curvatures.

Tolerances on Form of Thread

It remained then to consider the tolerances. The measurement at the National Physical Laboratory of bolts and nuts made in the ordinary course of the work, and especially of aircraft and other similar parts, during recent years had afforded valuable information of the accuracy attained by manufacturers, as well as of that needed for interchangeability.

In dealing with tolerances it is convenient, whenever possible, to base them on a formula connecting them with the other dimensions on which they depend. For screw threads these are the pitch of the screw and the diameter of the cylinder on which it is cut—for a screw of given form the depth of the thread and the curvatures at crest and root are all proportional to the pitch. For the B.S.W. or B.S.F. series of bolts and nuts the pitch is definitely related to the diameter, and it appeared best to treat the tolerances as depending on the pitch only.

TABLE 1 BRITISH STANDARD WHITWORTH SCREW THREADS

Tolerances for Bolts

Nominal Diameter of Screw	No. of Threads per in.	Pitch	Tolerance on Pitch per in. length of Thread	Full Diameter			Effective Diameter			Core Diameter		
				Max.	Tolerance	Min.	Max. for a Screw of Correct Pitch	Tolerance	Min.	Max.	Tolerance	Min.
In.		In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
1/4 (0.25)	20	0.05000	0.0035	0.2500	0.0018	0.2482	0.2180	0.0018	0.2162	0.1860	0.0023	0.1837
1/2 (0.5)	12	0.08333	0.0030	0.5000	0.0025	0.4975	0.4466	0.0030	0.4436	0.3933	0.0032	0.3901
1	8	0.12500	0.0025	1.0000	0.0035	0.9965	0.9200	0.0050	0.9150	0.8399	0.0045	0.8354
2	4.5	0.22222	0.0021	2.0000	0.0050	1.9950	1.8577	0.0084	1.8493	1.7154	0.0064	1.7090
3	3.5	0.28571	0.0019	3.4000	0.0060	2.9940	2.8170	0.0114	2.8056	2.6341	0.0078	2.6263

Mr. Sears, Superintendent of the Metrology Department of the National Physical Laboratory, was able to show that tolerances proportional to $\sqrt{p}$, p being the pitch, agreed very closely with those found to work well in practice over a large series of pitches, certainly over the whole range covered by the B.S.F. and B.S.W. series, and indeed some way into the B.A. series. He showed further that the quantity $0.01\ \sqrt{p}$, p being measured in inches, was a convenient unit of tolerance, and that the tolerances suitable for the B.S.F. series were all given by some small multiple of this quantity. Accordingly, for ordinary work, the Committee has specified the tolerances given in Table 2, while for finer work a table of close fits, having half the above tolerances, has been adopted.

These tolerances are all negative on the bolt, positive on the nut, so that theoretically a bolt, if within the tolerances, should always pair with the corresponding nut, even if in the table of dimensions the maximum dimensions of the bolt are the same as the minimum dimensions of the nut, the dividing line being the theoretical form. But it is not possible to secure this in all cases. The gages used to test the work have their own tolerances, and are also subject to wear. To overcome these difficulties, an allowance of 2 mils is specified everywhere between the largest bolt and the smallest nut.

It seems probable that in the case of the close fits this will need reconsideration; for many purposes it is more important to secure a tight fit than to have complete interchangeability among a large series of bolts and nuts, and, with the figures given in the table, when the maximum nut is paired with the minimum bolt, and the pitches and angles of the two happen to be identical, the fit will be a slack one.

Tolerances in Pitch and Angle

It will be noted that the tables do not specify tolerances in pitch and angle; it has been pointed out already that in the case of a bolt an error in pitch can be compensated by a reduction of effective diameter of approximately twice the total pitch error; an error in angle can be compensated in the same manner. It is a necessary condition then for a bolt that the total reduction in effective diameter required to compensate the errors of pitch and angle must never exceed the permissable tolerance on effective diameter; a similar condition holds for a nut.

A simple graphical method of calculating the effective diameter equivalents of the pitch and angle errors has been devised by Captain Bishop, while a simple mechanism for applying Captain Bishop's method has been developed at the National Physical Laboratory. Denoting by x the effective diameter error, y and z the effective diameter equivalents of the pitch and angle errors, Captain Bishop introduced the term "grade" to denote $x+y+z$, the sum of these three; it will be found to measure the difference in diameter between the standard nut and a bolt of standard form which would just pair with a nut of the same dimensions as the bolt in question; the play, meaning thereby the lateral shake between the given bolt and a standard nut, is measured

TABLE 2 TOLERANCES IN TERMS OF PITCH

	Full Diameter	Effective Diameter	Core Diameter
Bolt........	$3 \times .01\sqrt{p}$	$2 \times .01\sqrt{p}$	$4 \times .01\sqrt{p}$
Nut........	$4 \times .01\sqrt{p}$	$2 \times .01\sqrt{p}$	$3 \times .01\sqrt{p}$

by $x-(y+z)$. For some purposes it is found convenient to specify screws by their grade and play. The grade indicates in a general way the difference between the bolt and the standard; the play gives a measure of the slackness of fit.

It has been pointed out already that the pitch error with which we are concerned is not the error per pitch or per unit length, but the total error in the length of thread engaged; the error per pitch which is permissible then will depend on the number of threads engaged, and the manufacturer who desires to know whether a tool cutting threads with some definite errors per pitch will cut a screw up to the specification, requires also to know the length of thread engaged. The Committee are now engaged on a series of tables which will give the corrections in effective diameter required to compensate pitch and angle error.

Gages and Gaging

The importance and difficulty of the question of gages and gaging have been before the Committee almost since its inception, and the principles on which it depends have been often stated.

The gaging of plain cylindrical surfaces is a simple matter; to gage a ring a go and a not-go plug suffice; for a shaft we need either go and not-go rings, or go and not-go snap gages. But for a complicated form like that of a screw, the matter is far from simple; the screw is made up of many elements, and each needs separate consideration. A little investigation shows, however, that for exact work the go gage must gage all the elements simultaneously, while each element requires a separate not-go gage. Thus, for a screw there are seven elements: Full diameter, core diameter, effective diameter, pitch, angle of thread, radius at crest, radius at root.

In symmetrical threads like the Whitworth, the last two elements are the same. The go gage insures that the work nowhere oversteps the theoretical boundary; the not-go gages confine the tolerances on the various elements within the specified values. If interchangeability alone is to be gaged, and a more exact knowledge of the errors of the various elements is not required, the not-go gages can usually be reduced to the first three. The form at root and crest is immaterial, provided the full and core diameters are not too greatly reduced: The go gage insures that the standard boundary is nowhere overstepped. The go gage also insures that the reduction in effective diameter has been sufficient to compensate the errors, if any, in pitch and angle, while the not-go effective-diameter gage provides that the effective diameter is not less than is tolerated in the tables. Thus, a complete go gage and three not-go diameter gages are needed.

It is easy to provide gages for the full and core diameters: In the case of plugs a simple ring, or a suitable snap gage, suffices; for nuts a plain cylindrical plug gages the core diameter; the full diameter is tested by a screw gage having one or two turns, with a very thin thread arranged to bear on the full diameter only. The effective diameter of a nut can be gaged by a screw plug of one or two turns, cleared at the roots, and with the crests ground off so as to bear only on the slopes of the threads; while for the effective diameter of a plug a ring gage bearing only on the slopes is available. A design of effective-diameter gage which is satisfactory and not too complicated has not, however, been found as yet, and the Committee are still giving the matter careful consideration. One of the difficulties is that of inserting the gage: an incorrect thread on a piece of work may be burred or contracted at the end at which the gage enters; it rejects the gage and is apparently correct, whereas had the gage passed the obstruction it would easily also pass the whole of the rest of the screw, which should therefore fail. To overcome this, various forms of expanding gages are under trial at present. The fact that it is necessary for the go gage to be complete in all its elements adds greatly to the difficulty of making gages. It is sometimes suggested that in the case of a ring gage used for bolts it is sufficient to clear the gage at the roots of the thread, and check the full diameter of the work with an ordinary ring gage. In the case of the Whitworth thread with rounded crests this is inadmissible for two reasons: (1) There is no security that the work in the neighborhood of the crest does not overstep the theoretical shape, and in this case it would not enter a nut of correct dimensions, and (2) there is no means of determining the concentricity of the various parts of the thread.

In the case of a flat-topped thread, the first difficulty does not occur; provided the parts of the thread are concentric the two gages give the necessary boundary exactly, but the second difficulty still holds. Concentricity can only be tested by a gage of complete form, and the construction of such a ring gage with flat roots is more difficult than that of one with the roots rounded to the Whitworth curvature.

Methods of gaging such as have been described are practicable enough when dealing with a limited amount of work; they become tedious, and, so far as effective diameter is concerned, not very satisfactory when dealing with masses of stores as in munitions work or the ordinary commercial supply of nuts and bolts. For bolts a method of gaging by projecting the image of the work on to a screen carrying an accurate magnified drawing of the screw under test has proved rapid and effective, and apparatus for this is in use in many factories.

Another method consists in keeping a careful watch on the tools employed, being assured that so long as they remain correct within certain limits the work they turn out will come up to specification. Most valuable work in this direction is being done by the Panel on Taps Sub-Committee, which is investigating the methods of measuring taps, the conditions that connect the size of a tap and that of the hole it taps, the limits within which taps must lie in order to give specified results and the like, and in due time the result of the work will be available. The Panel will also deal with dies and chasers.

Tolerances on Gages

Another series of questions is raised by the consideration of the tolerances to be allowed on gages; as a rough rule we expect these to be from 1/5 to 1/10 of the tolerances on the work. Their sign, however, depends on the purpose for which the gage is required.

Six classes of gages are recognized:

Standard gages, for depositing with a recognized authority; reference gages, for use by manufacturers; inspection gages, used by inspectors to check the accuracy of the work and determine if it is within the limits laid down; shop gages, used in the workshop to control manufacture; check gages, for verifying the accuracy of other gages; and master gages, used only in the manufacture of, or for the purpose of verifying, check gages.

Testing and Measuring Gages

The demand for munitions gages has led during the past few years to an important development of the methods of testing and measuring gages.

Until recently gages of all kinds have been dealt with at the National Physical Laboratory at the rate of about 10,000 a week; at present over 2,000 screw gages are being tested weekly.

Machines have been devised at the Laboratory for the rapid performance of the measurements required. In the case of a plug gage the diameters and pitch are all measured in suitable machines, the form of the thread is examined in a projection apparatus and the concentricity is tested by the use of a complete ring gage.

For a ring gage the diameters are checked by suitable go and not-go gages, the pitch is measured and the form is verified by taking a cast and examining it in the projection apparatus.

Through the coöperation of the industrial power plants which have thus far put into force the standard recommendations of the United States Fuel Administration to promote efficiency in the use of fuel, a saving of 7,000,000 tons annually has been effected. That is to say, in the first six months from the announcement of the national program, 3,500,000 tons have been conserved, at the same time maintaining maximum production in the factories. The largest savings have been in Massachusetts, Pennsylvania, Connecticut, Illinois and New York.—*Power*, Nov. 12, 1918.

PRESENT PRACTICE IN THREAD-GAGE MAKING

By FRANK O. WELLS,[1] GREENFIELD, MASS.

THE manufacture of thread gages brings in all the difficulties of any thread product, multiplied according to the degree of accuracy required. The usual methods of making threads must therefore be refined and improved, and at the same time standardized for manufacturing purposes.

Correcting Lead Screw

Given the blank for a thread plug gage, centered and turned, the real trouble begins with chasing the thread. A lead screw should be as accurate as the product to be turned out by it. Errors in lead screws are of two kinds—errors in lead over a considerable length of the screw, and local errors from thread to thread. If, as is often the case, the lead screw was made for ordinary work instead of for precision work, its lead or pitch will

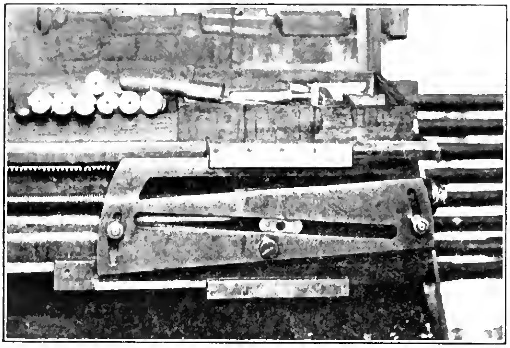

Fig. 1 Lead-Adjusting Attachment for Lathe

be irregular to a greater or less extent. The total deviation of the lead screw must then be determined, and the lead-adjusting attachment (Fig. 1), set to give the correct compensation.

The thread cut on a soft gage must always be slightly different from standard or finished pitch, by an amount equal to the expected change during hardening. This correction must also be made by the lead variator.

Adjusting attachments like that in Fig. 1 compensate fairly well for errors in the lead screw which are constant at any part of its length. They do not, however, take care of the trouble of "high and low" threads. In lathes used for thread-gage chasing the lead screw ought to be as perfect as possible from thread to thread and the ways of the lathe should be scraped accurately parallel and level so that the head and tail centers will be in line.

Chasing Tools

Given a fairly good lead screw, the next mechanical necessity is a good cutting tool correctly held. Such tools, with removable cutting blades, are shown in Figs. 2 and 3, one for inside and the other for outside chasing. It is a question whether a single cutting tool or a multiple-toothed chasing tool is better for this work.

The threading-tool blades in Figs. 2 and 3 are made to cut on a 20-deg. clearance angle. This clearance angle makes the actual included angle of the tool blade, normal to the straight cutting edge of the tool blade, 63 deg. and 8 min. The thread groove cut by a proper threading tool should preferably be from 15 to 30 min. sharp in order to facilitate the lapping operation. For all ordinary U. S. standard pitches the threading tool blade is set with its axis at right angles to the axis of the gage. It is only for Acme or similar very coarse thread work that it is necessary to incline the threading blade to a line parallel to the helix angle of the gage being threaded. When this helix angle is very steep it is necessary to modify the included angle of the cutting edge so that the angle cut, on a plane with the axis of the gage, will be as required by specifications.

A clearance channel is universally acknowledged desirable in a thread gage so that no chips lodging in the gage will bind between the gage and the thread crest of the tested thread and give a mistaken impression of a close fit.

There is great difficulty in getting men who are good at threading. Good threaders seem to be born, not made. The work requires a combination of brain, mechanical ability, sensitive touch, and above all, patience. Some otherwise good mechanics can never make good threaders. A green man with a phlegmatic temperament is a likely candidate for development. Few girls can be developed into handling fine threading—it requires just a little more mechanical sense than any appreciable number have had time to acquire.

With good men, fair lathes, the best cutting tools and the exercise of constant care, it is possible to get threading of gages

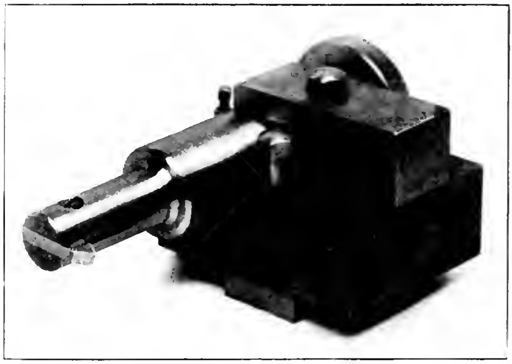

Fig. 2 Tool for Inside Chasing

down to a limit of accuracy which falls within the variations due to hardening. If a perfect contour of thread, and perfect angle, lead and walls could be secured when threading in a lathe, it would not be necessary to leave more than 0.0002 to 0.0006 in. oversize, knowing that hardening would increase this to from 0.0015 to 0.0020 in. Due to irregular swelling, shrinking and warping from thread to thread in the hardening, however, a certain amount of stock must be left on so that no point of the gage shall be distorted outside of the limits of the metal. If the thread, for instance, should take a quirk to the right so that its center line was displaced at the top of the crest by 0.0009 in., and the metal had been left 0.0015 in. larger than finished size, the reduction to finish could be made and still leave a complete crest.

Since a margin must be left for the vagaries of hardening, the necessary tolerance in lathe threading can probably be obtained by the precautions noted.

Formerly it was common practice to make the outside diameter of limit plug thread gages uniformly oversize in direct proportion to the oversize of pitch diameter. This practice was wrong because of the danger of the maximum or no-go plug forming contact on the outside diameter of the tapped hole and yet giving no indication as to the actual size of hole on the pitch diameter or the thread walls.

In view of the fact that both the go and no-go plugs are over

[1] President, Greenfield Tap & Die Corp.; Mem. Congressional Screw-Thread Commission; Mem. Am. Soc. M. E.

For presentation at the Annual Meeting, New York, December 3 to 6, 1918, of The American Society of Mechanical Engineers. The paper is here printed in abstract form and advance copies of the complete paper may be obtained by members gratis upon application.

basic or maximum screw size, they should both be provided with a minus tolerance below the minimum tapped-hole outside diameter, in order to assure that the gage will positively check the angular diameter. This can be done since there is no danger of the screw forming contact with the outside diameter of the tapped hole.

Hardening

The hardening question has always been the bane of threading. A series of tests made sometime ago by laboratories of manufacturing firms throughout the country demonstrated that threading on taps and dies can be gotten down to any reasonable limit of accuracy, but that this is not true of hardening. The inaccuracies in taps and dies, manufactured as is necessary by quantity methods, in general appear after hardening and are not present in the soft product. The same is true of gage threads, only of course the error involved is proportionally of more importance on such fine work.

During the process of hardening there is in the majority of cases an increase or swelling in diameter and a shrinkage in length, resulting in a shortening of lead, but the extent to which this occurs will vary in different pieces. Even with the quenching bath and the temperature of furnace kept uniform, the swelling in diameter in one set of duplicate samples of about an inch in diameter varied from 0.0008 to 0.0024 in., and the lead error varied from 0.0005 to 0.0025 in.

The only way to control this is to find a heat treatment and a quenching bath which will always give the same expansion and contraction under standardized methods of working and dipping, then see that the handling methods actually are standardized. And not only must uniform handling methods be followed, but the steel must be of uniform quality. For this reason it is necessary to have a supply of steel from which any piece may be taken and relied upon to act like every other piece. If such steel cannot be secured from the steel men, it is advisable to get the most uniform brand available and then standardize it still more by heat treatment.

Lapping

If the lathe work has been done correctly and the hardening without distortion the thread can be smoothed to a finish by lapping off not much more than 0.0002 in. Under ideal conditions, therefore, this would be the amount of oversize that would be specified for gages coming into the lapping room. A much neater and quicker job of cleaning the thread to size could then be done, and the cost of lapping would go down.

However, not only excessive oversizes but distorted pieces come into the lapping room. The lapping process can to a certain extent take out these inequalities as well as smooth the surface of the chased thread. It should be emphasized, however, that the lapping process is not for this purpose and that every correction that has to be made in the lapping costs excessively and slows up the other work. Lapping should not be depended upon to do correcting, but the threading should be in correct shape before reaching the lapping room.

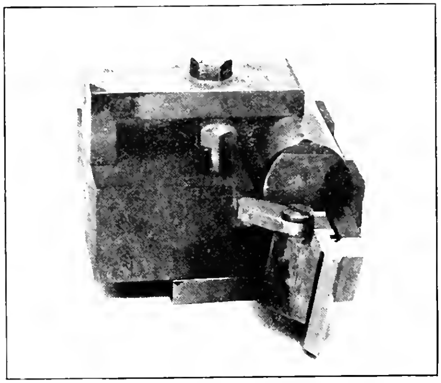

Fig. 3 Tool for Outside Chasing

If the angle of the thread is slightly too wide or narrow or tipped to one side, a skillful lapper can correct it. If the lead is a trifle too long or short, the lap can take it back to the proper length, by wearing the surface off on one side or the other of each thread. If the pitch diameter is too large, it can be worn down. But, of course, there is a limit to the amount that can be worn off by hand-applied friction, using the general form of thread as a guide, and still retain an accurate contour. It is practicable to take off a total of 0.0015 in. by lapping without spoiling the shape, if it is done carefully on only one gage. Therefore, allowing part of the overstock for smoothing, if the errors are not cumulative or all in the same direction, it is possible in lapping out 0.0015 in. oversize in diameter, to take care of an error of 0.0005 in. in lead and an error of 15 min. one way or the other in the angle.

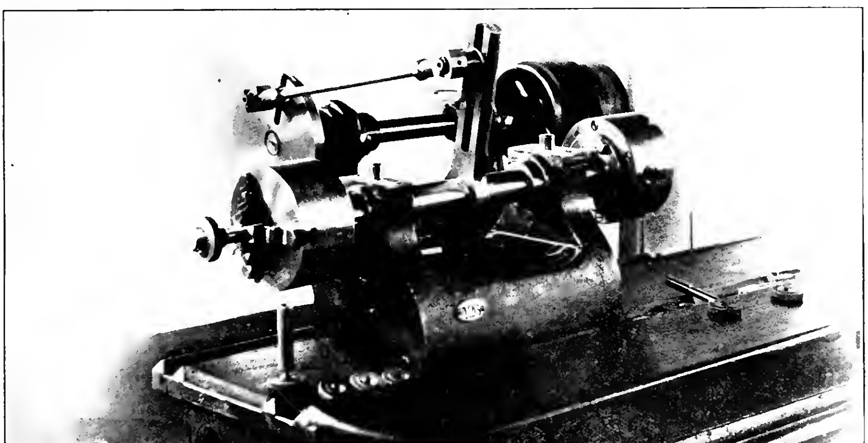

Fig. 4 Double Lapping Machine

Two forms of lapping machine for thread plug gages are

shown. In the best plug-lapping machines the plug is mechanically rocked back and forth through a fraction of a revolution, while the operative holds the lap still in one hand, encircling the plug. threaded more accurately than the gage which it is to correct. Flour of emery makes the most satisfactory lapping medium for thread gages, particularly for lapping the thread walls. Fifteen-

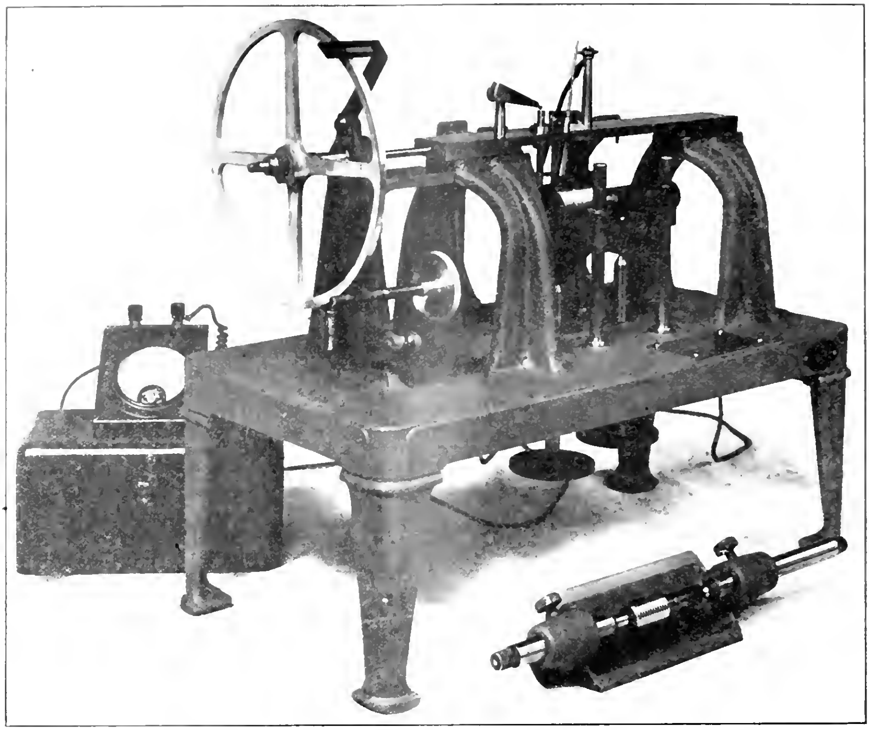

FIG. 5 BINGHAM POWELL LEAD-TESTING MACHINE

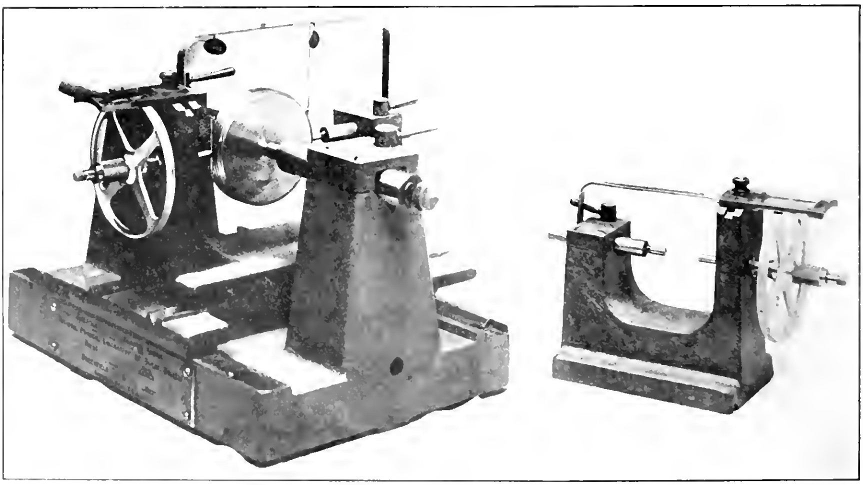

FIG. 6 MACHINE FOR TESTING PITCH

Since the operative might as well be using both hands, a double ended machine is provided, shown in Fig. 4.

Soft steel laps are most easily chased out smoothly and are the most durable. Some prefer cast-iron laps, however. The lap is an important part of the work; it must, of course, be

minute carborundum is satisfactory for lapping outside diameters. Sperm oil makes the most satisfactory medium for carrying the abrasive, chiefly because of its non-gumming quality and because at the same time it has more body than kerosene, which is quite commonly used.

Grinding Threads

Grinding out the inaccuracies in the larger-size threads is much more expeditious and cheaper than lapping them out. The problem of grinding threads becomes difficult, costly and impracticable, however, below a certain minimum size, in general, for the following reasons:

In grinding out a V-thread as near as practicable down to the theoretical triangular point, as is done in thread gages, there is intensified friction upon the delicate edge of the wheel and it wears away very quickly. It could not be used at all, were it not for the fact that the extreme edge of the wheel does not have to be maintained absolutely as an acute angle. On all practicable manufactured screw threads upon which the gage is to be used, whether U. S. S., International or Whitworth, at least the top eighth of crest is flattened or rounded off. Therefore, although the profile of the gage thread must be kept accurately straight along seven-eighths of the wall, the remaining eighth in the extreme root can be allowed to become a little rounded off, since it will not engage any part of the thread but will be used as a clearance space.

Now an eighth of a large pitch on a large diameter gives the wheel edge considerable margin for wear. The absolute length of this margin decreases toward the point in proportion as the pitch from thread to thread decreases, and soon the point is reached where the allowable eighth margin at the edge of the wheel wears away too fast for practicable replacement of wheels. One wheel should do at least one complete gage before needing to be trued at all, since the wheel cannot be taken out and put back in the same place with any success. This margin of wear on the wheel is now generally reached at a pitch of 16 threads to the inch, so that most gages below 5 16 in. pitch diameter have at present to be lapped out instead of ground.

There are other difficulties in the way of grinding small threads. On the average, the best thread-grinding wheel is about No. 150.H, as we find in our own work. For the grinding process, from 0.003 in. to 0.008 in. of stock should be left on a thread gage to enable the operative to set his wheel in the center of the thread by adjustment and trial, and also permit him to correct inequalities in lead, angle, or diameter due to hardening.

Out of 0.003 in. of stock he can increase or decrease the lead by 0.001 in., if the angle is already correct. Similar corrections in the other dimensions may be effected.

Work coming from the grinding room is then lapped smooth before it goes to the inspection room.

Inspection

Inspection in gage manufacture assumes an importance that it has in hardly any other branch of work. This is still more true of thread gages. The many dimensions that are on an apparently simple product require close attention to each separately and to all together.

To test the lead the Bingham Powell machine is a good instrument. The method of holding the gage, the micrometer wheel and vernier and the electric telltale which indicates proper contact of the measuring fingers and the thread, are shown in Fig. 5.

A testing machine fitted up with a slide rest in parallel so that only two wires are necessary is good for measuring pitch diameter, by aid of a micrometer reading. This machine is provided with two removable tables, one for large work and one for small, as shown in Fig. 6. To test the micrometer a set of Johansson blocks should be on hand, and finally to resolve immediately any doubts one might have as to the accuracy of a particular block or measurement, a good measuring machine should be on hand.

To examine the contour of the thread, the angle and the root, crest, and smoothness of wall, a projection machine as shown in Fig. 7, is the only proper thing. It instantly gives an enlarged silhouette of the thread, which speaks for itself, for the profile can be compared with pattern gages held upon the screen as in the illustration. The silhouette can also be photographed for transmission to a customer, by inserting a film or plate instead of the ground glass. Mechanism is provided for holding the gage, for focusing it and for turning it to the helix angle so as to get a symmetrical projection of the walls.

Sulphur casts of female threads can be taken in quick time and at small cost, and the contour examined in the same quick way. The method of pouring the melted sulphur into a molding frame held against part of the thread so as to get enough of it to give contour and lead, is shown in the complete paper.

Tolerance on Gages

One great difficulty with the business of manufacturing thread gages is the unreasonable and useless accuracy of gage tolerance and wear allowance sometimes requested by purchasing firms. When a tolerance of 0.0002 in. is set on a gage specification, it should mean that the customer's tolerance on product is as close as 0.001 in. If the purchaser's manufacturing tolerance is any broader than that, there is no use in keeping the gage so close.

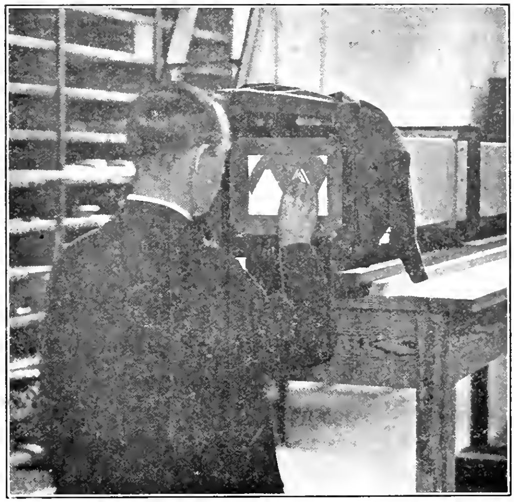

Fig. 7 Projection Machine for Checking Contour of Thread

A 0.0002 in. error would be lost in the comparison. In order to facilitate the making and to lessen the cost of thread gages, it is well to allow quite liberal tolerances in their manufacture, and we recommend the following as being applicable for most cases where medium tolerances are allowed on product:

From 4 to 6 pitch allow a tolerance of 0.0006 in.; from 7 to 18 pitch allow a tolerance of 0.0004 in.; from 20 to 28 pitch allow a tolerance of 0.0003 in.; from 30 to 80 pitch allow a tolerance of 0.0002 in.

The foregoing applies to master gages. For inspection gages the tolerances would be slightly wider, and would begin where the master inspection gage tolerances leave off. These would be as follows:

From 4 to 6 pitch a tolerance of 0.0009 in.; from 7 to 10 pitch a tolerance of 0.0006 in.; from 11 to 18 pitch a tolerance of 0.0004 in.; from 20 to 28 pitch a tolerance of 0.0003 in.; from 30 to 40 pitch a tolerance of 0.0003 in.; from 44 to 80 pitch, 0.0002 in.

All of the foregoing tolerances would be applied plus in the case of go male gages and no-go female gages; and minus on no-go male and go female thread gages.

The plus and minus tolerances given apply to pitch diameters of all thread gages and also to root or core dies of templets or female thread gages.

The maximum, or go, templet gage represents the maximum or basic screw and its manufacturing tolerances should be minus on pitch diameter and root diameter. The minimum, or no-go, templet should be made to plus tolerances with an extra plus allowance on the root diameter, which will insure this gage's really checking the effective size of the screw. The wear and adjustment tolerance on a gage should be coarse or fine on a sliding scale according to the manufacturer's tolerance on his product.

STANDARDS FOR LARGE TAPER SHANKS AND SOCKETS

By LUTHER D. BURLINGAME,[1] PROVIDENCE, R. I.

WAR needs have demanded the construction of machine tools embodying taper shanks and sockets of larger dimensions than it has been customary to build them. Most of the tapers established in the early days before the question of standardization was given much attention, present irregular variations in size and in depth, even within the same system, as will be noticed by observing the figures given in Table 1, where the most widely used tapers are described. The application to the large sizes of the rules followed in proportioning these early types, does not give the dimensions required to meet the new conditions.

The problem of working out a standard for the large sizes necessitated by present exigences was presented to the Brown & Sharpe Mfg. Co., and after an extended investigation and study of the conditions to be met, it has arrived at the tentative form described in this paper. The choice was based on a study and analysis of present established tapers, an investigation of the laws governing the use of tapers and a referendum of experience and opinion from a number of manufacturers and engineers who, because of their close contact with conditions most nearly like those desired to be met, it was felt would best be able to judge of the requirements.

TABLE 1 DATA ON TAPERS IN GENERAL USE

Taper per ft., in.	Included Angle	Ratio	Name	About when introduced	Where Used
½	2° 23′	1:24	Brown&Sharpe	1860	Milling machines and general
6/10	2° 52′	1:20	Jarno	1889	Reed lathes, Pratt & Whitney machines, etc.[1]
⅝	.	1:19⅕	Morse	1862	Twist drills, drill presses, etc.
¾	3° 35′	1:16	Sellers	1862	Lathes, boring machines, milling machines, etc.
1	4° 46′	1:12	Cambria	.....	Steam-hammer piston-rod ends
1½	7° 9′	1: 8	Muir (England)	......	Milling machines, "patent couplings" for arbors

[1] Also since used for German metric tapers.

Taper per Foot

As shown in Table 1, the well-established tapers for shanks and sockets now in use vary from ½ in. to 1 in. or more per ft., the tendency being to use a somewhat steeper taper for the larger than for the small sizes, perhaps because with small tapers, the liability to slip produced by the work is not so great and the "bite" of the taper when forced into the socket is sufficient to secure effective driving. In the larger sizes, tenons or tongues must be provided to aid in driving, and in the still larger sizes keys of some form are needed, as, unless the angle of taper is very slight, the tenons are liable to be twisted off. When such auxiliary means of driving is provided the taper can be made steeper, giving the advantage that the parts can be more easily separated.

An illustration of the use of a greater taper per foot for large as compared with small sizes is found in the "old American taper" having 9/16 in. taper per ft. up to the size 1 in. in diameter at the small end, beyond which the taper became ⅝ in. per ft.

An extreme application in the direction of steep tapers is in the arbor couplings used for milling-machine arbors, made by Wm. Muir & Co., Ltd., of England. These arbors are drawn into and removed from the socket by means of differential-threaded nuts, the taper being 1½ in. per ft.

On the other hand, tapers as slight as ½ in. per ft. have given satisfactory results in milling machines and other machine tools, where they have been in constant use for at least the last sixty years. The "bite" on the small sizes is sufficient, when driven in place, to hold without working loose under jar, while the angle is not so small as to prevent driving apart when desired. It is found, however, that occasionally a taper of ½ in. per ft. will stick so tightly as to require considerable force to separate the parts, perhaps in such cases as where a cold arbor is driven into a heated spindle. With a taper as slight as ½ in. per ft. there is seldom trouble from having the tenon twist off, as is so often the case with twist drills made with a taper of approximately ⅝ in. per ft., and where on account of the greater taper the "bite" of the taper fit does not carry so great a proportion of the load.

TABLE 2 MAGNUM STANDARD TAPERS, DESIGNED BY THE BROWN & SHARPE MFG. CO.

No. of taper	Diam. at large end, in.	Diam. at small end, in.	Depth of taper, in.	
19	4	3¼	12	
20	5	4⅛	14	
21	6	5	16	
22	7	5⅞	18	Taper = ¾ in. per ft. Depth of taper = 2 × diameter at large end + 4 in.
23	8	6¾	20	
24	10	8½	24	
25	12	10¼	28	
26	14	12	32	

TABLE 3 EXPERIENCE OF MANUFACTURERS WITH LARGE TAPERS

Name	Kind of machines	Taper per foot recommended	Depth recommended	Remarks
William Sellers & Co., Inc. Coleman Sellers, Jr.	Lathes; horizontal boring machines	¾ in.	At large end, 3 × diam. (or a little less)	Have used up to 8 in. diam
Mesta Mach. Co. J. E. Mesta, Asst. Supt.	Rolling-mill machinery, etc.	½ in.	3 × diam.	....
Newton Mach. Tool Works Nicholas P. Lloyd, Gen. Mgr.	Milling machines, etc.	Use ⅝ as std.; rec. 1 in. for large	....	Have used to 6 in. diam.
Tabor Mfg. Co. Wilfred Lewis, Pres.	General	0.6 or ¾ in.	....	....
Mead-Morrison Mfg. Co. J. T. MacMurray and Robt. Gow	General	1 in.	About 1½ in. × diam. + 2 in.	....
Westinghouse Elec. & Mfg. Co. E. R. Norris	General	¾ in.	3 × diam.	....
Bement & Miles W. J. Hagman	Steam hammers	½ and ¾ in.	....	The greater taper used for sizes above 3½ in.
	Steam forge hammers	1 in.	....	Sizes 2¼ to 12 in. diam.
	Lathes	¾ and 1 in.	Up to 5 in. at large end, 2½–3 × diam. 5 in. & over, 2.1 & 2½ × diam.	Sizes above 5 in. are 1 in taper per ft.
	Drilling & boring machines	⅝ in.	....	All sizes
	Milling machines	¾ in.	....	All sizes

[1] Industrial Superintendent, Brown & Sharpe Mfg. Co., Mem.Am.Soc.M.E.

For presentation at the Annual Meeting, New York, December 3 to 6, 1918, of The American Society of Mechanical Engineers. The paper is here printed in abstract form and advance copies of the complete paper may be obtained by members gratis upon application. All papers are subject to revision.

Principles on Which Tapers Depend

Oscar J. Beale of the Brown & Sharpe Mfg. Co., originator of the "Jarno" taper, made an investigation of the principles on which the taper of shanks and sockets should be proportioned, and published his findings in the *American Machinist* of October 31, 1889, p. 3. His analysis is a clear statement of conditions governing the taper per foot.

After asking, "Is there a scientific principle involved in establishing a taper?" he answers: "There is this principle, that the angle of the taper must not be so large that a center will not stay when driven in and that the angle need not be so small as to make it very difficult to back the center out," and after illustrating by means of a diagram he continues: "The average angle of repose in metals having smooth surfaces that are oiled is placed by Unwin at 4½ deg. and by Willis at 5 deg. Rankine gives an angle the same as or a little smaller than Unwin and adds that in some experiments the angle has been as small as 2 deg." From or other tapers with a less steep taper in the ease with which it will release when it is desired to drive it out. Further, it is a taper which apparently is now in most general use for large work, although its proportions, as far as the writer knows, have not previously been standardized.

The taper of ¾ in. per ft. was adopted by William Sellers & Co., Inc., of Philadelphia, about 1862, when they abandoned the flattened end or tenon and adopted a key fitting lengthwise of the taper for driving, rather than to depend largely upon the "bite" of the taper for that purpose.

William H. Thorne, in a paper[1] on Twist Drills presented before The American Society of Mechanical Engineers in 1885, after pointing out the objections to driving by a tongue as is the usual practice in using twist drills, says:

> A far better device is a key, fitted permanently into the sockets, and extended the entire depth of the latter. This key fits a groove in the shank of the drill, and supplies a perfect means of driving the latter, with a minimum of wear and strain. The end of the shank for a short distance is turned smaller, and is hardened to prevent any upsetting by the use of a drift or wedge in removing the drill. The amount of taper proper for the shank is a disputed question. The Morse taper averages less than ⅝ in. in diameter per ft., but with drills driven by means of a key ¾ in. per ft. is better as it enables the drills to be more readily removed from the sockets, and at the same time prevents them from falling out by their own weight.

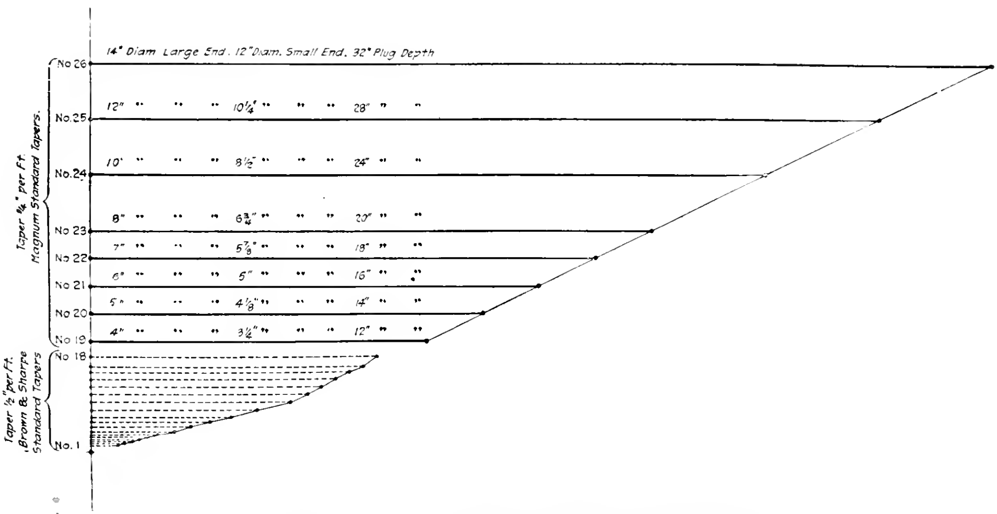

Fig. 1 Relation of Proposed Standard Taper Lengths to Established Brown & Sharpe Sizes

a further demonstration Mr. Beale concludes, regarding tapers, that if the angle must be such as to permit slipping, it should be as great as 10 deg., while if it should not permit slipping, it should be less than 4 deg. Also:

> If a center be of a taper whose sides make an angle of less than 4 deg., it is not likely to slip out, after being driven in, even though it be oiled. An angle of 4 deg. makes a taper of nearly ⅞ in. per ft. No center, so far as I have seen, has a taper greater than this, which is interesting as indicating that the machinist, in practice, has not exceeded the angle of safety given in the textbooks. . . . The smallest center angle that I know is something less than 2½ deg., which in practice has been found to be small enough. We are therefore at liberty to choose any angle of taper between 2 and 4 deg.

Mr. Beale chose for the Jarno taper, 0.6 in. taper per ft. (2 deg. 52 min.) as an average between these limits. This gives a ratio of 1 in 20, a ratio which has since been adopted for the German metric standard and is especially adapted for use with a decimal system of measurement. In applying it to the English system of measurement, however, it gives the dimension at one end of the taper in tenths and at the other end in eighths, a feature which, while not especially objectionable, lacks the advantage derived from using the taper of ¾ in. per ft., which gives, with each inch of depth, $\frac{5}{16}$ in. variation in diameter, so that when applied to large tapers, whose depth may be made to vary by 2 in. or 4 in., the diameter at both large and small ends come in whole or convenient fractional sizes.

A taper of ¾ in. per ft. also gives an advantage over 0.6-in.

Mr. George R. Stetson, in discussing Mr. Thorne's paper, said:

> The objection to a sharper angle or taper is that the drill has a tendency to draw out of the socket when coming through its work. This twists the tongue and produces most of the trouble complained of and would be best obviated by a taper of less than ⅝ in. to the foot.

What applies to the use of tapers for drills in this discussion applies in general to the use of tapers for sockets and shanks, and the conclusion can be drawn that if the "bite" of the shank is to be depended on to a considerable extent to do the driving, the taper should be small, even at the risk of finding occasional difficulty in separating the parts.

On the other hand, if adequate means of driving is to be provided in addition to the "bite" of the taper, there are advantages in making the taper greater, although not so great as to allow of jarring loose or dropping out readily.

Assuming that in all cases of machine tools using these large tapers either longitudinal or cross-hold-back keys or both will be

[1] Trans., Vol. 7, p. 132.

used for driving them, a greater taper per foot can be used, thus obtaining the advantage of easy removal with no sacrifice in driving efficiency. To meet these conditions, a taper of ¾ in. per ft. for large sizes seems ideal, based on scientific grounds and also on the experience of users.

Lengths for Tapers

While the length can be more elastic, a variation being less objectionable than in the case of the diameter or taper per foot, it is desirable to standardize it also. As previously pointed out, the tapers already established do not give proportions for lengths suited to large sizes. Thus the Jarno formula would make a taper of 14 in. in diameter at the large end, 56 in. long—much too long for practical needs and adding an excessive amount to the cost of both gages and reamers as well as of the machine. A proportion used by some Philadelphia manufacturers who have made the depth three times the diameter for moderately large sizes, is admitted by them to be probably longer than necessary even for these sizes. Such a proportion would make the above 14-in. taper 42 in. long.

The Proposed Standard

By the use of a constant, a formula has been derived applicable over a wide range, and giving, it is believed, satisfactory proportions. Fig. 1 illustrates the relation of the proposed taper standard for length as derived from this formula, to the established Brown & Sharpe sizes, showing that these new tapers follow in a regular progression beyond the largest established Brown & Sharpe sizes.

As a result of this investigation the sizes in Table 2 are proposed, to be known as Magnum Standard Tapers.

The reason for beginning the numbering at 19 is to avoid lapping on to the numbers of any of the systems now in use, No. 18 of the B. & S. standard being, so far as known, the largest standard as yet suggested. No. 19 of the new system is proportionately larger than the B. & S. No. 18, so that, starting with No. 19 seems logical, even though the new standard has a different name and is of a different taper per foot than the old.

It will be noted that the diameters at the large end are made basic and vary by inches, and with the length of taper obtained by the formula the diameters at the small end are in convenient fractional sizes.

Before determining on the proportions of the Magnum tapers the question of the proportions of large standard tapers was taken up with manufacturers and engineers having experience along these lines. Table 3 gives a digest of the opinions received from various sources in answer to the writer's inquiry as to their past experience with large tapers.

DETERMINATION OF STRESSES IN WIRE ROPE AS APPLIED TO MODERN ENGINEERING PROBLEMS

By JAMES F. HOWE,[1] WORCESTER, MASS.

THE consideration of stresses in wire rope necessitates the consideration of this problem from a broad standpoint so that each factor governing the action of wire rope will be fully understood. The structure of wire rope is such that axial compressive stresses need not be considered, only those allied to tension or bending requiring study. The first problem to be considered and the one upon which all stresses depend, is the determination of the strength of strands and ropes.

Strengths of Strands and Ropes

In constructing a wire rope a number of wires arranged according to some definite geometrical cross-section are twisted with a uniform pitch or lay into what is technically known as a strand. The object of twisting the wires into strands and strands into rope is to bind the wires compactly together and to increase the flexibility of the wire rope. Both the wires composing the strands and the strands composing the rope are twisted and laid up so that there is no torsion in either the wires or strands.

While stranding increases flexibility, it is not accomplished without some loss in strength due to twisting. It is obvious for comparative purposes that the strength of a straight wire may be taken as unity or 100 per cent. Strands are usually made of 7, 19, 37, 61, etc., wires, and ropes of six strands (occasionally eight). When a number of wires are twisted together around a central wire, they make an angle with the central wire or axis. The shorter the twist the greater the flexibility, but at the same time the strength is decreased proportionately. This will be understood from Fig. 1.

A wire with a strength S in a strand will have a component strength T along the axis of the strand, or

$$T = S \cos \theta$$

where

θ = angle of helix of wire in the strand.

Also, if

D_p = pitch diameter of strand

n = lay divided by pitch diameter of wires

d = diameter of wire in strand (assuming all wires the same size)

c = constant by which wire diameter is multiplied to produce pitch diameter

$$\text{Pitch circumference} = \pi c d \text{ and Lay} = nD_p \ldots\ldots [1]$$

In the case of a seven-wire strand, the center wire being straight, the total strength of strand W_s is obviously

$$W_s = S + 6S \cos \theta = S(1 + 6 \cos \theta) \ldots\ldots [2]$$

If θ_1, θ_2, θ_3, etc., represent the angle of the helix of successive layers of wires in a symmetrical concentric strand for layers of 12, 18, 24, etc., wires,

$$W_s = S + 6 \cos \theta + 12 S \cos \theta_1 + 18 S \cos \theta_2 + 24 S \cos \theta_3 + \text{etc.,}$$
$$= S(1 + 6 \cos \theta + 12 \cos \theta_1 + 18 \cos \theta_2 + 24 \cos \theta_3 + \text{etc.}) \ldots [3]$$

If the angles θ, θ_1, θ_2, etc., are equal the equation becomes

$$W = s [1 + (N - 1) \cos \theta] \ldots\ldots [4]$$

where N = number of wires in strand.

Similarly in a rope,

let W_r = strength of rope with hemp center

Y = angle of strands in rope (assuming 1 layer of strands such as 6 or 8)

N_1 = number of strands in rope.

The strand strength W_s must be applied in just the same manner as before, and

$$W_r = W_s N_1 \cos Y \ldots\ldots [5]$$
$$= SN_1 \cos Y [1 + (N - 1) \cos \theta] \ldots\ldots [6]$$

if all wires are twisted with equal angles.

In the case of solid strands such as 7, 19, 37, 61, etc., wires the results obtained from Formulæ [2], [3] and [4] are very close to actual figures. In the case of ropes, however, some other factors must also be considered.

In testing a full-size specimen of a wire rope there is always some nicking action between the strands as the load approaches a maximum, due to the compression of the hemp center. The larger the rope being tested or the stronger the rope of any diameter, the greater the compression of the hemp center will be. In fact, it has been found necessary in many cases where ropes are employed for very heavy duty such as in dredging operations on large sizes to manufacture wire rope with a wire

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For presentation at the Annual Meeting, New York, December 1918, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. The paper is here printed in abstract form and advance copies of the complete paper, which contains many useful tables on rope stresses, may be obtained by members gratis upon application. All papers are subject to revision.

center consisting of a smaller wire rope contained inside of the larger one. Still another factor which will affect the general results is the kind of material of which the rope may be composed. Very high-strength material in rope construction reduces somewhat the efficiency of a wire rope when tested to rupture. By efficiency is meant the ratio between the break of the completed rope and the sum of the strengths of the separate individual wires.

No single value for efficiency of break can be assigned to any given construction such as 6 x 19 as this varies somewhat for the different grades of wire used in rope making and also the angle of lay of strands, etc., which may be changed from time to time to suit service conditions. This fact was recognized by the rope manufacturers of the country at their 1910 conference in the establishment of standard breaking strengths.

In making up specifications for wire rope for any purpose, the data on strength published by the various rope makers may be considered as fairly reliable. These values of breaking strengths are intended to represent approximately average values. They may vary two or three per cent under or they may run over. This variation, however, will make very little difference with the factor of safety used in the engineering calculations.

The stresses to which wire ropes are subject in service may be grouped in two main divisions, namely,

1 Direct stresses due to applied load
- Static tension
  - *a* Vertical lift
  - *b* Inclined lift
- Moving tension
  - *a* Acceleration of load
  - *b* Retardation of load

2 Indirect or induced stresses
- Bending
  - *a* Direct bending
  - *b* Reverse bending
- Horizontally suspended cable supporting load.

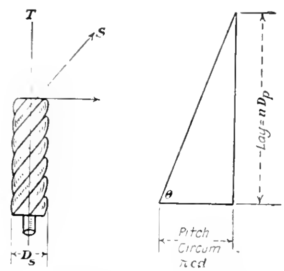

FIG. 1 EFFECT OF TWISTING WIRE ON THE STRENGTH OF ROPE

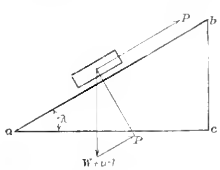

FIG. 2 DIAGRAM OF FORCES IN PULL ALONG INCLINED PLANE

STATIC TENSION

Considering these stresses separately, it is a simple matter to calculate the load to be lifted and add to this the weight of rope suspended vertically, thus obtaining the direct static tension.

Let W = load to be lifted
w = weight of rope per foot
l = length of rope suspended vertically
L = total load or tension.

Then

$$L = W + wl$$

INCLINES

For an inclined lift Formula [1] will be modified somewhat as follows (see Fig. 2):

Let λ = angle of incline
P = pull due to load $W + wl$
F = friction factor, which is a function of $(W + wl)$ and the angle of the incline λ.
$P = (W + wl)\ F \sin\lambda$.

The friction F of the cars on the incline operates normal to the line ab and is therefore a function of $\cos\lambda$. The maximum value is when $\cos\lambda = 1$, or on a level track, and the minimum for $\cos\lambda = 0$ when $\lambda = 90$ deg. Starting friction being the greatest, this alone need be considered. Assuming a value of 2 per cent,

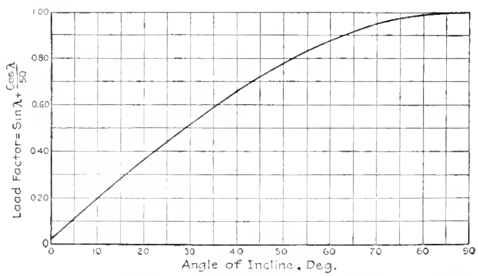

FIG. 3 VARIATIONS IN LOAD FACTOR WITH CHANGES IN ANGLE OF INCLINE

$$F = \frac{(W + wl)\cos\lambda}{50} \quad \ldots\ldots\ldots\ldots\ldots\ldots [7]$$

Therefore,

$$P = (W + wl)\left(\sin\lambda + \frac{\cos\lambda}{50}\right) \quad \ldots\ldots\ldots\ldots [8]$$

Values for the load factor $\left(\sin\lambda + \frac{\cos\lambda}{50}\right)$ for values of λ from 0 to 90 deg. are given in Fig. 3.

MOVING TENSION—ACCELERATION AND RETARDATION

In the case of very slow-moving ropes, the ropes stress in any straight portion will be equal to the load being lifted in the case of a vertical hoist or, on an incline, the tension due to the angle of incline, but there are many cases where rapidly moving ropes are subject to heavy stresses of acceleration or retardation where the factor of safety under static load is reduced very much by quick stops and starts. The value of the stress due to acceleration may be calculated thus:

Let T = time of acceleration
W = weight to be lifted, lb.
w = weight of rope per ft., lb.
E_r = modulus of elasticity of rope
a = acceleration or retardation of load, ft. per sec. per sec.
S = space in which acceleration or retardation is made
V = velocity of load, ft. per sec.
K = kinetic energy of the moving load
k = kinetic energy of the moving rope.

Then

$$K_t = K + k = C\ (W + wl) \quad \ldots\ldots\ldots\ldots [9]$$

where C is a constant by which the load is increased due to kinetic energy, and a factor representing the increase of the total load. Therefore,

$$K_t = \frac{WV^2 + wlV^2}{2g} = \frac{V^2}{2g}(W + wl) \quad \ldots\ldots\ldots [10]$$

but as

$$V^2 = 2aS$$

$$C\ (W + wl) = \frac{aS}{g}\ (W + wl) \text{ or } a = \frac{Cg}{S} \quad \ldots\ldots [11]$$

Also $\quad a^2t^2 = 2\ gC$

and if $t = 1$,

$$a = \sqrt{2gC} = 8.02\sqrt{C}$$

Indirect or Induced Stresses

Bending stress may be of two kinds, direct or reverse. As in the case of solid steel bars, reverse bending is much more severe than direct bending, resulting in greatly reduced life even if the size of sheaves used is fairly large.

Bending stress affects all ropes that are passed over sheaves, which service includes the vast majority of rope installations. Well-developed formulæ in mechanics give the value of this stress for solid round bars bent around a given diameter. When this problem has been considered in connection with wire rope more or less difficulty has appeared due partly to an erroneous conception of the fundamental principles which govern bending stress as applied to wire rope.

Several formulæ have been proposed to calculate the bending stress for wire rope. They all give values much larger than the actual values because the most vital and important factor of the entire problem has been neglected. Wire ropes are manufactured

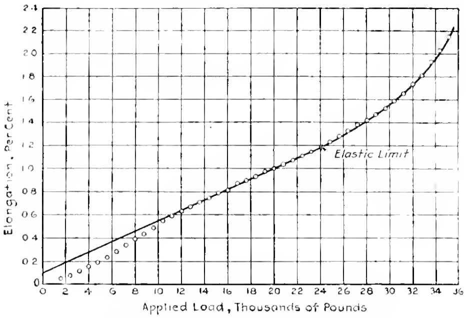

Fig. 4 Load-Elongation Curve of Wire Rope

not from *straight* wires but from *twisted* wires. The values obtained by these formulæ are correct, therefore, only for ropes composed of straight wires. That being the case, they are decidedly incorrect as applied to modern rope, which is made of *twisted* wires. When these formulæ were developed there were no experimental data available to check the results obtained, and they gained credence among engineers probably on account of the reputation of the authors who proposed them. In very similar manner the strength of ropes for many years was calculated as the aggregate strength of all the wires. Experimental data showed this conception to be wrong.

No check tests had been made to determine the modulus of elasticity of complete wire ropes. Owing to the twisting of wires to form wire ropes the modulus of elasticity of a wire rope is much less than that of a solid bar, as illustrated in Figs. 4 and 5, which represent curves of the modulus of elasticity of wire rope with hemp centers. Many other tests on similar ropes have proved conclusively that the modulus of elasticity of six-strand ropes will not run over 12,000,000 lb. and may be somewhat lower. In making such tests it must always be borne in mind that readings of elongation under light load are not as reliable—owing to the yielding nature of hemp core—as the values obtained under heavier loads. The values of the modulus of elasticity should be taken between the points where the stress-strain diagram is approximately a straight line.

Having determined the true value of the modulus of elasticity of a wire rope, we may now proceed to the determination of the bending stress in a wire rope. Considering the Reuleaux formula, $S = Ed/D$, if we replace E, the modulus of elasticity of a solid bar, with E_R, the modulus of elasticity of the rope as a whole, the formula becomes

$$S = E_R \frac{d}{D} \qquad [12]$$

which is the true bending-stress formula for a wire rope.

It should be specially noted that the value of S obtained is the stress per square inch of the greatest strained fiber, since it is the stress in the greatest strained fiber that determines the effect of the bending, just as it does in a beam under load. If we take the value of S and multiply it by the area of the wires in the rope, we obtain the actual bending stress in pounds. The interpretation of this value of the bending stress is important. The bending stress thus calculated shows the value equivalent to a direct tension on the rope.

Calculations may be made which show that over very small sheaves the bending stress by formula $S = E_R d/D$ gives a value greater than the strength per square inch of the material used in making wire rope. This shows that the elastic limit of the fibers of the steel has been exceeded and the rope has taken a permanent set.

The writer developed the formulæ given below for determining the modulus of elasticity of both strands and rope, which checks up with values obtained from a large number of experiments.

Considering first a strand, let E_s be the modulus of elasticity of a strand. Then E_s may be considered as a function of E, or

$$E_s = fE$$

Considering the first concentric strands composed of successive layers of strands, the modulus of elasticity may be determined by considering each layer of wires separately.

Let n = number of wires twisted together in one layer

nd = approximate circumference of pitch circle if the wires are laid straight (n should be in excess of 6)

d = diameter of individual wires composing the ring.

Then $\dfrac{\pi d}{\sin \alpha}$ = exact circumference of pitch circle (wires laid straight)

where α = angle subtended at the center of the ring by the radius of a single wire.

Also, let D_c = outside diameter of circular ring under consideration.

By trigonometry,

$$D_c = Cd$$

where C is an angular function depending upon the number of wires composing the circular ring.

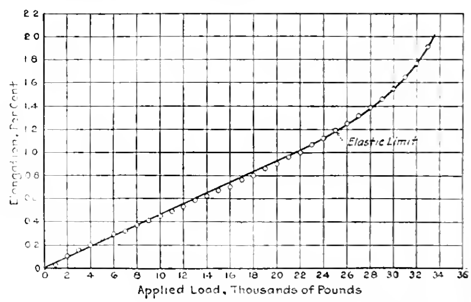

Fig. 5 Load-Elongation Curve of Wire Rope

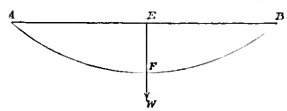

Fig. 6 Stresses in Horizontally Suspended Rope

$\dfrac{d}{\cos \theta}$ = the elongated diameter of the wires normal to the axis of the strand in the twisted arrangement.

where θ is the angle of wire relative to the axis of the strand, i.e., the developed angle of the helix formed by the twisted wire.

By trigonometry $\dfrac{\pi d}{\sin \alpha \cos \theta}$ = circumference of the pitch circle of the annular ring of twisted wires under consideration.

Let E_t = modulus of elasticity of the annular ring of twisted wires.

$E_t = fE$ and f is most nearly represented by the formula

$$f = \cos\theta\sqrt{\frac{D_e \sin\alpha\cos\theta}{\pi d}} = \cos\theta\sqrt{\frac{C\sin\alpha\cos\theta}{\pi}}$$

since $D_e = Cd$. Therefore

$$E_1 = E\cos\theta\sqrt{\frac{C\sin\alpha\cos\theta}{\pi}} \quad\ldots\ldots\ldots\ldots\ldots\ldots [13]$$

If $\theta = 0$, then $\alpha = 90$ deg. and $E_1 = E$.

Considering the quantity outside the radical, as θ grows smaller $\cos\theta$ approaches unity as a limit, hence

$$E\cos\theta = E \text{ at the limit } \theta = 0.$$

Considering the quantity under the radical with $\theta = 0$,

$$\frac{C\sin\alpha}{\pi} = 1 \text{ or } C = \pi$$

and Formula [13] may be written approximately as

$$E_1 = E\cos\theta\sqrt{\frac{D_e}{\pi d}}$$

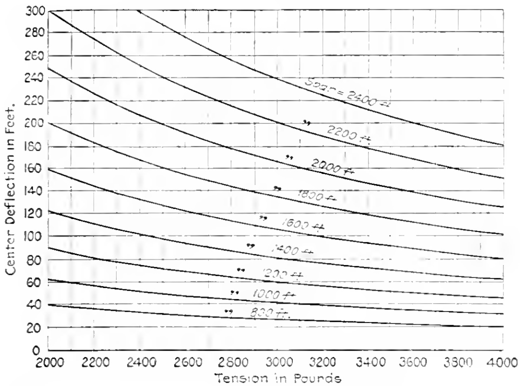

Fig. 7 Tension in Cable Spans for Distributed Load of 1 Lb. Per Ft.

Having determined the value of E_1 for one layer of wires, the value E_s for a strand of any number of layers or wires may be determined as follows:

Let E_1, E_2, E_3, etc., be the moduli of the various circular rings as determined by Formula [13], n_1, n_2, n_3, etc., the number of wires in the corresponding successive rings or layers, and E_s the modulus of elasticity of strand. The effect of various moduli upon the modulus of the strand as a whole will be determined by the number of wires and also by the modulus of the corresponding layer. Dividing this amount by the sum of the number of wires,

$$E_s = \frac{E_1 n_1 + E_2 n_2 + E_3 n_3 + \text{etc.}}{n_1 + n_2 + n_3 + \text{etc.}} \quad\ldots\ldots\ldots\ldots [14]$$

By means of this formula the values of the modulus of elasticity for any type of strand may be determined. If $E_1 = E_2 = E_3$, the modulus of elasticity of any strand $E_s = E_1$.

Considering a rope, the formula for modulus of elasticity takes the same form, only for E_1 we substitute E_s, using the following notation:

ϕ = angle of strands in the rope
N = number of strands in rope
d = diameter of strands

$\dfrac{\pi d}{\sin\beta}$ = exact circumference pitch circle

where

β = angle subtended at center of rope by radius of strand

$\dfrac{d}{\cos\phi}$ = elongated diameter of strand normal to axis of rope in the twisted arrangement

$\dfrac{\pi d}{\sin\beta\cos\phi}$ = exact circumference at pitch circle of strands of rope in the twisted arrangement

E_r = modulus of elasticity for rope

In a similar manner as before

$$E_r = E_s\cos\phi\sqrt{\frac{C\sin\beta\cos\phi}{\pi}} \quad\ldots\ldots\ldots [15]$$

For a compound rope of several layers of strands the modulus is determined as follows:

Let N_1, N_2, N_3, etc., represent the number of strands in successive layers, E_{r_1}, E_{r_2}, E_{r_3}, etc., the corresponding moduli and E_{mr} the mean modulus of rope. Then

$$E_{mr} = \frac{N_1E_{r_1} + N_2E_{r_2} + N_3E_{r_3} + \text{etc.}}{N_1 + N_2 + N_3 + \text{etc.}} \quad\ldots\ldots\ldots [16]$$

For a compound rope such as one of 6 ropes each having six 7-wire strands,

let Y = angle of rope strands in rope
ψ = angle subtended at center of rope by radius of rope strand
E_R = modulus of elasticity of compound rope

Then

$$E_R = E_r\cos Y\sqrt{\frac{C\sin\psi\cos Y}{\pi}} \quad\ldots\ldots\ldots\ldots\ldots\ldots [17]$$

Table 1 gives values of E_s and E_R, as obtained from Formulæ [14] and [15], and from the results of tests.

TABLE 1 MODULI OF ELASTICITY OF STRANDS AND ROPES

No. of Wires	Approx. Value θ for Outer Layer of Wires	Cos θ	Value of Modulus E_s by Formula	Average of Tests
7	9°–54′	0.9851	19,950,000	20,000,000
19	15°–30′	0.9636	17,760,000	18,000,000
37	16°–33′	0.9586	16,900,000	16,700,000
61	17°–8′	0.9556	16,600,000	17,000,000
Rope Construction	**Approx. Value of θ for Strand Angles**	**Cos θ**	**Value of Modulus E_R by Formula**	**Average of Tests**
6 × 7	14°–40′	0.9674	13,000,000	12,800,000
6 × 19	17°–52′	0.9518	11,400,000	11,400,000
8 × 19	20°–44′	0.9352	10,500,000	10,000,000
6 × 37	17°–52′	0.9518	10,800,000	10,400,000
6 × 42	19°–15′	0.9441	7,800,000	7,000,000

In obtaining the values of modulus of elasticity enumerated in Table 1, the value of E has been taken as 27,500,000 lb., since wire used in rope manufacture will not average much higher than 27,500,000. In fact, it may go as low as 25,500,000 and very rarely does it go as high as 29,000,000 lb. Soft bar steels on the contrary have a modulus of elasticity running about 29,000,000. Having determined the value of E_r for a given rope, the bending stress is readily obtained by use of the formula $S = E_r d/D$.

Reverse Bending

The value of reverse bending may be determined in exactly the same way as that of direct bending, but its effect is very deleterious, even if the amount is comparably small. If it were possible in the design of a machine not to have any reverse bends, the rope service would be much better; or, if a reverse bend is necessary, let it affect only one part of the rope, in which case the effect might be the same as that of simple bending.

There is one misconception in regard to bending which should be discussed at this point and that is, that it makes no difference whether a bend is 90 deg. or 180 deg. provided it goes around a sheave of a fixed diameter. The stress produced is the same in each case, and with the rope traveling between any two points all of the rope will have to take the bend whether it is 90 deg. or 180 deg. The only thing to be noted is that the bend is effective for a small fraction of a second longer in case it is 180 deg. as compared with 90 deg.

Stresses in a Horizontally Suspended Cable Supporting a Load

In this case a stress is produced in a rope suspended horizontally between two points due to the weight of the rope alone, and any load supported by the rope produces an additional stress which in most cases is not only equal to the load but to several times its value. In the case of a horizontally suspended rope, Fig. 6, assuming the curve to be parabolic in form, we may calculate stresses in a rope as follows:

Let L = total span in feet = AB
D = deflection in feet = EF
W = dead load at point F
w = weight per foot of the cable
S = tension in the cable at F
X = AE, position of load W with reference to point A.

Then, for the deflection due to weight of rope alone,

$$S_1 = \frac{wL^2}{8D} \text{ at the center of the span........[18]}$$

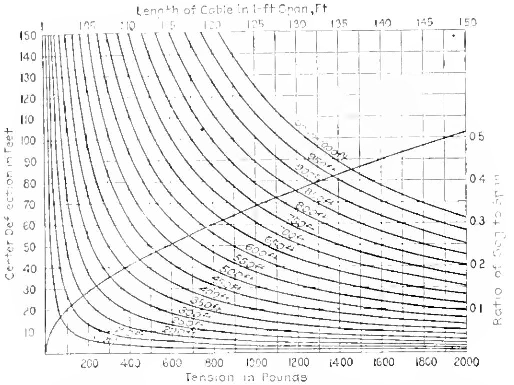

Fig. 8 Cable Tension in Terms of Center Deflection and Length of Cable for Different Ratios of Span and Sag

Formula [18] is applicable to all cases of uniformly distributed load such as a wire rope or large guy strand used for supporting a lead telephone or power cable, or a bare-copper high-tension feeder cable, at frequent intervals. The value of w must be taken, however, as the total weight per foot of both suspended and supported cable.

The stress due to the weight alone is

$$S_2 = \frac{WL}{4D} \text{ at the center of the span........[19]}$$

$$S = S_1 + S_2 = \frac{wL^2 + 2WL}{8D} = \frac{L(wL + 2W)}{8D} \text{....[20]}$$

From Formula [20] may be obtained the stress on any cable due to load and weight of cable.

The maximum stress on a cable span is at the supporting points A and B, Fig. 6, when the load is suspended in the center. Tension T at A or B equals tension in center plus the tension due to weight of rope wL and load W times the deflection D, or

$$T = \frac{S + D(wL + 2W)}{L} \text{..................[21]}$$

$$= S + D\left(w + \frac{2W}{L}\right) \text{............[22]}$$

Figs. 7 and 8 give the tension in cable spans in pounds for a distributed load of 1 lb. per ft. Fig. 8 also gives the length of cable in a 1-ft. span for different ratios of span and sag.

Preparation of Specification for Wire Rope

Close coöperation between the manufacturer and the engineer in drawing up a specification for wire rope will result in avoiding trouble which sometimes develops in a rope installation, or at least will improve rope service to the user. A few general remarks, therefore, in regard to specifications may not be out of place here.

Whenever possible, specify and use some standard construction of wire rope such as 6 x 7, 6 x 19, 8 x 19, 6 x 37, or 6 x 61. The relative flexibilities of these constructions are in proportion to the diameters of the wires from which they are made. Taking the value of the 6 x 7 rope as 100, the 6 x 19 will be 60; the 8 x 19, 50; the 6 x 37, 43; and the 6 x 61, 33. The sheave diameters will be in proportion to the values for these rope constructions.

Use the strengths shown in the manufacturer's rope catalog of some one of the four standard strengths of steel known by the following trade names:

a Crucible steel
b Extra strong crucible steel
c Plow steel
d Special brand improved plow steel (each maker has a trade name for this brand).

Physical properties of wire are sometimes specified, such as

a Tensile strength per square inch
b Elongation in 10 in.
c Bends over a fixed radius or proportionate radius
d Torsion test in 6- or 8-in. length.

Tensile Strength. Considering these in order, it is seen that, taking a rope of a given diameter and metallic sectional area and allowing for the loss of efficiency due to angle of lay of wires, it will have to have at least a certain strength per square inch in order to meet the required breaking strength.

Elongation. The elongation of rope wire is not very great as compared to annealed wire and the diameter of the wire is the determining factor. A fixed value for elongation covering all sizes of rope wire is unfair as well as untrue to actual conditions of steel manufacture.

Bends. Bends are sometimes specified on rope wire, the object being to eliminate any brittle wire, but no manufacturer would knowingly permit a single piece of brittle wire to be used in rope construction, as all wire would be tested when finished to eliminate brittleness. Rope wire will stand approximately six bends of 90 deg. alternately to right and left over a jaw with a radius equal to twice the diameter of the wire being bent.

Torsion Test. A torsion test in 6 or 8 in. is used by most wire manufacturers to test the uniformity of rope wire. Some rope specifications call for a test for torsion on wires to be used in rope. While it should not be necessary to specify this, still ungalvanized rope wire should stand in 8 in. as many twists as are obtained by dividing the constant 1.8 by the diameter of wire in inches, and proportionate twists in shorter lengths.

Factors Affecting Rope Service

One problem that is intimately linked up with rope service is the question of sheave diameter and the kind of bending to which a rope is subjected. Reverse bending should be avoided in every possible case as it has a very bad effect upon the durability of a wire rope.

For derricks the sheave diameter nowadays rarely exceeds 20 to 30 times the diameter of rope used, which is usually 6 x 19 or 8 x 19 construction. Hoisting machinery for coal towers, clamshell buckets for ore and coal handling are proportioned about forty times the rope diameter for 6 x 19 rope. Ladle cranes in steel mills use sheaves 30 times the rope diameter for 6 x 37 rope. Mine hoists use sheaves and drums from 60 to 100 diameters for 6 x 19 rope, and these are probably the most liberally proportioned of any machinery. Lift bridges have sheaves and drums 50 to 80 times the rope diameter for 6 x 19 rope.

One point that seems to have been lost sight of in designing machinery using large sizes of rope which require large diameters of sheaves and drums, is that in place of 6 x 19 rope it is possible to use 8 x 19, 6 x 37 or 6 x 61 rope and reduce the diameter of both sheaves and drums to more reasonable proportions, and still not have any greater bending stress in the rope. Crane builders have for years been using the 6 x 37 rope with good success and the writer would recommend for general hoisting work (excepting mines) that for ropes larger than 1½ in., 6 x 37 rope be used, and for those larger than 2 in. that 6 x 61 rope be employed.

Another factor affecting rope service is the personal equation of the operator who is to handle the wire rope. The skill with which any rope is handled coupled with freedom from sudden jerks or quick stops vitally affects its life. Similarly, the external wear or abrasion of the wires composing the rope influences the durability of the rope. Properly aligned sheaves, loads that are not excessive, and absence of any points where friction would cause undue wear, will all contribute to longevity of rope service. If the external wear is excessive, the rope maker can only partially overcome this difficulty by the use of stronger and harder grades of steel. Of the four grades of steel mentioned above, crucible is the softest and improved plow steel the hardest.

It might be thought at the first glance that all it is necessary to do to solve the problem of abrasion is to use the hardest possible steel. This is not necessarily true, because each of the four grades has physical characteristics that are possessed by the others, only in a greater or lesser degree. If, therefore, in the design of a machine requiring wire rope it is found that crucible steel will give an ample factor of safety and sheaves and drums are of suitable size so that this grade of rope may be readily supplied, then the chances are that crucible steel will be the best grade of rope to be used, bearing in mind always the question of abrasion. Such is the case in the vast majority of mining operations in the United States. Some mining operations are, of course, using plow steel, but the bulk of the coal-mining industries use crucible-steel rope, or at the most the extra strong crucible, with here and there an occasional plow-steel rope. In other metal mines both crucible- and plow-steel ropes are being employed. In some cases where loads have been increased the grade of rope employed has been changed from crucible or plow steel in order to take care of the increase in load. Iron-ore mines, for instance, are generally using the plow-steel grade of rope because of the heavy loads lifted and the grinding action of the iron-ore dust which becomes more or less intimately attached to the rope in the process of hoisting.

Corrosion is another element which affects the service factor. This is due to the rope's being subjected to the action of the elements or an acid mine water, sulphurous gases, etc. The higher the grade of steel, the more rapid will be the corrosion resulting from such exposure. Good lubrication where it is possible to maintain it will have a large influence in counteracting the corrosive effect, but in some cases it is next to impossible to get any lubricant to stay on the rope, and in such cases only the resistant action of the steel itself to the corrosive effect is left. When this corrosion has reached the point where pitting has reduced the metallic sectional area of the wires and they have started to break, then the life of the rope is practically gone.

Ascertaining the proper value of all stresses, together with the choice of a reasonable and safe factor of safety, will contribute largely to the longevity of wire rope under any set of conditions.

THE COOLING LOSSES IN INTERNAL-COMBUSTION ENGINES AS AFFECTING THEIR DESIGN

By C. A. NORMAN,[1] COLUMBUS, OHIO

THERE is considerable evidence that a great part of the heat loss to jacket water in an explosion engine occurs, not during the expansion stroke, but rather in the exhaust passages. Coker found by direct measurement a temperature drop of 150 deg. cent. (270 deg. fahr.) between the gas in the cylinder at the end of the expansion stroke and the gas in the exhaust pipe. Dugald Clerk found indirectly that of a total measured jacket loss of 25.4 per cent, about 16 occurred in the cylinder, and consequently 9.4 per cent in the exhaust passage. Losses in the exhaust passages, however, have no influence on the thermal efficiency of the engine. In order to arrive at the influence of varying proportions and speeds on the efficiency it would be necessary to determine separately the losses during the expansion stroke for a whole series of engines, varying only one factor at a time. No such investigation has to the knowledge of the writer been undertaken.

The formula for cooling loss developed later by the author from the published work of Clerk and others, while based on purely theoretical considerations, has nevertheless been found to represent fairly both the results of careful experiments and general experience, and its presentation at this time would therefore seem to be abundantly justified.

Method Employed by Dugald Clerk in His Experiments

Clerk equipped an ordinary gas engine with a contrivance enabling him momentarily to close the inlet and exhaust valves while the engine continued to run. A series of recompressions and reëxpansions of the same burned charge took place in the cylinder. A sample diagram of these fluctuations is given in Fig. 1.

With no cooling and no friction losses the recompression ought always to carry the gas temperature back to its value at the beginning of the previous expansion. As a matter of fact, Fig. 1 shows a constant falling of the temperature from point B to points D, F, H, etc. By means of calculation or determination of the temperature at one point, definite temperature values can be assigned to all the other maximum- and minimum-pressure points on the diagram and an estimate of the actual temperature drops and the average temperatures during the strokes can be made. With the aid of the speed of the engine it is also possible to give the results in terms of reduced temperature drops per second corresponding to certain average temperatures. The results are given in the form of the curves reproduced from Clerk's work in Fig. 2.

These curves show reduced temperature drop per second on the cold engine running light at 120 r.p.m. for a full expansion stroke (a) and for the upper 3/10 expansion stroke (a'). Also for the hot engine running light at 160 r.p.m. for the full expansion stroke (b) and loaded during the upper 3/10 expansion stroke (b'). The intersection of the curves with the temperature axis gives the mean temperature of the wall.

The curves in Fig. 2 give temperature drop, not heat loss. The expansion work in an engine cylinder is directly connected with the temperature by means of the specific heat. On the other hand, the work can be directly evaluated from the indicator diagram. In this way the specific heat of the gas in the cylinder at various temperatures can be ascertained.[1] Clerk gives the values found in Table 1.

Table 1 gives a striking illustration of the increase of the specific heat with the temperature. This increase is not uniform, however. It is considerable at lower temperatures, but almost nil at higher temperatures. Clerk in his original paper deems this behavior partly due to delayed combustion and hence considers his specific-heat values as merely "apparent."

Very thorough investigations of the specific heats of gases have been carried out by Nernst and his pupils.[2] From these it would appear that only carbon dioxide with certainty behaves in the manner indicated by Clerk's experiments. The specific heat of all other common gases, even that of superheated steam of sufficiently

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For presentation at the Annual Meeting of The American Society of Mechanical Engineers, New York, December 3 to 6, 1918. The paper is here printed in abstract form and advance copies of the complete paper may be obtained by members gratis upon application. All papers are subject to revision.

[1] See Proceedings of the Royal Society, A, vol. 77, p. 499.

[2] See Nernst, Theoretische Chemie, 1913, p. 267.

high temperature, shows rather a linear increase with the temperature. For the mixture used by Clerk the specific-heat values he gives seem to be too high, at least at lower temperatures. This is the opinion also of the Gaseous Explosion Committee of the British Association. Yet, as will be seen below, the deviations are not very great, considering the accuracy possible. By means of his heat values Clerk has succeeded in accounting very satisfactorily and in a new and striking manner for the heat balances in several combustion engines. In the illustrative examples figured in this paper these values have at times been used. This can be done without question when only general laws for design are to be established.

TABLE 1 APPARENT SPECIFIC HEAT (INSTANTANEOUS) AT CONSTANT VOLUME, C_v, EXPRESSED IN FT-LB. PER CU. FT. OF WORKING FLUID AT 0 DEG. CENT. AND 760 MM.

Temperature, Deg. Cent.	C_v Ft-Lb.	Temperature Deg. Cent.	C_v Ft-Lb.
0	19.6	800	26.2
100	20.9	900	26.6
200	22.0	1000	26.8
300	23.0	1100	27.0
400	23.9	1200	27.2
500	24.8	1300	27.3
600	25.2	1400	27.35
700	25.7	1500	27.45

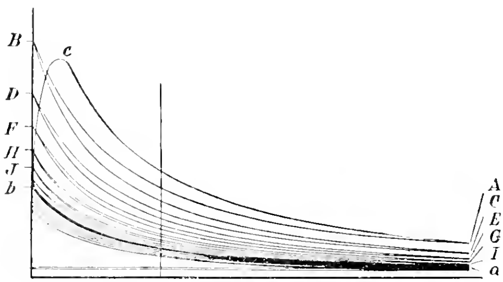

FIG. 1 CLERK DIAGRAM OF EXPLOSION AND ALTERNATE COMPRESSION AND EXPANSION OF HOT GASES IN ENGINE CYLINDER

Clerk gives the average composition of his combustion gas as follows:

	Volumes
Steam (assumed gaseous)	11.9
Carbon dioxide	5.2
Oxygen	7.9
Nitrogen	75.0
	100.0

The molecular weight of this mixture would be 27.96, or practically that of pure nitrogen, and the weight of 1 cu. ft. at 0 deg. cent. and 760 mm., 0.078 lb. The specific heat for the mixture at various temperatures is given in Table 2, in customary units, the values having been derived from the Clerk and the Nernst values.

The difference between the two series of specific-heat values given in Table 2 amounts to about 10 per cent in the middle of the range, but is barely 1 per cent at atmospheric temperature and less than 2.5 per cent at 1500 deg. cent. (2700 deg. fahr.). With the aid of Clerk's specific heats the cooling curves in Fig. 3 have been obtained. These curves give the cooling loss during the whole expansion stroke, reduced, however, to heat units per unit weight of gas per second. If, then, we compute the work theoretically obtainable from 1 lb. of gas with the temperatures and the expansion occurring, and if we compute the heat necessary to raise 1 lb. of gas from the temperature at the end of compression to the temperature at the end of the explosion, we can derive the actual expansion work as well as the percentage cooling loss. This, however, applies only to the Clerk engine.

TABLE 2 SPECIFIC HEAT OF CLERK'S WORKING MIXTURE

Temperature		Specific heat. B.t.u. per lb. or cal. per kg.	
Deg. cent.	Deg. fahr.	According to Clerk	According to Nernst
32	0	0.180	0.178
212	100	0.192	0.183
392	200	0.202	0.187
572	300	0.211	0.192
752	400	0.219	0.196
932	500	0.225	0.201
1112	600	0.231	0.205
1292	700	0.236	0.210
1472	800	0.240	0.214
1652	900	0.244	0.219
1832	1000	0.246	0.223
2012	1100	0.248	0.228
2192	1200	0.250	0.232
2372	1300	0.251	0.237
2552	1400	0.2515	0.241
2732	1500	0.252	0.246

APPLICATION OF CLERK'S HEAT-DROP CURVES TO OTHER ENGINES

Influence of Surface-to-Volume Ratio.—Clerk's experimental engine had the following dimensions:

Cylinder diameter, in.	14
Stroke, in.	22

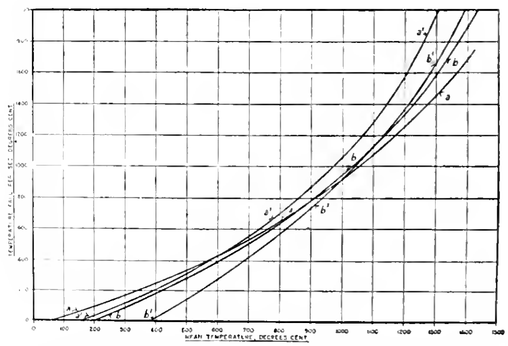

FIG. 2 TEMPERATURE DROP INCURRED PER SECOND AT DIFFERENT MEAN TEMPERATURES CALCULATED IN TIME. EACH LINE IS THE MEAN OF THREE CARDS UNDER THE GIVEN CONDITIONS

120 r.p.m. Cold { (a) Whole stroke; (a') Upper 1/10 stroke 160 r.p.m. Hot Load 50 b.h.p. { (b) Whole stroke; (b') Upper 3/10 stroke

Total cylinder volume with full-out piston, cu. ft.	2.41
Total cooling surface with full-out piston, sq. ft.	11.2
Sq. ft. of cooling surface per cu. ft. of volume	4.64

Now, the most simple assumption to make with regard to cooling losses is that they vary directly as the ratio of surface to included volume. For this assumption there is considerable support in the results of experiments with explosions in closed vessels. Table 3 gives data on the surface and capacity of the vessels used by several different experimenters, and Table 4, values of the temperature drop in the same vessels as recorded by Clerk.

The values in Table 4 have been plotted in Fig. 4. The experiments were carried out at widely differing places and times by

TABLE 3 EXPLOSION EXPERIMENTS WITH CLOSED VESSELS

Reference No.	Experimenter	Capacity of vessel, cu. ft.	Internal surface of vessel sq. ft.	Ratio of surface to volume, sq. ft. per cu. ft.
1	Hopkinson (large vessel)........	6.2	17.3	2.79
2	Bairstow and Alexander Hopkinson (small vessel)........	0.82	5.02	6.12
3	Hopkinson (small vessel)...	0.684	4.33	6.33
4	Clerk (first vessel)........	0.183	1.79	9.78
5	Massachusetts Institute Technology	0.180	1.79	9.94
6	Clerk (second vessel)..	0.150	1.60	10.65

different experimenters, using different methods, with vessels of differing shapes. It should not cause any surprise that the points are scattered. Nevertheless, it can hardly be denied that they are more naturally represented by straight lines, as shown, than in any other manner.

As far as experimental evidence goes, it then certainly seems to counsel the assumption of direct proportionality between heat loss per unit time and the ratio of surface to included volume. For geometrically similar vessels this ratio varies inversely as the linear dimensions. For similar engines running at the same number of revolutions the cooling losses would then vary inversely as the cylinder diameter. This has led to the conclusion that the cooling losses could be reduced almost to zero by employing sufficiently large dimensions. How unjustified this is will appear after some further scrutiny.

Influence of Speed. In the derivation of the heat-loss curve from Clerk's experiments it has been tacitly assumed that the heat loss varies directly as the time. No other assumption with regard to heat transfer has ever been made. With all other conditions equal, the heat loss in an engine should then vary inversely as the r.p.m. It is important, however, to note that all other conditions should be equal. It is known that if an engine is speeded up, something may be gained in efficiency, yet not as much as should be expected if the heat loss dropped in direct proportion to the increase in speed. The reason for this is often given as increased turbulence with increased speed. This would, of course, increase the convection losses. If the valves are correctly located and correctly proportioned there should be no more turbulence at high speed than at low speed, unless the turbulence is intentionally increased in order to accelerate combustion.

For the same engine, an increase in r.p.m. means an increase in piston speed and an equal increase in gas velocity along the walls. The old idea was that the coefficient of heat transfer from gases increased directly as the square root of the rubbing velocity of the gas. We can probably do no better in the present connection than adhere to this old idea, even though it expresses the relations somewhat too simply. We should then put the heat loss directly proportional to the square root of the piston speed. Consequently, if the known heat loss of a certain engine be denoted by L_o, and its surface-to-volume ratio and its piston speed, and r.p.m. by R_o, V_o and N_o, respectively, then for another similar engine with values R, V and N, working under the same temperature conditions the heat loss

$$L = L_o \times \frac{R}{R_o} \times \frac{N_o}{N} \times \sqrt{\frac{V}{V_o}} \qquad [1]$$

In the form just given the formula is serviceable only for comparing with each other engines working under similar temperature conditions, with similar fuels. It does not take into account variations in expansion ratio, or in maximum temperature; nor does it give absolute heat losses in heat units per unit weight of gas. It can easily be given this added range of usefulness by connecting it with the heat losses per second per unit weight of gas given for varying mean temperatures for the Clerk engine by the curve in Fig. 3.

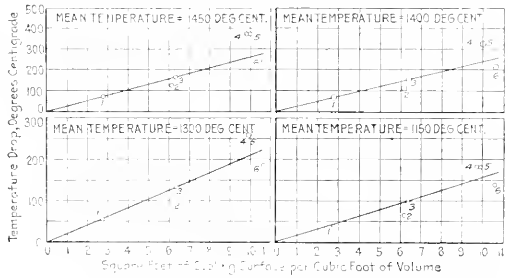

Fig. 4 Explosion Experiments with Closed Vessels: Drop in Temperature in 0.05 Sec. at Mean Temperatures Given. Pressure before Explosion, Atmospheric

Assuming a certain maximum temperature, or calculating it approximately with the aid of the specific heats given in Table 2,

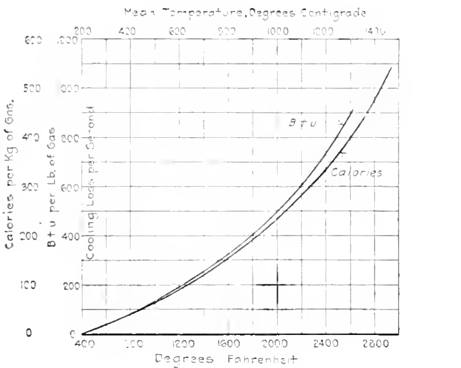

Fig. 3 Cooling Loss per Second and Unit Weight of Gas for Full Stroke in Clerk Experimental Engine

TABLE 4 DROP IN TEMPERATURE IN 0.05 SECOND AT MEAN TEMPERATURES GIVEN, DEG. CENT.

Pressure before explosion in all vessels, atmospheric

Reference No.	Ratio of surface to volume, sq. ft. per cu. ft.	Drop in temperature in 0.05 sec. at mean temperature of 1450 deg. cent.	1400 deg. cent.	1300 deg. cent.	1150 deg. cent.
1	2.79	80	68	52	38
2	6.12	127	114	93	65
3	6.33	166	153	131	100
4	9.78	378	327	257	182
5	9.94	372	327	257	182
6	10.65	238	216	184	138

it is possible then to estimate from the expansion ratio of the engine the temperature drop during the expansion by the use of an assumed polytropic exponent. From this we get close enough for our purpose the mean temperature during expansion as an arithmetic average. The corresponding heat loss C is read from the curve in Fig. 3 and it is the loss in B.t.u. per lb., or cal. per kg. of gas used for an expansion stroke lasting one second. To get the loss for any other duration of stroke it is simply necessary to multiply C by the actual duration in service. If the actual r.p.m. is N, this duration is $30/N$. The surface-to-volume ratio in the Clerk engine was 4.64 sq. ft. per cu. ft., and the piston speed at 160 r.p.m.—the speed at which the curve ap-

plies—586 ft. per min. Consequently, for any engine of surface-to-volume ratio R and piston speed V the expansion cooling loss in heat units per unit weight of gas used is

$$L = C \times \frac{30}{N} \times \frac{R}{4.61} \sqrt{\frac{V}{586}}$$

or

$$L = 0.267(CR/N)\sqrt{V} \ldots\ldots\ldots\ldots [2]$$

In Formula [2] R is expressed in sq. ft. per cu. ft., V in ft. per min., and N in r.p.m., while C can be either in B.t.u. per lb., or cal. per kg., or in any other units for which a C curve is available. If R should be given in sq. in. per cu. in., which is more convenient in most cases, then

$$L = 3.2(CR/N)\sqrt{V} \ldots\ldots\ldots\ldots [3]$$

where V is the piston speed in ft. per min. as is customary.

Application of the Cooling-Loss Formula to Actual Cases

Influence of Absolute Dimensions on Cooling Losses. Assume in the first instance that the piston speed does not vary. Particulars of series of such engines for a piston speed of 1000 ft. per min. and a bore-to-stroke ratio of 1:1.5 are given in Table 5.

TABLE 5 ENGINES WITH PISTON SPEED OF 1000 FT. PER MIN. AND STROKE-TO-BORE RATIO OF 1.5

Diameter, in.	3	10	15	30	42
Stroke, in.	4.5	15	22.5	45	63
R.p.m.	1333	400	266	133.3	95

In this case the r.p.m. varies inversely as the diameter, and so does the surface ratio. Consequently for the same C, L is constant. Thus, as far as the formula for the same expansion ratio and the same maximum temperature goes, the cooling losses and hence the indicated efficiency of these engines would be the same for all dimensions. Actually in order to avoid cracking of the metal, the cooling will have to be much more efficient for the larger engines. If they are double-acting, then even the pistons will be water-cooled. Even so, the maximum temperatures and maximum pressures will have to be kept down. The larger engines will therefore have a tendency to be rather less efficient than the smaller ones. On the other hand, with very high values of N the combustion is likely to consume a large part, if not the whole, of the stroke. In many cases, in fact, a good deal of the combustion will take place in the exhaust pipe. This can be prevented by extremely efficient carburization and ignition. Yet, on the whole, the likelihood is that, with the same compression, the best efficiencies will be found in the middle of the range. This would seem to be borne out by experience.

It may, however, be said that unvarying piston speed for all dimensions does not correspond to actual conditions. In some aeroplane and automobile engines piston speeds are found approaching, if not exceeding, 2000 ft., while it might perhaps be conservative to let the piston speed of very large engines remain below 750 ft. Suppose that at the large-size end the piston speed is half of what it is at the small-size end. The number of revolutions at the large-size end would be only half of what it would have to be to limit the cooling loss to its value at the small size end, piston speeds being equal. This would tend to make the cooling loss twice as large at the large-size end. On account of the lower value of the piston speed this loss is reduced in the ratio of $\sqrt{2}$. The upshot is that the loss would be about 40 per cent greater for the large size.

There is then absolutely no reason to look for high efficiency in large dimensions. High speed, even though connected with high piston speeds, is preferable, even from the pure efficiency point of view—provided the combustion can be effected satisfactorily.

Influence of Varying Stroke-to Bore Ratio. In this paragraph it will be assumed that the change in stroke-to-bore ratio is not consequent upon a change in expansion ratio. The question is: With a given expansion ratio and temperature range, how should a cylinder be proportioned for best efficiency? A basic cylinder of 5 in. diameter and 6 in. stroke, with the same total volume and the same clearance volume for all other proportions, will be considered. The expansion ratio may be 5—that of the Clerk engine; the speed, 1200 r.p.m.; the piston speed will vary from case to case.

Using Formula [1] the conditions found are those recorded in Table 6.

TABLE 6 ENGINES WITH UNVARYING VOLUME AND VARYING STROKE-TO-BORE RATIO

Ratio, stroke to bore	1.0	1.2	1.4	1.6	1.8	2.0	2.5
Diameter, in.	5.3	5.0	4.74	4.53	4.35	4.2	3.9
Stroke, in.	5.3	6.0	6.63	7.25	7.81	8.4	9.75
R, sq. ft. per cu. ft.	12.7	12.8	13.1	13.3	13.5	13.8	14.3
Piston speed, ft. per min.	1060	1200	1326	1450	1562	1680	1950
Cooling loss, per cent (for Clerk engine 16 per cent).	7.85	8.4	9.05	9.6	10.1	10.8	12.0

The cooling loss increases regularly with increasing stroke-to-bore ratio. The absolute magnitude of the loss is small and the extreme variation changes the thermal efficiency by only 4 per cent. However, this 4 per cent means from 15 to 20 per cent saving in fuel. In an aeroplane 1 lb. of weight would be saved in fuel for a 10-hr. flight for every hp. of the engine output. This is not negligible, and will count more and more as longer and longer flights over sea, or over enemy territory, are attempted.

Influence of Varying Stroke-to-Bore Ratio Consequent on Varying Expansion Ratio. The next step is to investigate the influence of varying expansion ratio on engines of the same output and the same speed, the increase in expansion being brought about by lengthening the stroke. With increased compression and increased stroke the output per sq. in. of piston area will increase for the same number of revolutions. To obtain equal output the cylinder diameter will have to decrease with increased expansion ratio, as indicated in Table 7.

TABLE 7 INFLUENCE OF VARYING EXPANSION RATIO ON ENGINES OF THE SAME OUTPUT AND THE SAME SPEED

Volumetric expansion ratio	3	5	7	9
Cylinder diameter, in.	5	4	3.5	3
Stroke, in.	5	6	7	7.5
Ratio, stroke to bore	1	1.5	2	2.5
Surface-to-volume ratio, R, sq. ft. per cu. ft.	13.3	15.5	16.7	19.0
Piston speed, ft. per min.	1000	1200	1400	1500
Max. temperature, assumed, deg. fahr.	3270	3270	3270	3270
Max. temperature, assumed, deg. cent.	1800	1800	1800	1800
Final temperature of expansion, deg. fahr.	2240	1850	1630	1470
Final temperature of expansion, deg. cent.	1227	1007	887	802
Heat loss, B.t.u. per lb. of gas	100	103	108	118
Heat loss, cal. per kg. of gas	56	57	60	65
Indicated work, approx., B.t.u. per lb. of gas	171	337	271	297
Indicated work, approx., cal. per kg. of gas	95	132	151	165

Polytropic exponent in computation of temperature drops, 1.3; compression work assumed equal to 30 per cent of expansion work.

As Table 7 shows, while the cooling loss increases 18 per cent, the indicated work increases 74 per cent. The value of high expansion, even though gained by increased stroke-to-bore ratio and decreased cylinder diameters, is hereby clearly demonstrated. For average conditions, however, a high-expansion engine would be more efficient with a large diameter and a short stroke than with a small diameter and a long stroke.

Character of the Combustion in High-Speed Engines. In Table 7 the cooling losses and the indicated work are given in heat units per unit weight of gas. If to obtain percentages an attempt were made to calculate the thermal efficiency of the engine by reference to the heat supplied during combustion, some very astonishing figures would result, such as those in Table 8. Here the maximum temperature has been assumed equal to 3270 deg. fahr. (1800 deg. cent.), in all cases and the mechanical efficiency equal to 0.85.

TABLE 8 APPARENT SHAFT EFFICIENCIES FOR ENGINES IN TABLE 7

Volumetric expansion ratio	3	5	7	9
End temperature of compression, deg. fahr. abs....	1000	1170	1290	1390
End temperature of compression, deg. cent. abs.....	556	648	718	773
Temperature rise to 3730 deg. fahr. abs...	2730	2560	2440	2340
Temperature rise to 2073 deg. cent. abs.	1517	1425	1355	1300
Heat required, approx. (C_v = 0.225), B.t.u. per lb. of gas	615	576	550	525
Heat required, cal. per kg. of gas.	342	320	305	292
Shaft thermal efficiency from indicated work in Table 7 (mech. eff. 0.85)	0.236	0.35	0.42	0.48

It is evident that, even though 7 and 9 may be unusual expansion ratios in actual engines, we can never hope to attain brake efficiencies as high as those in Table 8. In arriving at these efficiencies no use has been made of the calculated cooling losses; we have simply taken a polytropic-expansion exponent equal to 1.3 and assumed that all heat is added before the expansion commences to take place.

Clerk in his paper before the Royal Society concludes from his experiments on an engine running at only 160 r.p.m. that some combustion is proceeding even during his first reëxpansion, i.e., after the whole normal expansion stroke and a whole intervening compression stroke. All experiments with closed vessels show gaseous explosions to take certainly not less than $\frac{1}{40}$ sec., and this only with over-rich mixtures. With normal mixtures, it takes a much longer time than that to reach the maximum pressure. Turbulence accelerates combustion very much. Yet such direct experiments as we have seem to show that with normal mixtures even a turbulent combustion would take all of $\frac{1}{40}$ sec. One-fortieth of a second, however, is exactly the time occupied by the whole expansion stroke of an engine running at 1200 r.p.m. We have then absolutely no reason to assume that the combustion is complete before the expansion commences. In the series of engines just considered, it is far more reasonable to assume that it continues during the whole expansion stroke.

Assuming this we might approach the conditions actually obtaining by figuring with an isothermal expansion. During such an expansion all the heat added passes directly into work. Assume a temperature of 1600 deg. cent. (2912 deg. fahr.) to obtain during the expansion, then with an expansion ratio of 5 we find for the corresponding engine in Table 7 the values given in Table 9.

TABLE 9 SHAFT EFFICIENCY AND COOLING LOSS OF ENGINE OF TABLE 7 WITH EXPANSION RATIO OF 5, ASSUMING ISOTHERMAL EXPANSION

	B.t.u. per lb.	Cal. per kg.
Isothermal expansion work (gas constant = 0.071)..	385	214
Heat added between compression temperature (708 deg. fahr., 375 deg. cent.), and max. temp. (C_v = 0.225)	496	276
Cooling loss, estimated	162	90
Total heat supplied.	1043	5803
Compression work (exponent = 1.3)	104	58
Indicated work	281	156
Shaft efficiency (mech. eff. = 0.85).	0.229	0.225
Cooling loss, per cent	15.5	15.5

The shaft efficiency is now about what would be expected from an engine of this size and speed, and the cooling loss is considerably increased. The main reason for the lowered efficiency, however, is not cooling loss, but delayed combustion. To increase efficiency in explosion engines running at very high speeds, the main prerequisites are extremely efficient carburation, extremely efficient ignition, and *perhaps*, if feasible, some means for increasing the turbulence during combustion. It would hardly be good practice to increase turbulence by means of greater gas velocities and greater throttling losses in valves.

DAYLIGHT VS. SUNLIGHT IN SAWTOOTH-ROOF CONSTRUCTION

By W. S. BROWN, PROVIDENCE, R. I.

Many processes of manufacturing require for best results, natural illumination consisting of sufficient and well-diffused daylight with, at the same time, however, the important limitation that little or no direct sunlight shall fall upon the working plane. That is, there is a sharp distinction between daylight and sunlight and their relative desirability. The former consists of illumination by reflected and refracted light, properly designed fenestration, resulting in an evenly distributed, well-diffused light with consequent lack of sharp shadows and contrasts. The latter, or illumination by direct sunlight, is objectionable for many reasons of varying relative importance, such as the following: Its heating effect, especially in warm, southern climates; its color which has a sensation value containing a greater proportion of red rays than daylight; its actinic effect upon materials used in the manufacturing processes; and the fact that it is unidirectional and of excessive intensity resulting in glare, sharp shadows and contrasts.

Diffusion of daylight in sawtooth buildings is obtained by placing the sawteeth so that the glass or lighting area faces the northern sky; sufficient intensity being dependent, among other things, upon the size and slope of the lighting area. Evenness of distribution is procured by properly apportioning the lighting areas. The amount of direct sunlight admitted daily, the time of its admission, and its duration are evidently dependent upon three considerations, the last two of which may be varied within certain practical limits. They are:

a Day of the year, determining as it does the sun's path across the sky

b Direction in which the lighting area faces as regards the points of the compass

c Slope of the lighting area.

For a given lighting area, a variation in its slope is accompanied by a very appreciable change in the amount of daylight admitted. That is, as the pitch of the lighting area is made steeper, the amount and duration of direct sunlight entering the building is lessened, but only at the expense of the general illumination. Conversely, as the slope of the lighting area is decreased, the intensity of daylight is correspondingly increased, but there also is concurrent therewith a greater amount and duration of direct sunlight. The question then becomes: How steep should this slope be? What is the proper balance between the two contending requirements of little sunlight and much daylight? Also at what time of day will direct solar rays fall upon the working plane, in what locations and volume, and for how long a period?

Naturally, no general answer can be given, but each individual problem should be worked out only after careful study has been made of the particular conditions and requirements which have to be met, not excluding first cost. In the Southern States, for example, the tendency is to adopt a more nearly vertical lighting area than in the northern part of the United States or Canada, on account of the greater altitude of the sun and its intense heat. Occasionally it has been found advantageous to so locate machinery as to avoid any direct sunlight during the working hours.

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With a view, therefore, to clearing up such questions as these, the writer's firm, F. P. Sheldon & Son, undertook to work out, in connection with what empirical data they already had, a rational method of design for sawtooth-roof construction.

The subject is necessarily divided into two closely related parts, the first concerning *direct sunlight*, its amount, time of admission, duration, and location on the working plane; the second relating to intensity of *daylight* upon the working plane.

Part I Orientation of Sawtooth Buildings and Slope of the Lighting Area as Related to Requirements of Least Direct Sunlight

In the practical problem of the sawtooth roof, the effective slope or *vertical angle* of the lighting area, on account of projecting jets, gutters, and sash rails, and the interference of roof rafters, etc., is *greater* than the pitch of the glass itself; this often amounts to as much as 7 or 10 deg. Similarly the *horizontal angle* or bearing of the lighting area with respect to the sun's rays may be greater or less than the nominal angle on account of projecting vertical sash bars, etc. This difference often amounts to as much as 5 or 8 deg.

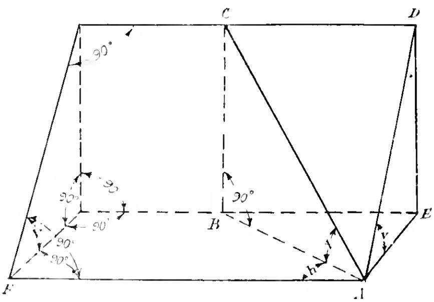

Fig. 1 Path of Direct Sunlight

The position of the sun at any given time depends upon the latitude of the place, time of day, and calendar date, and may be obtained from standard altitude and azimuth tables. Knowing these, the time of admission and duration of direct sunlight for any day of the year may be calculated as follows:

In Fig. 1, let the plane determined by the three points, A, C and D represent the lighting-area plane, and let points A, B and E define a plane parallel with the horizon. These two planes intersect in line AF. The acute angle v is then the effective slope or vertical angle of the lighting-area plane.

Also let line AB represent the horizontal direction or bearing of the sun with respect to the building at any assumed calendar date and time. That is, angle h is the difference between the sun's true bearing or azimuth and the true corrected bearing or azimuth of the lighting-area ridges, each azimuth being read easterly or westerly from north, according to whether morning or afternoon conditions are being computed.

Now pass plane ABC through AB perpendicular to plane ABE cutting the lighting-area plane ACD in line CD. By construction this plane also contains the sun's altitude line through point A. Consequently, it is evident that if vertical angle x is greater than the altitude of the sun, a condition of total shade exists within the building at the given time. And contrarywise, if x is less than the solar altitude, the sun is in front of the plane of the lighting area and some direct sunlight is entering the building.

Now, to find x in terms of v and h (see Fig. 1),

$$AE = ED \cot v$$

and

$$AB = ED \cot x$$

and

$$\cos (90 - h) = \frac{AE}{AB}.$$

Substituting in the last equation the values of AE and AB,

$$\cos (90 - h) = \frac{\cot v}{\cot x}$$

whence,

$$\sin h = \frac{\cot v}{\cot x}$$

and

$$\tan x = \sin h \tan v \quad [1]$$

From the above equation exact information may be obtained as to the time of admission of direct sunlight and the number of hours of its duration. The solution of a numerical example will illustrate the method of procedure.

A Numerical Example, Sunlight Conditions

Given a sawtooth building located in north latitude 36 deg. Orientation of building is such that azimuth of sawtooth ridges = 99° 08′ E. Angle of glass = 73°. *Required* to find sunlight conditions on June 10 (sun's declination 23° N.).

By inspection, according to azimuth tables, sunlight will enter the building from sunrise until at least 9:20 a. m. apparent time, because the sun's azimuth up to that time is less than that of the sawtooth ridges. The method now consists in finding by trial at what time the sunlight entirely disappears from the building.

Assume 10:20 a. m., at which apparent time, according to the tables, the sun's azimuth = 114° 08′ E., and its altitude 64° 46′. Now, v = 73° plus a correction for projecting jets, gutters, etc., as previously explained. (This may be found from detailed section of building and in this case will be assumed as 7°.) Then $v = 73° + 7° = 80°$). Applying the correction as explained above,

$$h = 114° \, 08' - (90° \, 08' - 5°) = 20°.$$

Entering Equation [1],

$$\tan x = \sin 20° \tan 80°$$

whence

$$x = 62° \, 43'.$$

Since at this time the solar altitude (64° 46′) is greater than x, a small angle of sunlight is entering the building. The above process may be repeated with a slightly greater assumed value of h, with the result that within a few minutes all direct sunlight will be found to be entirely excluded from the building.

To obtain afternoon conditions, the operation should be further continued until such time as sunlight is found to reënter as follows:

In this case, instead of assuming the time, and computing h, the reverse method will be pursued and, as a further short cut, it may be reasoned that since the lighting area faces slightly toward the east (that is, N, 9° 8′ E.), h at the transition period will be less than in the morning.

The westerly azimuth of the sawtooth ridges is now used for reference with the tables and equals 90° 0′ — 9° 8′ = 80° 52′. Try $h = 6°$, at which time the sun's azimuth becomes (80° 52′ — 5°) + 6° = 81° 52′, the apparent time being, from the tables 4:34 p. m., and the sun's altitude being from the tables 30° 10′. Entering Equation [1],

$$\tan x = \sin 6° \tan 80°$$

whence

$$x = 30° \, 41'.$$

Since x is 0° 31′ greater than the solar altitude, it is evident that no direct sunlight is entering. However, the angular difference is very slight, and if the computations were carried on a step further, sunlight would be found to come in approximately five minutes later.

In this case, then, on June 10 a condition of total shade exists within the building from approximately 9:20 a. m. until 4:34 p. m., *apparent time*. Where the apparent time is different from standard time, the proper allowance should, of course, be made. Furthermore, an additional correction must be applied in places where the daylight-saving plan is in effect.

Generally it will be found advisable to solve a given problem for at least two sets of conditions, that of the longest day of the year (June 21, declination, 23½° N.) and the average day of the year (March 21 and September 23, declination, 0°).

In the example above, it will be noted that the duration of total afternoon shade is 4 hr. and 34 min. and is considerably greater than the duration of morning shade, which is only 2 hr. and 40

min. This is due to facing the lighting area slightly (9° 8′) toward the east, and suggests quite a range of possibilities as regards orientation.

By applying the principles of descriptive geometry, the amount and location of direct sunlight at any given time may be obtained, if desired, by finding the lines in which the solar rays through the top and bottom limits of the lighting area intersect the working plane—the direction of these rays being taken from altitude and azimuth tables. It may also in this case be necessary to include the effect of side walls, division walls, etc.

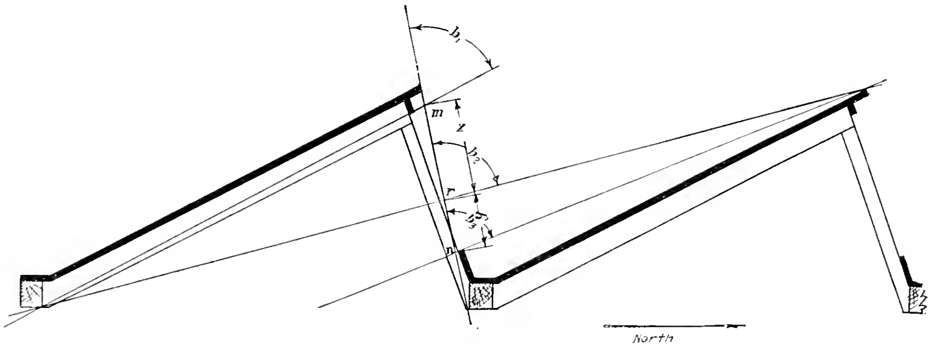

Fig. 2 Area of Direct Skylight Admission

For convenience, Table 1 is appended, giving different values of x for assumed values of h as applied in the second method of the example given above. Its use makes unnecessary any reference to trigonometrical tables, unless closer results are desired, for angles not given.

Part 2 The Relative Intensity of Daylight Received from the Northern Sky as Influenced by the Size and Slope of the Sawtooth Lighting Area

It doubtless has been noted that, by essence, Part 1 lends itself to exact mathematical solution. This is not the case, however, with Part 2, for which, as will be explained later, the answer is not to be found so precisely on account of the necessity of introducing certain more or less arbitrary and variable factors. It should, therefore, be applied only with discrimination and strict regard for its practical limitations.

The total amount of diffused daylight entering a building through sawtooth sash and made available for use (direct sunlight being excluded) may be analyzed as consisting of:

d = light from sky *directly* incident upon the working plane

rd = light from sky *directly* incident upon the underside or ceiling of sawtooth roof and thence being diffusely *reflected* to room below (one reflection)

r_1c = *combined* light from *sun and sky*, diffusely reflected from upper outdoor surface of adjacent sawtooth roof directly to room below (*one* reflection)

r_2c = *combined* light from *sun and sky*, diffusely reflected from the upper outdoor surface of the adjacent sawtooth roof, to underside or ceiling of sawtooth in question and thence being again diffusely reflected to room below (two reflections).

The total amount of light entering the building and due to the summation of the above four elemental quantities is therefore

$$L = d + rd + r_1c + r_2c \ldots\ldots\ldots\ldots\ldots [2]$$

The author has derived the following approximate formulæ for determining each one of the quantities in Formula [2]:

$$d \text{ (per sq. ft. of } F) = \frac{aS_{x+y} \cdot \frac{180}{\pi} \cdot \frac{\text{vers } a}{a}}{F} \ldots\ldots\ldots [3]$$

where S_{x+y} = area of opening in lighting-area plane as defined in Part 1

F = floor area in sq. ft. over which light from area S_{x+y} is effective, that is, one bay long and a properly chosen assumed width selected for S_{x+y}

a = angle of light rays with lighting plane

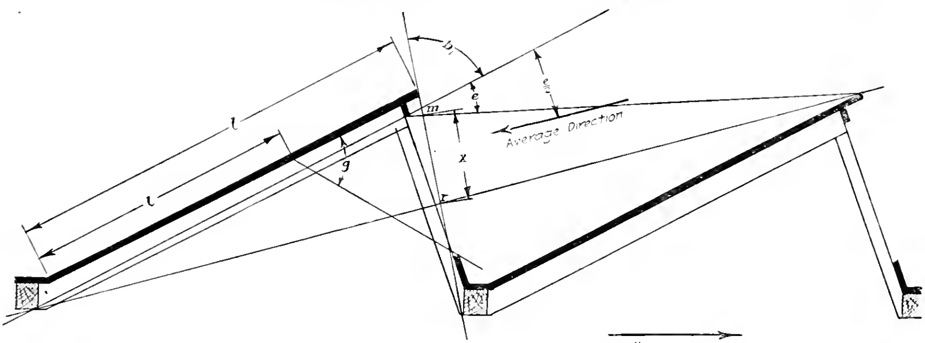

Fig. 3 Path of Skylight Reflected from Ceiling

$$= \frac{x\,\frac{b_1 + b_2}{2} + y\,\frac{b_1 + b_2}{2}}{x + y}$$

as will become evident by inspection of Fig. 2:

$$rd \text{ (per sq. ft. of } F) = \frac{R_1 D \frac{e}{2} S_g \sin\left(b_1 + \frac{e}{2}\right)}{F} \ldots\ldots\ldots [4]$$

[1] A full account of the trigonometric derivation of these formulæ is given in the complete paper.

where R_1 = coefficient of reflection of ceiling

D = proportion of reflected light utilized to total, which may be taken as

$$\frac{180° - g}{180°} \quad \text{(see Fig. 3)}$$

c = sky angle, Fig. 3

$b_1 + \frac{c}{2}$ = average direction of light rays;

$$r_1c = KS_1R_2P_1\left(d + \frac{rd}{R_1D}\right) \ldots\ldots\ldots\ldots\ldots [5]$$

representing average shade line on average day of year

P_2 = proportion of reflected light included between any vertical angle α, Fig. 5, from any point P

$$= \frac{\theta_2 + \theta_1}{2\pi} - \frac{\sin(\theta_2 + \theta_1)\sin(\theta_2 - \theta_1)}{2\pi(\theta_2 - \theta_1)}$$

and the other letters have the same meanings as in the preceding formulæ.

It will be observed that no reference is made to any particular standard unit of flux or intensity of illumination, and the formulæ

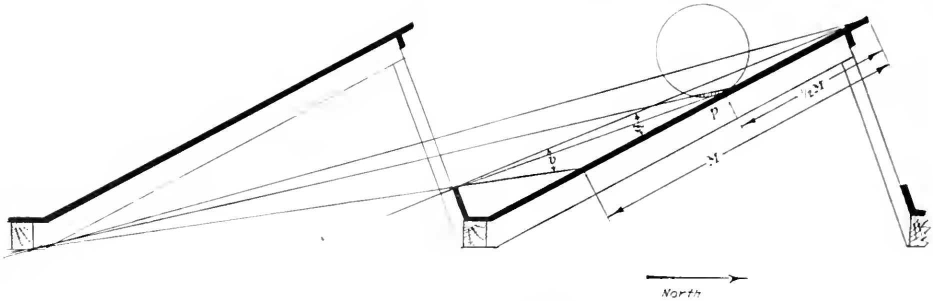

Fig. 4 Sunlight and Skylight Reflected from Roof Top

where K = average ratio of quantity of direct sunlight and skylight incident upon one square foot of roof surface as compared with the quantity of skylight only incident upon and passing one square foot of lighting area S_{x+y}

S_1 = ratio of effective roof area to lighting area S_{x+y}

R_2 = coefficient of reflection of roofing material

P_1 = amount of light obtained by reflection from roof, its proportional value included within any

give only the relative or comparative amounts of light furnished under their several respective headings.

The following example illustrates the method of applying these formulæ.

A Numerical Example, Diffused Daylight Conditions

Given the same typical sawtooth roof as in the example in Part 1, having angle of glass = 73°. *Required* to find the total amount of daylight entering, that is, quantity L, Equation [2].

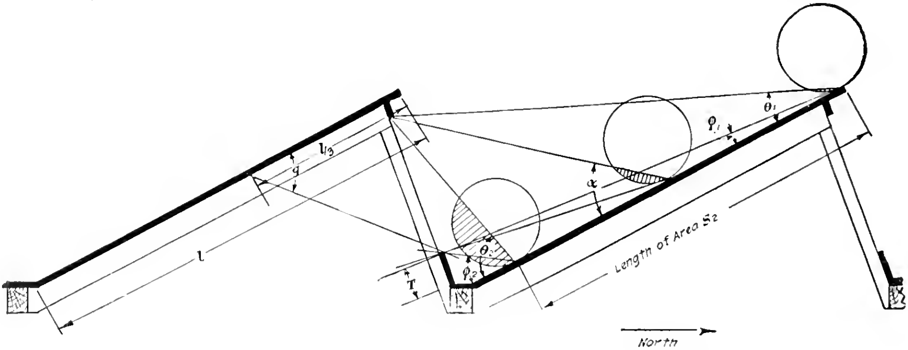

Fig. 5 Entrance of Sunlight and Skylight by Double Reflection

vertical angle g from any point P being represented by shaded portion of tangent circle in Fig. 4

$$= \frac{g}{\pi} - \frac{\sin 2g}{2\pi}, \text{ approximately;}$$

$d + \frac{rd}{R_1D}$ = quantity of direct sunlight incident upon and passing area S_{x+y} as determined by [3] and [4];

$$r_2c \text{ (per sq. ft. of } F) = KS_2R_1R_2P_2D\left(d + \frac{rd}{R_1D}\right) \ldots\ldots [6]$$

where S_2 = ratio of effective roof area to light intensity computed for roof area included between sawtooth ridge and a horizontal line part way down roof

To find quantity d, Equation [3]. From the detailed building sections, it is found that

$b_1 = 72° 30'$; $b_2 = 86°$; $b_3 = 80°$; $x = 44''$; $y = 22''$;

whence

$$a = \frac{44\frac{72.5 + 86}{2} + 22\frac{86 + 80}{2}}{66} = 86° 30'$$

and

$$\frac{180}{\pi} \cdot \frac{\text{vers } a}{a} = \frac{180(1 - 0.165)}{80.5\pi} = 0.592$$

Let the computations be based on a section of the sawtooth having a length equal to the width of one sash, i.e., 8' 3", the latter

having a net width of glass equal to 7′ 3″. The length of span between valleys is 17′ 0″. From the foregoing,

$S_{x+y} = 7.25 \times 5.5 = 39.9$ sq. ft. and $F = 17 \times 8.25 = 140$ sq. ft

Therefore entering Equation [3],

$$d = \frac{80.5 \times 39.9 \times 0.592}{140} = 13.6$$

TABLE 1 SHOWING VALUES OF x IN TERMS OF h AND (c)

$h°$	x for $c = 70°$	x for $c = 75°$	x for $c = 78°$	x for $c = 80°$
3	8° 11′	11° 03′	13° 50′	16° 30′
5	13° 28′	17° 59′	22° 18′	26° 16′
7	18° 29′	24° 28′	29° 52′	34° 36′
10	25° 30′	32° 57′	39° 24′	44° 32′
15	35° 28′	44° 01′	50° 40′	55° 44′
20	43° 15′	51° 55′	61° 05′	62° 43′
25	49° 15′	57° 36′	63° 20′	67° 22′
30	53° 59′	61° 49′	66° 59′	70° 34′
35	57° 36′	64° 58′	69° 41′	72° 56′
40	60° 30′	67° 22′	71° 42′	74° 40′
50	64° 36′	70° 43′	74° 30′	77° 03′
60	67° 15′	72° 48′	76° 12′	78° 30′
70	68° 49′	74° 05′	77° 18′	79° 22′
80	69° 44′	74° 47′	77° 50′	79° 52′
90	70° 0′	75° 0′	78° 0′	80° 0′

To find quantity rd, Equation [4]. From the detailed building sections, it is found as before that $b_1 = 72°\ 30'$; $x = 44''$; $e = 25°\ 30'$; $g = 40°$. Basing the computation on the same length of sawtooth as before,

$S_x = 7.25 \times 3.66 = 26.5$ sq. ft.

$F = 140$ sq. ft.

also,

$$D = \frac{180 - 55}{180} = 0.7.$$

Assume that ceiling of sawtooth roof is painted white and has a coefficient of reflection $R_1 = 0.60$. Then, entering Equation [4],

$$rd = \frac{0.6 \times 0.7 \times 12.75 \times 26.5 \times \sin(72°\ 30' + 12°\ 45')}{140} = 1$$

which is relatively small compared with d.

To find quantity r_1c, Equation [5]. From the detailed building sections, it is found that $q = 15°$

$$= 0.26 \text{ radians, whence } P_1 = \frac{0.262}{\pi} - \frac{\sin 30°}{2\pi} = 0.004.$$

According to a publication entitled *The Sun*, by Charles G. Abbott, S.M., Director Smithsonian Astrophysical Observatory, the average intensity of sunlight plus skylight on this sawtooth roof may be deduced as being during working hours, and for ordinary atmospheric conditions, four times that of skylight on the lighting-area plane. Therefore, let $K = 4$.

S_1 from the detailed sections is found to be 2.3. Assume the roof to be covered with clean white slag having a coefficient of reflection = 0.5. Therefore, entering Equation [5],

$$r_1c = 4 \times 2.3 \times 0.5 \times 0.004 \left(13.6 + \frac{1}{0.6 \times 0.7}\right) = 0.3.$$

This quantity, represented by Equation 5, is usually so small that it may be omitted entirely from the computations.

To find quantity r_2c, Equation [6]. From the detailed building sections, it is found that

$\theta_2 = 80° = 1.4$ radians

$\theta_1 = 24° = 0.42$ radian

whence

$\theta_2 + \theta_1 = 1.82$ radians, and $\sin(\theta_2 + \theta_1) = 0.97$

$\theta_2 - \theta_1 = 0.98$ radian, and $\sin(\theta_2 - \theta_1) = 0.829$.

Therefore,

$$P_2 = \frac{1.82}{2\pi} - \frac{0.97 \times 0.829}{2\pi \times 0.98} = 0.16.$$

S_2 is found to equal in this case 2.7.

$K = 4$, $R_1 = 0.6$, $R_2 = 0.5$, and $D = 0.7$, as before. Therefore, entering Equation [6],

$$r_2c = 4 \times 2.7 \times 0.6 \times 0.5 \times 0.16 \times 0.7 \left(13.6 + \frac{1}{0.6 \times 0.7}\right) = 5.8$$

Whence, Equation [2]

$$L = 13.6 + 1.0 + 0.3 + 5.8 = 20.7$$

This total quantity may be compared with a corresponding value computed for a sawtooth building already in service and of known degree of excellence as regards intensity of natural illumination.

In case additional illumination is required an alternate design having increased glass area or a flatter slope, or both, might be considered and in this connection it is interesting to note that if the pitch is decreased by only 10°, the glass area remaining the same, L figures out to be increased by about 15 per cent. On the other hand, assuming the building placed as in the first example and applying the principles of Part 2, it is found that considerable sunlight will enter for the entire day. That is, the period of total shade would be decreased on June 10 from more than 7 hr. to zero, direct sunlight being present continuously.

This information, when extended to comprehend that for other days of the year, including the day of average length, and when used in conjunction with the particular conditions and requirements of the problem in question (not excluding first cost), should facilitate the selection of the most advantageous design.

Various means have been adopted to exclude direct sunlight from the interior of such buildings, and all of them seem to have the disadvantage of reducing the total illumination. Sawtooth buildings with glass vertical, that is, with the effective angle of the lighting area actually *overhanging* are not uncommon; whitewashing the glass results in some protection against direct solar rays and a cooler interior, but also in glare and considerable loss of light.

Whatever glass is used, cleanliness is essential; furthermore the significance of Equation [6], indicating the possible average relative amount of reflected light, emphasizes the importance of adopting where practicable, light-colored roofing materials such as white slag, and also the use of white dust-resisting washable paints upon sawtooth ceilings of buildings in which maximum daylight is desired. If either of the above surfaces had been black, the average reduction in daylight for the second example would have been equivalent to 30 per cent, or, expressing it another way, the increased light resulting from their use amounts to over 40 per cent.

As before noted, Part 2 of the paper should be applied only with due regard to its practical limitations. It furnishes a means of comparison with known designs and is based on fair-weather conditions and with sunlight on the building as a whole. During cloudy weather the amount of useful light contributed from the top of the sawtooth roof is, of course, decreased, but, on the other hand, the quantity of direct skylight, which has been found to constitute the major portion of the total, is often thereby considerably increased.

Conclusions

From the foregoing analyses it is evident that the height of valley (T, Fig. 5) for a given construction should be made as low as is consistent with protection against the elements, including snow and ice.

Furthermore, it will be seen that for a given building the use of a *small* number of *large*-scale sawteeth as against a greater number of *smaller* units having the same pitch, results in considerably increased daylight due to fewer number of valleys of height T, and consequently less proportionate obstruction. This principle, of course, should be applied with due regard to the structural limitations and the architectural considerations which may be involved, together with the important question of uniformity of daylight intensity.

It is also worthy of note that the adoption (for the reasons above outlined) of flatter sawteeth with increasing terrestrial latitudes works out well in conjunction with the heating requirements, since it results in less cubage and radiating surface.

EMPLOYMENT OF LABOR

By DUDLEY R. KENNEDY,[1] PHILADELPHIA, PA.

MUCH concerning the description of the engineering and construction of the Hog Island Shipyard has appeared in various trade and technical journals. The labor requirements of the undertaking and the different phases of the activities undertaken in connection with the problem of securing employees and providing for their needs and comfort are explained in this article.

The contract between the United States Shipping Board and the American International Shipbuilding Corporation, Emergency Fleet Corporation, signed on September 13, 1917, called for the construction of the largest shipyard in the world and 120 ships, to be built therein, all in twenty-one months. Seventy of the boats were to be cargo carriers of 7,500 dead-weight tons and 50 boats of 8,000 dead-weight tons, combination cargo and transport.

The yard was to have 50 shipways, or two more than the six largest yards in America combined, with the necessary administration and service facilities to properly serve this number of ways.

The construction of the yard was practically complete on October 20, 1918. The following figures give an idea of what has been accomplished:

18 miles of streets and roads
82 miles of standard gage ballasted railroad track
21 miles of water pipe
50 shipways requiring the major portion of the 127,000 piles driven
72,500 ft. of drainage ditches
71,350 ft. of sewage piping
90,000 ft. of compressed-air pipe for the second largest compressed air plant in the world, the largest being at the Rand Mine in South Africa
16,300 ft. of fuel-oil pipe
A water-supply plant from which the plant is now using daily 2,000,000 gallons of water
250 buildings
15 large restaurants and cafeterias, serving daily 12,000 to 18,000 meals
4 ships have been launched
11 are under construction
61,000 tons of steel have been placed in ships
7,000,000 rivets have been driven
The bulk of 3,500,000 cu. yd. of material to be dredged has been removed and all of the divers and sundry things incidental and necessary to all this, which can be readily left to the imagination of a group of engineers familiar with such general problems.

All this has required the expenditure of much money. To illustrate more graphically just how much, and with what speed the job has progressed, it may be added, that the rate of money expenditures has been five times that of the Panama Canal.

In the inception of the job when the engineering estimates were in preparation, it was recognized that the labor problem would be one of the cardinal difficulties of the undertaking. Notwithstanding the difficulties, there were upon the payroll on January 19, 1918, 26,700 men, and there are now 35,000 employees. To obtain this number and maintain the necessary interim quota it has been necessary to hire a few more than 230,000 people in a calendar year. This means a labor turnover of nearly 700 per cent.

Let us see what conditions were when the job was started. Hog Island is situated about eight miles south of Philadelphia City Hall, upon the Delaware River, in a comparatively isolated spot, known principally for its shooting and its mosquitoes, inaccessible as far as regular transportation facilities were concerned.

At first, there was no passenger transportation into Hog Island by rail and how the employees traveled to and from Philadelphia is and will always remain largely a mystery.

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Today there are two trolley lines, a steam shuttle line connecting with the main line of the Pennsylvania and the Reading, and an excellent train service over a special cut-off line of the Pennsylvania.

In the inception of the job, the management, appreciating the size of the "Human Engineering" phase, organized a department styled the Industrial Relations Department, having jurisdiction of the branches Employment, Medicine, Surgery, Sanitation, Safety, Housing, Feeding, General Welfare and Service and Compensation. Each of these will be described separately.

EMPLOYMENT DEPARTMENT

The manager of Industrial Relations ranks, with equal authority, with six other heads of departments, reporting direct to the President. This is an important point, as many companies now appreciate the importance of the "Human Machine" to a degree which places an executive in charge of Industrial Relations with authority paralleling that of executives in charge of other major phases of administration. This department occupies a two-story building 251 ft. long by 48 ft. wide, with an ell 132 ft. long by 63 ft. wide.

The Employment Department occupies the bulk of the first floor. The waiting room is 85 ft. by 48 ft. and will accommodate 800 men. The building was planned to afford as nearly a stream line or continuous process as possible through the various stages of the necessary employment routine; therefore the waiting room is situated at one end of the long face of the building. Immediately the applicant for employment finds for himself a place in one of six lines, formed before six doors, over each of which appears the name of the positions or jobs for which men are being examined in that "interviewing room."

In each of these six rooms is a man familiar with the specifications of the job or jobs for which he is selecting applicants, and into his room he receives in turn the men in line, and to each he gives a short, courteous, but adequate and firm catechising and determines his fitness for the position which he seeks.

Having accepted the applicant, he passes him on to the registration clerks, of whom there are about 25, who fill out a registration blank covering the many details which it is necessary to record for purposes of identification, for the State Workmen's Compensation Law, for the Selective Draft and for statistical purposes. This form when completed is handed the man and he proceeds to the physical examination, where he enters one of thirty booths and receives an examination in the nude to determine his fitness for work and for the particular job to which he is assigned.

Successfully passing this examination, the applicant proceeds to the photographic room, where he is photographed *with* his sequential employment number, which becomes his identification and payroll number, and his height and weight and date of hiring. This information is placed in a rack by lettered and numbered cards, and the new employee stands with his chin just over the rack so that the printed photograph shows all this information. This business of plant protection and identification has been perfected to such a nicety as to make possible the taking, developing and printing of 4000 of these pictures a day.

The new man is then taken to the Dispatcher and there the new men are grouped and taken by one of 15 messengers to the portion of the work for which they have been hired. When the messenger delivers a new employee to a department, the requisition issued the day previous is canceled, and the foreman signs a receipt discharging the obligation of the Employment Department.

The messenger is made necessary for several reasons, but principally because the plant covers 900 acres, has eighteen miles of streets and is $2\frac{1}{2}$ miles long and a mile wide, and it is quite a task for a newcomer to find his way about.

Medical Department

The Chief Surgeon is responsible for the medical, surgical, and sanitation divisions. The hospital equipment is the most up-to-date procurable and the hospital contains an anesthetic room, operating room, X-ray room, first-aid dressing room, re-dressing room, two wards containing 21 beds, dental clinic, eye clinic, heat-treatment room, etc.

In the month of August 1918 the plant had 7583 accidents, of which, however, only 160 were time-losing accidents of over one day. The percentage of accidents was only 0.97 per cent of the men employed, or less than 1 per cent, and the infections ran 1/8 of 1 per cent, all of which compares favorably with the best records shown by the largest commercial companies in the country.

Sanitation

Hog Island has all the problems of sanitation and hygiene of any city of 35,000. Working under plans of this Department, the mosquito has been absolutely eradicated and with it vermin of all kinds. The Department maintains a chemical and bacteriological laboratory which tests the drinking-water supply at all points of egress daily, analyzes sewerage, samples and tests all food served, and does all the work of the hospital on sputum, pus, excretions, blood, urine, etc. The Department maintains the medical dispensary, contagious hospital, and detention barracks, and its alertness and efficiency have made possible the phenomenal record of last winter as to the general health of workers, resident on the Island, and the record of the present influenza epidemic. For both, Hog Island records were as good as any shown by army cantonments.

Safety Department

The Safety Department is modeled along lines in general use by the larger corporations and the figures before quoted on accidents show that it has done its work well in so quickly bringing a "mushroom job" to the standards of the old-established corporations.

Housing Department

The Housing Department task has been trying, but barracks have been completed on the Island for 5000 employees, a bachelor hotel has just been opened accommodating 2200 men, with 2200 rooms. It is in fact the largest hotel in the world today. The E. F. C. has finished and is completing a unit of 953 homes of brick construction for married employees of Hog Island which rent for an average monthly rental of $25 for six rooms and bath.

During the last year the Housing Department has furnished 16,500 accommodations in the city of Philadelphia, and this in the face of the Philadelphia Housing Association's statement of a year ago that the city possessed not more than 5000 accommodations for the incoming human flood.

Feeding Employees

The Commissary Department is one of the most interesting on the Island. Its employees number 700, in 27 different units, the largest of which accommodates 3000 at a meal, and it feeds an average of 17,500 persons per day and during August of this year served 486,964 meals. The Department is run by the company for its employees without profit. Straight meals sell for 30 cents each, while the average cafeteria meal receipts are about 33 cents.

Service and General Welfare

The Service Department handles the matters most readily understood as welfare. These include the plant industrial Y. M. C. A., athletics, the plant weekly paper, and general services and welfare.

The welfare of the women employees is in the hands of a woman physician who fills the joint capacity of Welfare Director and Medical Advisor for them.

There are now employed over 2500 women. Most of these are in the offices in various capacities, and in the commissary department, but the employment of women for yard work has long since passed the experimental stage and women are working in our yards at 20 different tasks—from common labor to such skilled tasks as acetylene cutters and welders, and their number is being constantly augmented as the prejudices are being broken down and as the man-power shortage grows more acute.

Workmen's Compensation

The Workmen's Compensation for employees is administered by a branch of the Industrial Relations Department under the terms of the Pennsylvania Act.

The wage setting and adjustment for the job has been a serious task, and while the U. S. Shipping Board Labor Adjustment Board has fixed a standard scale for all shipyards, covering the shipbuilding trades, the construction of Hog Island presented many problems on construction rates involving almost every conceivable craft. Notwithstanding the hardships to which workmen have been subjected, and the difficulties with which the works has been beset, not one day has been lost through strike or labor difficulty. The "open shop" has maintained throughout and it is only justice to say here that organized labor has, in the main, lived up to its agreement with the Government in not attempting to force recognition or the "closed" shop.

Almost the universal problem with employers has been the question of securing a sufficient number of employees to operate at maximum capacity. It has been a question of "collection," not of "selection."

INDUSTRIAL ORGANIZATION AS IT AFFECTS EXECUTIVES AND WORKERS

By CHARLES E. KNOEPPEL,[1] NEW YORK, N. Y.

THE object of this paper is to establish some rules of efficient organization for the practical guidance of executives in developing an intelligent system of industrial relationship. Now more than ever, after so many years of war, it is required to direct every effort to increasing industrial production and promoting international trade, in order to coöperate in the tremendous task involved in reconstructing the world.

Three facts must be borne in mind in connection with the problem of industrial relationship: Industry is nothing but the collective action of various individuals; management consists of controlling and guiding the acts of the different agents engaged in industry; and industrial relations are the reactions created in all individuals, as a result of this control or guidance on the part of the management.

The flow of influence in relationship is from the administrative executives to the operating heads, to the superintendents, and finally to the workmen. In order for this influence to operate successfully there must exist a system of proper coördination

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among the various agencies in industry. Well-defined policies in the executive branch of an administration secure contentment and satisfaction in the workers.

The following suggestions are offered in an effort to formulate a code of practical laws of efficient organization:

The Objective

A tentative plan of organization should be worked out and decided upon. Owing to the presence of unknown factors, which cannot be determined in advance, the ultimate objective cannot be agreed upon at the outset; in fact, it will be well toward the completion of the work before the final type of organization can be settled upon. No plan can be worked from the top down in its entirety, nor should one be worked altogether from the bottom up, for this would result in a development lacking coördination. The game should be one of "playing the ends against the middle."

Greatest Complication

A department should be divided into the most difficult functions which the men in charge will be called upon to undertake. The evolution of industry from a one-man stage to that in which many men are needed for the handling of specific things, has been based, consciously or otherwise, on this "law of greatest complication." In manufacturing, for instance, there was no doubt a time when the same man could both design and sell what was to be made and then go out in the shop and make it. But as the knowledge required of a man to design, sell, and to make, became greater and more complete and intricate, it became necessary to form two sections or departments, each of which took over one of the functions named above. Each department was placed in charge of a specialist, and both departments were supervised by the man who formerly handled all the details himself.

This law that is involved applies not only with reference to a business as a whole, or to a single department of a business, but to any division of any department.

There are several reasons for establishing this law: First, to guard against putting more work on the shoulders of a man than he has the knowledge and ability to handle; second, to make it possible to pick out the hardest job first; to make possible the selection of that work which will yield the greatest returns in the shortest possible time.

Concentration

Each section, division, or department of a business should be so arranged as to contain all the factors which will effect the performance of only its own function. If such a plan is adopted, the head of the work can be held strictly responsible for the successful conduct of his department, as he controls all the factors in connection therewith and can therefore be given to understand that he will stand or fall according to his showing.

The strict observance of this law when organization is being effected greatly reduces the amount of supervision required, and also tends to develop and strengthen the men in the concern. If a man is given full charge of a division or section of a business, and controls every factor that affects the successful performance of the main function of that division or section, he can be held wholly responsible for that function. If, however, other men besides himself have charge of some of the factors affecting the success of that function, it is impossible to hold him solely responsible for it. The only method of supervising him, under such circumstances, will be to hold him responsible for all the operations in his charge that affect the performance of his function, and then to check him up carefully. Such a system involves an excessive amount of work in supervising, and also forces the man himself to follow personally all the details of the work he supervises, in order that, when called to account for them, he may be familiar with their condition. Any one, under such a handicap, will naturally become absorbed in details, to the detriment of his executive work.

Individualism

A battle cannot be won by half a dozen generals, all of whom have equal authority. There must be one-man control.

There is nothing more confusing in an organization than for employees to have more than one man to whom they are directly responsible, and nothing that so quickly destroys discipline as to have a manager go over the heads of his subordinates. Yet these are among the faults we find most frequently in organization work.

When a man enters an organization, his duties and all matters which he is to be held responsible for should be definitely stated to him. In addition, he should be told who the head is to whom he is responsible for carrying out his duties, as well as who the men are that will be responsible to him.

Mutual Capacity

When a department or business is reorganized, a division should be made with reference to the knowledge and ability that will be required of the man who shall supervise the work, as well as with respect to the knowledge and ability that those men must have who shall actually carry out the work. Then, too, what is to be done must be within the capacity of the average types of men who are fitted to fill the various positions.

If an organization is divided according to its most difficult function so that the knowledge required for each position will be as little as possible, and the positions are arranged so that each executive has complete control of all the factors affecting the success of his function, the executive jobs, as a rule, can be well handled by average men. If, however, the organization is incorrectely divided, and each executive is given a slice of this and a part of that, and the success of each man's job is dependent on the successful handling of a lot of work that is handled by other executives, then there will be great difficulty in obtaining executives who can produce satisfactory results. Even if the company, under such circumstances, does hire executives of proved ability, they will soon deteriorate under the bad form of organization, will lose all their initiative, and will become worthless in a few years.

Specialization

An organization should be divided so as to develop specialists. To this end, care must be taken that one department head shall not duplicate the work of another.

Specialists are developed by allowing men to work in a limited field of knowledge. In other words, a man is so developed that instead of knowing many things superficially, he will know a few things extremely well. If the knowledge necessary to manufacture and market a number of products is divided up into a number of limited fields of knowledge, as it were, and one man is put in charge of all the work in each of these fields of knowledge, these men will become specialists. Now if, under each of these men, each of the sub-heads is in charge of all the work representing one portion of that field of knowledge, then there is an organization of specialists.

In an organization of specialists there is no difficulty in finding men to fill competently executive positions, for the average man with executive ability can handle efficiently a large amount of work in a limited field of knowledge.

Responsibility

An executive should be held responsible for the total proven results, or for inability to secure results, and not for the details of the methods that he uses in trying to secure these results.

It is a frequent fault in organizations that the bigger executives—especially those who, when the concern was small, followed all details—judge the executives under them by various details that they find wrong, instead of judging them by the total proved results in that section of the business for which those minor executives are directly responsible.

Permanency

What would happen if, during an engagement, a member of an artillery squad, or of a gun crew on a battleship, should suddenly be killed, and none of the others should know what to do in his place? The consequences would be serious indeed. And yet in industry we find many cases in which no provision has been made for training men to fill the positions of their superiors, in case anything should happen to the latter. A man may at any time be transferred, or he may die, or be taken sick, or resign his position, or take a vacation, or be dismissed from the employ of the company. In any of these cases, it will be the duty of some one else to fill the gap at least temporarily, perhaps permanently, and if no one has been trained to take over the new work, results are bound to be unsatisfactory, if not disastrous.

Relationship

A business is nothing more or less than the adjustment of individuals, to the end that all may follow a definite policy, or line of procedure. One of the weaknesses in business is the almost universal practice of giving an individual only the most general kind of instructions concerning what to do and how to do it.

A man is engaged to do a definite "something," and just what that something is should be known by all with whom he comes in contact; otherwise he cannot be held responsible for results. His functions in the business, his duties in performing this function, and his relation to others and of others to him, should be sufficiently defined so as to enable him to work efficiently.

Personnel

A set of specifications covering the qualifications required in each of the members of the personnel should be determined before making their selection. Hiring men is, or should be, like purchasing materials, in that there should be, first of all, definite knowledge of what is required. After all, it is a case of matching qualifications against requirements. If we know what we want, we can check the merits of the material that we examine. For instance, if a position demands close application, long hours, and indoor work, it is sheer folly to engage a man who loves the open and therefore detests confinement and close application. He would naturally be inefficient because discontented and unhappy.

If it is essential in buying a machine, to lay down certain specifications, and then make sure that the machine measures up to them, it is just as important to have specifications in regard to the men we shall engage, in order that we may check their qualifications against them.

Instructions

A ship without a compass would not be used in ocean transportation; a boiler without a safety valve would not be used in a steam plant. And yet in industry there is little, in many plants, that corresponds to compass and safety valve; or, in industrial terms, there is a lack of instructions and charts.

Anything worth defining is certainly worth recording and yet we have all seen organizations of people working together without any guide whatever in the form of standard practice, no definite idea of functions and duties, no charts showing relationship. The difference between having such charts and not having them is simply the difference between organization and disorganization.

The concern that insists on properly issuing complete written information covering the material it buys or the product it sells, will deem it unnecessary to have written instructions and charts covering the operations of the people who use the material and make the product.

Staff

The chief of staff should be a man of experience, tact, and exceptional analytical ability. Every department manager should have the right to call on the staff to assist him in the solution of his problems, and to have them make detailed studies of any sections of his department that are not running satisfactorily. If the managers can be induced to make such calls on the staff freely, the results obtained will be satisfactory, but if staff advice has to be forced on them the results will be poor. Staff consultation should never be forced on a manager except when the reports from his department show decidedly poor results and he does not call on the staff for assistance. In these cases it should be suggested that the staff assist him, and if he refuses to take the suggestion, he should be forced to accept their coöperation.

Functions of an Executive

The functions of an executive should be: To exercise general supervision over the business or the department; to analyze results critically; to put new problems before his men for their consideration, advice and action; to criticize subordinates when results are not forthcoming, explaining the reason why; to see that the prescribed practice is regularly followed.

An executive should not attempt to do everything himself, but should deputize authority among competent assistants. He should not waste time over minor details, and, most important of all, he should study men in order that he may be able to arouse in them the greatest possible amount of initiative.

If the solution of the present economical problems is ultimately dependent on the successful development of industry, and this can be achieved only by efficient organization, it is the duty of every industrial community to take the steps necessary for securing an undisturbable harmony between its various social elements. By the coöperation of capital and labor, with a perfect understanding between the employer and the employee guided by a sense of justice and fair dealing, industry will contribute mightily to the progress of the world.

LABOR DILUTION AS A NATIONAL NECESSITY

By FREDERICK A. WALDRON,[1] NEW YORK, N. Y.

THE term "Labor Dilution" originated in England shortly after the declaration of war with Germany. Its original application was intended to carry out in effect what the definition of the word "dilution" literally implied; namely, a thinning or spreading out. As applied to labor, it means the thinning out or spreading of the functions of the skilled workmen among those that are less skilled, and a Bureau of Labor Dilution was therefore established by the Government to supervise and carry out its requirements.

The original objective of this bureau was to relieve the skilled workman in the performance of certain functions of a task and employ less skilled workers for the purpose of accomplishing a given task in a shorter time.

The development of the work of this bureau has been such that economies heretofore unknown have been established and the fact brought before the manufacturer in evidence strong and beyond contradiction that many things done for apparent necessity were not at all necessary to the proper and efficient conduct of busi-

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ness. Its work, during the war period, will become a national industrial asset and change the entire mental attitude of the employer and the employee to one of greater coöperation and higher efficiency for years to come

Unintentionally, perhaps, and unconsciously this bureau has created an element in labor dilution which was not included in the original program, as it has already established in the minds of the consumer that waste of labor and materials is the greatest foe to labor dilution that a nation may have.

This is a vital problem, and it is the engineer who must solve it in a scientific and satisfactory manner. For years following the war our work must be done in the spirit of conservation, with profits a secondary consideration. This involves the engineering of men in the broadest sense, since the supplies of both have become so seriously depleted through the waste of war.

Ultimately it will be the "survival of the fittest." A nation's industries must be those for which it is particularly adapted; they must be conducted in the most economical manner, and facilities for vending and transporting their products must be on an equally economical basis. For products of equal quality, those having the lowest unit costs will naturally maintain commercial and industrial supremacy. The nation which can deliver to the consumer its converted natural resources in the minimum of time with the least expenditure of human energy is the nation which will lead the industry and commerce of the world.

To accomplish this there must be a broad and comprehensive national policy in the organization of our legislative, banking, business, agricultural, transportation, mining and manufacturing policies.

As the value does not appear until labor has been applied to nature's labyrinth of wealth, it is incumbent that the study of labor requirements and performance be given most careful consideration, and to this end it will be helpful to summarize the conditions which confront us at the present time, as follows:

1 The equipment and physical condition of our transportation facilities are not being kept up to the pre-war condition of efficiency
2 Agricultural industries are suffering for the lack of labor and intensified productivity of soil
3 Our roads and highways are rapidly deteriorating due to the lack of man power to construct new and repair the old roads
4 Work on the enlargement and development of public utilities is practically at a standstill
5 Irrigation projects are practically stopped
6 The manufacture of munitions, when abandoned, will place an immense amount of machinery in the scrap heap. This must be replaced by new machinery
7 Operations in the erection of buildings other than those required for immediate war needs has practically ceased
8 The output of our steel mills has been practically absorbed by the Government for war work
9 Immigration has practically ceased
10 The birth rate will supply but a small percentage of the man power needed.

From the enumeration of the above items, it can be fully appreciated that the accumulation of work to be performed is stupendous. Therefore, if our present methods continue, the great problem will be to obtain labor for this work.

It is self-evident that we cannot depend on European immigration to this country for this period. The depletion of man power due to war losses and the demand for this power in the reconstruction period abroad, combined with the internal development that is likely to take place in Russia, will mean that immigration from these countries will be prohibited. Further, of the man power sent by this country to Europe, at least ten per cent will be incapacitated for work of a strictly laboring character.

We will, therefore, be practically dependent upon native-born Americans based on our population of 1900 to 1905, which is estimated as 90 to 95 million. The best available statistics at the present time would indicate that the average birth rate of this country is 25 per thousand population and that the death rate is 15 per thousand, leaving a net gain of ten persons per thousand. This means that there will come to workable age in the post-war period about 900,000 yearly, of whom approximately 400,000 will be males.

While the employment of an abnormal number of females as a war measure is right and justifiable, its continuation during the post-war period is problematical from the standpoint of the nation's man power.

This brings the subject of Labor Dilution as a National Necessity to a phase much broader in its meaning than that which was originally intended.

Broadly speaking, labor dilution should consist not only in the functionalizing of the work of the skilled man with that of the less skilled man, but it is equally important to eliminate useless and unnecessary labor which, at the present time, is deemed necessary due to the mental attitude and the habits formed in years of development and peace. It would seem, therefore, that the problem of labor dilution can best be approached by classifying into the following program:

1 Standardization (indirect); (a) Legislative methods, (b) business and financial methods, (c) transportation methods, (d) mining and agricultural methods, (e) manufacturing methods.
2 Coöperation (indirect): (a) Legislative methods, (b) capital and labor, (c) engineering methods.
3 Elimination (direct): (a) Non-essential statistical work and data, (b) non-essential office work, (c) non-essential administrative work, (d) non-essential sales and advertising work, (e) the idle citizen or loafer.
4 Education (direct): (a) Of the legislature, (b) of the business man, (c) of the engineer, (d) of the executives, (e) of the laborer.
5 Occupation (direct): (a) Analysis, (b) distribution, (c) localization, (d) compensation.

Standardization (Indirect)

While the final effect of standardization on labor dilution is indirect, this is the foundation on which it should be built. The principal divisions are outlined above and will be briefly analyzed in the order of their importance.

a Legislative Methods. All laws regarding the conduct of business should be simple and direct, and the purpose in view should be the eliminating from the honestly conducted business, complications or hardships involving unnecessary expense and red tape; such laws to be drawn up with the hearty and consistent coöperation of the legislator, the business man and the employee, with the view of making them as simple and direct as possible. With honesty of purpose and fair dealing on the part of all, there should be no serious difficulty in establishing laws that would be much more simple and uniform than those at present in force.

b Business and Financial Methods. Where there has been rapid growth and an immense volume of business, it has necessarily carried with it an enormous labyrinth of complication, duplication and detail work which requires the employment of a large number of non-producers to care for records necessary to bring the raw material to the consumer. The result of standardization would, in a measure, automatically eliminate this labor and tend to reduce the cost of doing business.

c Transportation Methods. The amount of labor involved in the transportation of raw material to the consumer, directly or indirectly, is enormous. By the adoption of standard forms, carriers, and an improvement in the vehicles of transportation, with improved methods of handling materials at the terminals, a great amount of labor would be liberated for other work.

d Mining and Agricultural Methods. The amount of labor employed on this class of work could be greatly reduced by the introduction of new machinery and the perfecting of existing machinery. In mining great progress has been made in the reclaiming of what was once considered waste ore. Certain strides have been made in the agricultural field whereby the productivity per acre of ground has been greatly increased. This practice, however, has not been employed in a large number of the small

areas under cultivation. Intensive mining and farming should be given more attention.

e. Manufacturing Methods. The standardization of production in our factories would eliminate a large amount of surplus materials which are now carried in stock by the dealers, and would allow of interchangeability of parts that are most essential and enable business to be transacted direct with the consumer. This would reduce the inventory investment of manufacturers and dealers, thereby reducing the number of pieces to be made and the labor applied thereon.

Coöperation (Indirect)

It naturally follows that, in order to obtain the benefits from standardization, coöperation should obtain to the fullest extent; and by continuous and systematic effort on the part of the legislator, the business man, the engineer and the workman, the essentials under the head of Standardization would begin to produce results.

Elimination (Direct)

The natural results following standardization and coöperation would be elimination, since many employed at the present time would necessarily be transferred to other lines of occupation.

The general headings covering the classes of work eliminated are included in the preceding classification.

Education (Direct)

Following standardization, coöperation and elimination there should be a concerted effort to educate to a new epoch of economy. The term Education as applied to this particular phase of the situation is used as an expression for the change of the mental attitude of the public from that of extravagance to that of basic economy. It should teach that "waste makes want and want makes woe," and that the conservation of our present energy and natural resources is of greater national value than the unlimited accumulation of the almighty dollar.

Occupation (Direct)

Last but not least, occupation should be considered in the problem of labor dilution. An era is approaching in which the conditions of the present and past will be entirely changed and which will involve a wholesale change in the distribution of occupations.

In order that this may be done with the least disturbance, a careful analysis should be made of the adaptability of the individual to the occupation, and consideration should be given to the distribution of such occupations. Coincident with this should follow the locating of industries at such points as will insure economic production.

The occupational problem that will ensue will always lead to differences of opinion, but it is governed largely by supply and demand and the standards of living in different communities or nations. The lower the standard of living, the lower the compensation for labor. The higher the standard of living, the higher is labor compensated. The problem, however, resolves itself into the production and delivery to the consumer at the lowest possible cost with a fair profit to the manufacturer.

These are facts showing that "a condition and not a theory" confronts us. If it is expected to keep in circulation the currency of the world at the present rate, it is necessary that public improvements, manufactories, agricultural and mining interests should continue at a rate commensurate with the present circulation of money.

This means a gradual readjustment, and, in order to be prepared for this readjustment, the problem should be looked squarely in the face and the way paved by which such readjustment can be made with the least possible disturbance. This can only be done by careful planning and action on the part of the country's greatest men in preparing to meet the problem of labor dilution in a broad way.

The English, with their customary conciseness, have expressed in the two words, "Labor Dilution," that which it would require volumes to describe or discuss.

A study of the problem indicates that, in its broadest meaning, Labor Dilution and the Engineering of Men are practically synonymous, since the former involves all that the latter implies.

USE OF NON-FINANCIAL INCENTIVES IN INDUSTRY

By ROBERT B. WOLF,[1] SAULT STE. MARIE, ONT., CANADA

THE basis of all "non-financial incentives" is interest in work. Interest in work implies a desire to produce, actuated by internal motives rather than external discipline.

Production means creation, and the industrial creative function in man is a mental process and lies in his intelligent adaptation of means to ends. It is useless, therefore, to look for real creative work unless the workman has a chance to think and to plan; any other working environment either fails to attract or actually repels the workman, and as a consequence offers no incentive to increased effort.

Work which does not call for thoughtful reflection and which uses only muscular effort tends to draw men down to the level of the brute and makes for industrial irresponsibility and consequent social disorganization. The unthinking man cannot be a responsible man.

It is the self-conscious faculty of man which distinguishes him from the animal and makes him, above all, a creative center through which the universal life-giving power can deal with a particular situation in time and space.

To use a homely illustration with which every one is familiar, the traffic at each crowded street crossing cannot be regulated from the City Hall; it requires an individual (the traffic policeman) in the congested spot to deal with each particular situation as it arises, and upon his powers of observation and selection depends the orderly flow of traffic.

It is only through the individual life that the universal life can act, and therefore the universal is compelled to evolve many individual lives if organization and order is to replace the unorganized state represented by the purely generic operation of natural law.

The problem of social organization is, then, how to organize society upon the basis of respect for the individual. This is also the industrial problem as well, for industry in the broadest sense is society in its highest form of activity because it is essentially constructive and therefore creative activity.

It was an inevitable corollary to the universal plan of creation that the individual life came into being, not to create material substance as that had to be before individual life could gain consciousness. The function of the individual life, however, is to create by a thought process conditions especially selected to produce results which nature unaided would find herself unable to produce.

This is what the horticulturist does. His power lies in his knowledge of natural law, and his creations are made possible because he conforms to the law. The uncultivated orchard reverts to its original wild state when no longer attended by man, but increases in productiveness by continued thoughtful application of man's power of selection and adaptation.

It is by a similar process of conscious selection that such devices as the steamboat, steam engine, electric generator and the

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telephone came into existence. They did not come into being, and never would have been created by the generic operation of nature's laws.

* * *

The creation of artificial conditions, which, taken all together, we call civilization, is, of course, the product of man's organizing power. While self-consciousness, the power of realizing the self as apart from the rest of the universe, has been a human faculty for untold ages before the present highly organized state of society had been attained, it is nevertheless true that now, for the first time in the history of the white race, we are confronted with the problem of correcting the repressive or selfish character of civilization so that it will serve the mass of humanity. If we fail to accomplish this it will be destroyed by the same creative power which brought it into existence.

We must learn how to change the industrial environment from one which repels mankind to one which attracts. In other words, the incentive to work must be inherent in the nature of the work itself.

Now what are the conditions which we must meet in the industrial world to make work attractive? We have ample evidence that increasing financial returns have failed to stimulate productivity; and, on the other hand, the constant demand for shorter hours and the increasing labor turnover is proof that work in most of our industries not only does not attract, but actually repels, the workman. We must, therefore, look into the working conditions themselves for the answer. This is the only scientific method of procedure.

* * *

It can be shown that creative work can be done to a great extent in modern industry, and that it can be accomplished without radical changes in equipment, greatly to the advantage of both employer and employee. To do this, individual progress records are necessary, so that the workman can know from day to day how he is improving in the mastery of the process.

The first example, illustrated by Fig. 1, is from that branch of the wood-pulp industry known as the sulphite process, and shows a cooking chart which was designed to give the cook information about the reactions in the digesters in which the wood chips are cooked in a 6 per cent solution of sulphurous acid partly combined with a lime base.

The digesters have a conical top and bottom and are usually 50 ft. high by 15 ft. in diameter. After the acid and chips are put into the digester and the cover is put on, steam is turned in at the bottom and the pressure brought up to 75 lb. per sq. in. above atmospheric pressure.

As this does not heat the digester sufficiently to produce disintegration of the wood, it is necessary to relieve gas through a relief valve on the cover. Because of the removal of this gas, which is afterward reclaimed, more steam can come in at the bottom and thus the temperatures are advanced. The skill in cooking consists in the proper control of the relief valve.

Before the introduction of these cooking charts illustrated by Fig. 1, all this was left to the unaided judgment of the cook, with usually nothing to help him but a small hand thermometer and a pressure gage. Of course, great variation in the pulp was the result. The cooking charts, plotted by the cooks themselves, however, helped greatly as they enabled the quick visualization of the work. On these charts temperatures are converted to pressures for the reason that the pressure in the digester comes from two sources, one the natural pressure due to steam, and the other due to the sulphurous acid gas.

* * *

At the end of the cooking process the gage and steam pressures will naturally come very close together, as the greater part of the SO_2 gas has been used. The gas pressure curve is obtained by subtracting the steam pressure from the gage pressure. It is really a resultant of the other two. If it drops too rapidly the cook knows he is relieving his digester too hard and checks the opening of the relief valve. If it does not drop rapidly enough he knows he must open the valve wider in order to increase the relief. Of course, the figures are taken from recording instruments which are checked daily to insure accuracy. Naturally, an ideal cooking chart was soon formed, being the joint work of the cooks handling the digesters and of the chemical research department.

Immediately after the introduction of these charts a very marked increase in the uniformity of the pulp was noticed, and the cooks, while at first opposed to the new method of "cooking with a lead pencil," as they called it, soon learned to like their work much better for the reason that they now had some way of visualizing the work in its entirety.

In addition to more uniform quality of the pulp, the yield from a cord of wood increased something over 5 per cent.

We soon found that it was necessary to give some sort of continuous progress record if we were to keep up the interest in the work, because no man could carry in his mind anything but a

Hours	Temp	Gage Pressure	Steam Pressure	Gas Pressure
0		0		
1		20		
2		48		
3	212	75	0	75
4	222	75	3	72
5	233	75	7	68
6	240	75	10	65
7	250	75	15	60
8	259	75	20	55
9	273	75	29	46
10	288	75	41	34
11	284	57	38	19
12	281	40	35	5
13				

NAMES OF COOKS AND GENERAL INFORMATION FILLED IN HERE.

ACID TEST { *Total* 7.00, *Free* 6.05, *Combined* 0.95 }

Acid Temperature 75 Degrees Fahrenheit.

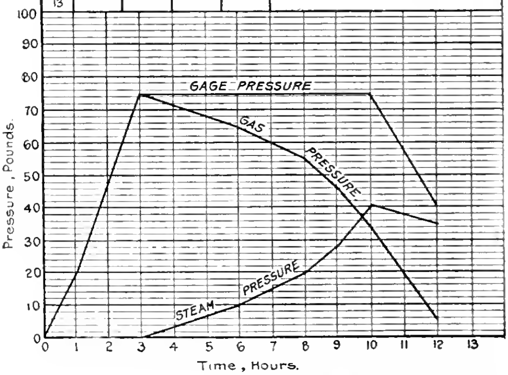

FIG. 1 REACTION IN DIGESTERS IN WHICH WOOD CHIPS ARE COOKED

general impression of his progress from day to day. Several good records for one day are only like so many good golf drives. They are a source of satisfaction at the time; but just as the score in golf denotes our real mastery of the game, so does the progress record measure the man's increasing mastery of his work, and we feel that it is one of the moral obligations of the management to keep such records for the individual workman.

* * *

Such records can be grouped under three main headings: quantity records, quality records and economy or cost records. Quality records, which occupy the middle position, are, perhaps, of the greatest importance, for they bring the individual's intelligence to bear upon the problem, and as a consequence, by removing the obstacles to uniformity of quality, remove at the same time the obstructions to increased output. The creative power of the human mind is, however, not content simply to produce the best quality under existing conditions of plant operation. The desire to create new conditions for the more highly specialized working out of the natural laws of the process demands expression, and this expression at once takes the form of suggestions for improvements in mechanical devices.

This desire contains within it the germ of economic thought which will unfold and express itself eventually in a request for cost records, and the organization that neglects its opportunity to satisfy this desire is overlooking one of the great avenues leading toward intelligent productive effort.

Because of the interrelation of quality, quantity and economy records, any complete record of individual progress must, of course, take them all into account. However, as this is not always practical, we have at least one of three ways of measuring progress always open to us.

Table 1 shows how we keep a continuous progress record of the work, which is mainly one of quality. By quality I do not necessarily refer to the quality of the material produced, as most of our records refer to the quality of the work performed: in other words, the nearness to which the workman approaches the ideal standards which he has helped to form. The democratic coöperative forming of these standards by the joint work of the trained technician and the practical workman is absolutely essential, otherwise continuous progress will not be made. The whole plan must be really educational in nature, and to be so the records must record the natural laws of the process and the individual's degree of control of forces in the material elements that he is using. The more factors that can be recorded, the greater the interest in the work. The reason for this is obvious.

Referring again to Table 1, it will be noted that there are nine men cooking. These men are posted in the order of seniority, with the highest monthly record on top. There are three foremen at the top of the record. Each of these foremen has three cooks under him, and their standing is made up by taking the average records of the men under them. In this way we are enabled to get not only the individual records of the men, but the group, or teamwork records, as well. The lower group is merely for the convenience of the department head in charge and gives the relative standing of the large, medium and small digesters. This is irrespective of the men who are working on them.

The total progress record figures in the first column are made up of the temperature, color, time and blowing records. The relative values that these have in the total record are shown at the top of each column, the total adding up to 100. The small variation in the monthly average column is characteristic of all our progress records, and shows how great is the incentive when individual effort is intelligently recorded.

The temperature record is obtained by taking half-hourly readings from the recording-thermometer chart, upon which a standard temperature curve has been plotted, calling each reading which happens to fall on the standard line 100, and a reading 20. deg. either side of the standard line 0. For each degree off of the standard, 5 points are deducted from the progress record.

The color record indicates how near the men come to blowing the digester when the color of the liquor shows the proper amount of lignine in the solution. The sample, drawn from the side of the digester, is compared with the standard color. To get a mathematical value for this factor, a range of colors from a very dark to a very light was obtained, the particular shade which was taken as standard marked 100 and one shade either side 10 points less than 100.

The time record is obtained by calling a certain time of cooking 100, and taking off on each digester cooked one point for each minute above or below this standard.

The blowing record is obtained by calling 30 lb. pressure 100 (most of the cooking being done at a pressure of 75 lb. per sq. in.) and 60 lb. 0, the idea being to get the pressure as low as possible before blowing the digester.

It will be noted that the temperature value is higher than any of the others. This is because it is the most important element. The color record coming next in importance is given the next highest value, etc.

TABLE 1 RECORDS OF INDIVIDUAL COOKS

Date, June 2, 1916.

Name	Total Progress Record		Relative Value 50: Temperature Record		Relative Value 35: Color Record		Relative Value 10: Time Record		Relative Value 5: Blowing Record		General Information: Average Maximum Temp.		General Information: Average Test 5th Hour 1.25		General Information: Average Test 6th Hour .80	
	Daily Avg.	Mo. Avg.	Daily Avg.	Mo. Avg.	Daily Avg.	Mo. Avg.	Daily Avg.	Mo. Avg.	Daily Avg.	Mo. Avg.	Daily Avg.	Mo. Avg.	Daily Avg.	Mo. Avg.	Daily Avg.	Mo. Avg.
Myler......	88.2	88.3	84.8	85.9	99.3	98.3	90.6	88.6	58.8	59.5	293.6	294.7	139	134	100	103
Duggan......	86.2	87.7	81.8	85.1	96.4	97.7	95.3	91.9	59.2	60.8	299.0	298.5	134	133	96	95
S. T. Ellis...	85.8	87.1	79.1	83.2	98.8	97.7	95.1	93.8	57.9	59.7	299.8	299.6	125	129	101	102
Rodgerson...	86.7	89.3	83.3	88.2	99.2	99.0	92.5	88.8	64.3	62.1	296.2	294.7	161	134	105	103
J. P. Ellis.	89.5	88.7	87.2	86.8	96.7	97.7	96.7	94.8	56.3	62.0	294.7	297.2	123	129	94	96
McKee...	88.8	88.3	84.8	86.0	100.0	98.9	90.5	90.0	56.4	59.9	294.4	294.7	132	133	96	101
Teeling..	88.0	88.2	84.2	85.9	100.0	98.5	92.8	90.7	62.0	61.0	299.5	298.3	128	135	91	104
McKelvy..	83.1	87.1	77.1	84.4	96.0	97.8	93.3	89.0	62.0	60.5	204.3	298.8	122	129	96	97
Element..	84.9	87.2	79.1	83.8	96.7	97.7	95.2	92.2	59.3	59.9	297.8	299.7	130	131	98	95
McLean...	83.9	87.2	75.3	81.9	98.8	99.1	97.8	93.3	59.2	57.8	306.4	302.1	137	134	109	102
Johnson.......	85.4	86.4	77.9	82.2	97.5	96.1	94.4	97.0	52.3	60.2	294.5	296.3	136	131	102	101
Neil.....	89.2	86.1	89.2	86.1	86.3	83.7	98.8	96.8	54.6	56.3	289.3	294.4	130	133	100	105
Large.......	86.6	87.4	82.0	85.5	98.5	98.3	91.9	87.0	59.8	59.9	299.0	296.4	129	133	95	100
Medium...	87.2	87.9	83.3	85.7	98.5	97.7	94.9	91.8	58.6	61.6	295.2	296.9	134	132	99	99
Small......	85.9	86.5	80.1	83.1	98.2	97.9	94.9	88.3	57.6	58.3	298.4	299.3	131	133	102	100

* * *

In the plant where this system was developed were employed over 1200 men, and perhaps half of these men had individual progress records and the rest came under some sort of group progress record. Invariably the records proved themselves to be an incentive to greater productivity.

* * *

Fig. 2 shows the concrete results obtained by giving the cost sheets to the department heads and job costs to the maintenance foremen. There was a rapid increase in production from 1908 to 1913, also a rise in repair material used, as well as an increase in the cost of maintenance labor. The fourth curve, showing the amount of material used for each dollar spent for maintenance labor, is more or less a resultant of the other two. The gradual rise from 1908 to 1911 in this curve was due to the increased material-consuming power of the maintenance men because of the introduction of labor-saving devices, such as pneumatic and electric portable tools. There was a drop in this figure in 1912 and 1913, but we were unable to get a real thought of economy started in the plant until the departmental cost sheets and job cost sheets were started. These were put into effect first in the beginning of 1914, and there was an immediate drop in the curve from an average of about $2.35 worth of material spent for each dollar spent for labor, down to $1.55 in 1914 and $1.05 in 1915.

The drop in production in 1914-15 was due to war conditions which were unavoidable. It is a significant fact, however, that in spite of this drop in production the maintenance material cost per ton of pulp was reduced to approximately half the amount under

the conditions of higher production during the two preceding years.

In none of this work did we pay bonuses to a superintendent, department head or workman; our salaries and wages were high, but payments were all on a monthly, weekly or hourly basis. The increased effort, therefore, came entirely from a desire within the individual to be productive. Of course, this sort of creative effort produced great changes in operating conditions—we increased our yearly production from 42,000 tons to 111,000 tons without adding to the number of digesters for cooking the pulp, or wet machines for handling the finished product, and we changed our quality from the poorest to the very best.

* * *

We should never lose sight of the fact that the degree of conscious self-expression which the workman can attain is in direct proportion to the ability of the organization to measure, for his benefit, the impress of his personality upon it. The most democratic industrial plant, therefore, is the one which permits the fullest possible amount of individual freedom to each member, irrespective of his position, and at the same time is so sensitively adjusted that it reflects immediately the effects of his actions. If his actions result in injury to others he will see that as a part of the whole he, himself, must also suffer.

* * *

Man is not an animal, but a free, self-determining mental center of consciousness whose reason for existence is that the universal life can deal with a particular situation in time and space, and by this means be enabled to evolve a material universe organized to express the one great individual life of which we are all a part.

In conclusion let me say that I am well aware that to some of you this may seem like pure philosophical speculation far removed from the practical affairs of everyday life. I have said nothing, however, that I cannot back up by any number of additional illustrations, and my hope is that the examples given will stimulate others to make similar investigations, so that we can fulfill our mission in this country by evolving an industrial philosophy which will have for its ultimate aim the continuous unfoldment of the latent powers in man.

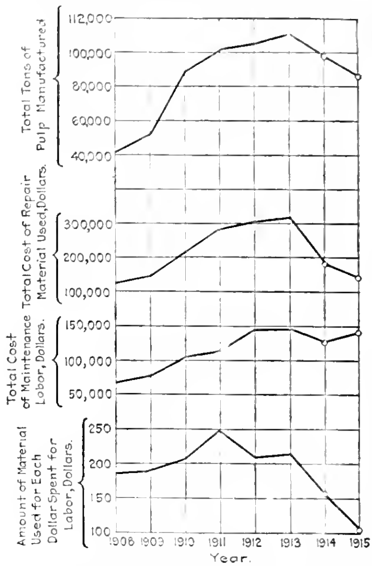

Fig. 2 Showing Concrete Results of Cost Sheets

UNIFORM BOILER LAWS

By E. A. BROOKS,[1] ATLANTA, GA.

In 1914 there were between five and six hundred people killed outright, some fifteen hundred injured, and several millions of dollars in property and production lost in this country through the needless explosion of boilers. I say "needless" explosions after due consideration, for it is a fact that the majority of these occurred where the boilers were not subject to regular inspection either by the state or by insurance companies.

One experience is enough to convince any one that safe boilers are altogether desirable. One morning when passing down a line of boilers in my charge I was startled to observe that the steam pressure on one boiler was 300 lb. per sq. in. It developed later that one bright water tender had, through ignorance, oiled the safety valves! Of course the oil evaporated and stuck the safety valves to its seat. But knowing this did not help the situation at that time one bit, but what did help was the fact that the boiler was built with a *safety factor of five*, as is prescribed by the A.S.M.E. Boiler Code.

There has been a strong feeling all over the country for proper legislation along the line of safer boilers. Our Society felt this need and set its wonderful resources to work to formulate laws for this purpose, which, while providing a maximum of safety for the users and public, would not in any way put an undue hardship upon the boilers. This was completed and is now known as the A.S.M.E. Boiler Code. It has been conservatively estimated that this code, if paid for at consultation rates, would have cost $250,000.

As The American Society of Mechanical Engineers is precluded from engaging in public campaigns relating to legislative matters, The American Uniform Boiler Law Society was formed to secure the adoption of the A.S.M.E. Code in its entirety in the various states and to promote the manufacture and sale of safer boilers. This new society is an organization of boiler manufacturers and users and as far as possible is representative of every branch of the boiler industry.

The enactment of boiler laws by the various states is not new at this time. Through the influence of the members of this Society and others the state of Massachusetts passed a bill governing the use and installation of boilers in 1907. Since that time there have followed New York, New Jersey, Pennsylvania, Ohio, Indiana, Michigan, Wisconsin, Minnesota, California, the U. S. Navy and other branches under Government supervision.

From the manufacturers' angle we can readily appreciate that through standardization the small manufacturer would be given the benefit of the years of research and study of some of the brightest engineers in the country, while the large manufacturer would be given the benefit of large-scale standardized construction. The purchaser of boilers, while not conversant with boiler construction, could feel reasonably safe in buying a boiler coming under the A.S.M.E. Code requirements so far as safety is concerned. This does not mean that all boilers would be equally safe. It simply means that for the type of boiler under consideration the purchaser could feel that it was built as safely as that particular construction would allow.

At the present time there are in force quite a number of boiler laws for the different states. It is not unusual to see a boiler stamped as good under Massachusetts boiler laws, the laws of Ohio, or the city of Cincinnati. This brings us fact to face with a very vital necessity, namely, that of *standardizing these laws*.

Unless the states which have not passed boiler laws wake up to their responsibilities, all the old, second-hand boilers from

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Abstract of paper presented at a meeting of the Atlanta Section of The American Society of Mechanical Engineers, October 1918.

their progressive sister states will find a sale in them and will be a source of unending trouble. Boilers do not stand very well being ripped out of their original settings and being reset. Every year the records indicate quite a number of explosions from this very cause alone.

The active work so far done in our state of Georgia was started by Mr. Chas. E. Gorton, Chairman of the American Uniform Boiler Law Society, on a visit in the south this year. He interviewed many of those interested, and as a result State Senator Wohlwender of the 24th district introduced in the state senate a bill covering Mr. Gorton's recommendations. The bill was referred to a Committee on Commerce and Labor.

Inasmuch, however, as this session of the legislature was an adjourned session and there were a large number of bills before the assembly, this bill was never reported out of the committee. The Commissioner of Commerce and Labor was, however, favorable to the bill and it had his entire approval. The text of the bill is given below in the belief that it will prove of value to engineers in other states who are considering the question of boiler standardization:

Senate Bill No. 258, by Mr. Wohlwender of the 24th. Commerce and Labor.

An Act to establish a State Board of Boiler Rules in the State of Georgia; to define the duties and powers of said Board; to pro the use of steam boilers in this state; to provide for the appointment of Boiler Inspectors; to provide penalties for the violation of this Act, and for other purposes.

Be it enacted by the General Assembly of the State of Georgia, and it is hereby enacted by authority for the same:

Section 1. There is hereby created a State Board of Boiler Rules in the State of Georgia, to be known and styled as the Georgia State Board of Boiler Rules.

Section 2. Said board shall consist of three members. The Commissioner of Commerce and Labor of the State of Georgia shall be ex-officio one of such members, and shall be chairman of such board. Within ten days after the passage of this Act it shall be the duty of the Governor of this state to appoint two members of said board. One of said members to be appointed by the Governor shall be a man who shall have been actively engaged in the manufacture of steam boilers in this state for the period of three years prior to his appointment and the other of said members to be appointed by the Governor shall be a man who shall have been actively engaged in a business in this state requiring the use of steam boilers in the operation of said business for a period of three years prior to his appointment. Within ten days after any person shall be notified of his appointment as a member of said board by the Governor he shall accept or decline said appointment and upon his acceptance he shall subscribe and forward to the Governor the following oath: "I do swear that I will faithfully and impartially perform the duties of a member of the Georgia State Board of Boiler Rules to the best of my ability, so help me God." Upon such oath being filed in the office of the Governor he shall issue to said member a certificate of his appointment.

Section 3. From the fund derived from inspection fees provided for in Section 6 of this Act, the members of said Board of Boiler Rules shall be allowed and paid their reasonable traveling expenses incurred in attending to the business of such board. No member of the board shall receive any compensation for his services except the Secretary-Treasurer, who may be paid a reasonable compensation for his services as such, payable from the fund derived from inspection fees as provided for in Section 6 of this Act.

Section 4. The term of office of each member of said board to be appointed by the Governor shall be three years, subject, however, to the following provisions: Of the two first appointments to be made by the Governor to membership on said board one shall be made for the period of two years and one for the period of three years, and after the expiration of the terms of office of the members so first appointed each subsequent appointment shall be for a term of three years, and any vacancy that may occur for any cause shall be filled by the Governor for the unexpired term. The person who may be appointed to any vacancy on said board shall possess the same qualifications for membership on said board as those required by this Act of his predecessor in office.

Section 5. The first meeting of said board shall be held within thirty days after the appointment of the first two members of said board hereinbefore provided to be appointed by the Governor, and at a time and place to be designated by the Commissioner of Commerce and Labor of this state. At its first meeting and annually thereafter said board shall elect from its membership a vice-chairman and a secretary-treasurer ,each of whom shall hold his office until his successor is elected and qualified. The secretary-treasurer shall give a bond in such sum as the board may determine. Said board shall prescribe such rules and regulations for its proceedings and government as will carry into effect the provisions of this Act. There shall be at least two meetings of such board held each year on the second Wednesday in January and July. Special meetings may be held on the call of the chairman of the board. A majority of said board shall constitute a quorum. Said board shall keep a record of its proceedings and a register containing the names and addresses of all persons, firms and corporations to whom permits shall be issued allowing steam boilers to be used or operated in accordance with the provisions of this Act and the rules and regulations prescribed pursuant to the same.

Section 6. The said Georgia State Board of Boiler Rules is hereby charged, directed and empowered:

To formulate and publish rules and regulations for the safe and proper construction and use of steam boilers in connection with manufacturing and industrial enterprises in this state, such rules and regulations to conform as near as may be practicable in the judgment of said board with the Boiler Code of The American Society of Mechanical Engineers.

The rules and regulations formulated and published by said Board of Boiler Rules shall become effective on and after the approval of the same by the Governor of this state. Rules requiring a change in methods of construction of boilers or in the character of materials used shall not be enforced until six months after their approval by the Governor. The provisions of this Act shall not be construed to apply to boilers installed prior to the time when this Act becomes effective, except in so far as the same become necessary, in the judgment of said board, to protect life and property. After any of such rules and regulations so formulated and published by the board and approved by the Governor shall become effective, no steam boiler for use in connection with manufacturing or industrial enterprises shall be installed in this state which does not conform to such rules and regulations.

To employ a Chief Inspector of Boilers and such deputy inspectors of boilers as in the judgment of said board may be necessary, and such office help as in the judgment of said board may be necessary, and to fix the compensation of such inspectors and office help, such compensation to be paid from the fund derived from inspection fees provided for in Section 6 of this Act. Such Chief Inspector shall possess qualifications which shall be prescribed by said Board of Boiler Rules, and each deputy inspector shall be appointed only after he shall have satisfactorily passed in the judgment of said board a written examination as to his fitness for such position, which said examination shall be conducted in accordance with such rules and regulations as may be prescribed by the said board.

To issue and revoke permits allowing boilers to be operated in accordance with the provisions of this Act and the rules and regulations prescribed pursuant to the same.

To keep a complete record of the type, dimensions, age, conditions, pressure allowed upon, location and date of last inspection of all boilers to which this Act applies.

To fix the fees to be paid by the owners and users of boilers to be inspected under the provisions of this Act and the rules and regulations prescribed pursuant to the same, provided that no fee for the inspection of any boiler internally and externally inspected shall exceed the sum of five dollars per inspection, and provided, further, that not more than ten dollars shall be collected for such inspections of any one boiler during any one year.

Section 7. In addition to the inspectors authorized by Section 6 of this Act, the board shall upon the request of any company authorized to insure boilers in this state, issue to any boiler inspectors of said company commissions as special inspectors of the Georgia State Board of Boiler Rules, but such special inspectors shall receive no compensation from, nor shall any of their expenses be paid by, said board, and the continuance of a special inspector's commission shall be conditioned upon his continuing in the employ of a duly authorized boiler inspection and insurance company, and upon his maintenance of the standards imposed by the rules and regulations prescribed pursuant to this Act for the construction and operation of boilers. Such special inspectors shall inspect all boilers insured by their respective companies, and issue permits for the operation of such boilers, copy of which he shall transmit to the Board of Boiler Rules, and such insured boilers shall be exempt from all inspection, other than that of the respective insurance companies' inspectors. Each special inspector shall within ten days following each annual inspection made by him report the date thereof to the Board of Boiler Rules.

Section 8. All fees for inspections of boilers provided for under Section 6 of this act shall be paid in advance to the Secretary-Treasurer of the said board to be held as a fund for the use of said board. No funds shall be paid out except on a warrant signed by the chairman and the secretary-treasurer of said board and no expense of any character shall be created in excess of the amount derived from fees to be fixed in accordance with the provisions of Section 6 of this Act. The funds derived from such fees shall be applied by the board to the compensation of members appointed by the Governor as provided in Section 3 of this Act and to expenses of operation of said board including compensation to be paid inspectors and office help. All surplus on hand on January 1 of each year, after paying all expenses of the operation of said board, shall be turned into the State Treasury.

Section 9. The provisions of this Act shall not apply to boilers in marine or railroad service that are under the inspection regulations of the United States Government, or to motor road vehicles, or to boilers of fire engines brought into the state in an emergency to check conflagration, nor shall it apply to boilers used exclusively for low-pressure steam and hot-water heating and boilers used exclusively for

hot water supply, carrying a maximum allowable working pressure not to exceed 15 pounds per square inch on boilers used exclusively for low-pressure steam heating, and not to exceed 30 pounds per square inch on boilers used exclusively for hot-water heating or hot-water supply.

Section 10. Any person, firm or corporation violating any of the provisions of this Act or any provisions of the rules and regulations prescribed pursuant to the same shall be deemed guilty of a misdemeanor and upon conviction thereof shall be fined not exceeding one hundred dollars or imprisoned for not exceeding three months in the discretion of the court.

Section 11. The rules and regulations to be prescribed by said Board of Boiler Rules pursuant to this Act shall become effective on January 1, 1919.

Section 12. Be it further enacted that all laws and parts of laws in conflict with the provisions of this Act be and the same are hereby repealed.

In conclusion, we find that the only effects that the adoption of the laws would have on the present installations would be to render them safe through the inspection of regular inspectors of the state or insurance companies.

All new boilers would conform to the code as prescribed by this Society.

We can each do our part by getting behind the organizations which we represent and get them to do their part through members of the state legislature. We should each ask ourselves if we are willing to sit still and see this law, which would uplift our state as outlined, tabled again at the next session of our legislature. Practically all the boiler manufacturers represented in Georgia are prepared to build code boilers, and it will take only our concerted efforts to put this bill through next year.

WORK OF THE BOILER CODE COMMITTEE

The Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York City.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval, after which it is issued to the inquirer and simultaneously published in THE JOURNAL, in order that any one interested may readily secure the latest information concerning the interpretation.

Below are given the interpretations of the Committee in Cases Nos. 200-206, inclusive, as formulated at the meeting of October 25, and approved by the Council. In this report, as previously, the names of inquirers have been omitted

CASE NO. 200

Inquiry: Can the requirements of Par. 312 of the Boiler Code be construed to imply that protecting coverings of non-conducting material may be removable the same as if a cast-iron removable sleeve were used? A literal interpretation of the paragraph as worded would seem to indicate that only a cast-iron protecting sleeve may be removable.

Reply: It was not the intent of the Committee to limit the application of the term "removable" to any particular form of protecting covering, as it is obviously desirable that any form of covering should be easily removable for convenience of examination of the blow-off pipe.

CASE NO. 201

Inquiry: May rivets be used where the heads are not of the form required by Par. 255 of the Boiler Code (Edition of 1918), which refers to specific forms of rivet heads that are acceptable under the rules, but where they are driven with forming tools which bring the final form to any one of the acceptable forms of heads shown in Fig. 20?

Reply: The requirements of Par. 255 may be considered as fully met if the form and proportions of the finished heads correspond to those indicated in Fig. 20 of the Boiler Code (Edition of 1918).

CASE NO. 202

Inquiry: What is the correct method under the rules of the Boiler Code (Edition of 1918) of calculating the safety valve requirements for waste-heat boilers used in connection with the manufacture of illuminating gas, to which the boilers are driven alternately during the blow periods of water-gas machines, and in which there are occasions when the tarry deposit from the gas must be burned off the heating surfaces, producing a temporary extremely high rate of local heating?

Reply: The minimum number and size of safety valves required for these boilers as in other boilers, is determined by Par. 271. In this case the Committee considers this safety valve capacity should be checked by Par. 275*a*, and if found insufficient should be increased.

CASE NO. 203

Inquiry: Will an automatic fire door which consists of a metal plate or plates that slide within retaining guides or grooves, meet the requirements of Par. 328 of the Boiler Code in which specific reference is made only to doors of the inward-opening type or those which are provided with a substantial and effective latching device? A sliding door of the type above described, obviously is neither of the inward-opening type nor has it any latching or fastening devices.

Reply: The intent of the requirements in Par. 328 was that means shall be provided to prevent the firing or inspection door "from being blown open by pressure on the furnace side," and the ruling is therefore not limited to the specific types of mechanisms named. If a door is so constructed that it cannot be blown open by pressure on the furnace side, no matter in what position it may be found, it obviously meets the requirements of Par. 328.

CASE NO. 204

Inquiry: An interpretation is requested of what may be considered a "substantial and effective latching or fastening device" for firing or inspection doors to prevent them from being blown open by pressure on the furnace side. Does an over-balanced weighted form of latch which is so fitted to the fire door fulerum that it cannot jump out of latch when the door is closed under any conditions, meet the requirements of this rule?

Reply: The intent of the requirement in Par. 328 was that means shall be provided to prevent the firing or inspection doors "from being blown open by pressure on the furnace side." If a door is so constructed that it cannot be blown open by pressure on the furnace side, it obviously meets the requirements of Par. 328.

CASE NO. 205

(In the hands of the Committee.)

CASE NO. 206

Inquiry: Is it permissible, in bracing the rear lower segment of an h.r.t. boiler, to so design the angle irons of the structural reinforcement used across the rear head for attaching through braces, that they may also be considered as taking the place of a certain amount of through stay area.

Reply: The practice referred to in the inquiry is permissible if the members are designed in accordance with the requirements for structural reinforcements in Par. 201 of the Boiler Code (Edition of 1918).

ENGINEERING SURVEY

A Review of Progress and Attainment in Mechanical Engineering and Related Fields, Including Abstracts of Articles in Current Technical Periodicals

Boring for Oil in Britain

WHAT may be called the inauguration of the crude-oil industry in the United Kingdom took place in October. A public ceremony on the Duke of Devonshire's estate, about seven miles south of Chesterfield, marked the beginning of the first boring operation.

American aid is figuring prominently in the situation. Not only has most of the machinery to be used been imported from the United States, but forty drillers have been brought over and will work under the supervision of one of the foremost oil experts of America.

The scheme originated in the enterprise of Lord Cowdray, head of the firm of S. Pearson & Son, Ltd., who has placed at the disposal of the British government the services of the firm's geological experts and the information which they have accumulated. The firm is now directing the work as agents of the Ministry of Munitions.

What has been done is all preparatory work. It throws no additional light on the probabilities of oil being found. The boring of the wells, a long and expensive process, is the only decisive test. But Lord Cowdray and those with him have great confidence in the accuracy of the conclusions which the experts have made. These conclusions are based on a study of the geological formation of the district, and they have not been hastily drawn. Investigations were begun in 1914 under the direction of Dr. Veatch, an American petroleum expert, who was formerly connected with the United States Geological Survey.

A considerable time must elapse before the success or failure of this first well can be determined. (*Journal of Commerce*, Nov. 1, 1918, p. 2)

Output of New Locomotives Doubled in Three Months

B. M. Baruch, Chairman of the War Industries Board, authorizes the following:

The standard-gage steam-locomotive industry of the United States, operating under the direction of the War Industries Board, has increased its rate of production approximately 100 per cent in the past three months. Last week the output of the three standard-gage companies was 144 locomotives. Since 1910 and up to last August, the highest number ever turned out in a single year was 3776, which would prove an average weekly output of 72.6 locomotives.

The achievement is particularly noteworthy from the fact that, in bringing about the tremendous jump in production, it has been unnecessary to expend a dollar to increase plant facilities or enlarge the existing works, items of considerable expense in the development of most of the other war industries of the country. Redistribution of orders and concentration by each of the plants on particular types of locomotives has made possible the intensity of effort unprecedented in the industry.

The "Pershing" locomotive, built on standardized plans designed by the United States Military Railways, has not only been made the sole type of steam locomotive in use behind the American lines in France, but, at the instance of the War Industries Board, has been adopted by the British and French governments as the standard type for their armies on the western front.

Last August the Government, face to face with an immediate and urgent demand for steam locomotives for use in this country and France, was seriously considering the establishment of Government plants to meet the emergency. It was proposed that approximately $25,000,000 should be spent for this purpose. At the suggestion of the War Industries Board the expenditure was held up in favor of the present plan.

Under the arrangement adopted, the construction of all the locomotives of standard gage for use in France was assigned to the Baldwin Locomotive Works, whereas all orders for the United States Railroad Administration were divided between the American Locomotive Co. and the Lima Locomotive Works. These three companies comprise the entire standard-gage steam-locomotive industry of the country. By this method of distributing the work, each of the plants has been able to develop extraordinary speed.

Normally the output of the Baldwin Works never exceeded 60 locomotives a week. Last week it turned out 87 engines complete, not to mention 7 gasoline locomotives and 3 electric locomotives, and general repairs on ten steam engines, and the promise is for even better returns during the present month. The American Locomotive Works has likewise accomplished excellent results, for while the number of locomotives is not so great, the tonnage represented in the output is proportionately as large; that is to say, whereas the "Pershing" locomotive weighs about 83 tons complete, the average weight of the locomotives called for by the Railroad Administration is approximately 150 tons. Similarly the Lima Works have developed to a marked degree in the last three months; and, as in the case of the other two concerns, without e pansion of plant or plant facilities.

The importance of the results attained in this direction in their relation to the war program generally is indicated by the fact that the Government is spending this year in the construction of these locomotives, both for use in France and on the Government-operated roads in this country, approximately $200,000,000. (*Official Bulletin*, Nov. 2, 1918, p. 1)

British Machine Tools

A British author, J. Judson, recently delivered an address in England containing some rather startling statements. According to this speaker, the British tool industry had been practically stationary during the last quarter of a century before the war, while Germany and America made big strides ahead.

As an illustration, he stated that from 70 to 80 per cent of the machinery used in the manufacture of British aircraft engines is of foreign make. The largest machine tools to be found in Great Britain at the present time (purchased before the war, of course) are of German make.

During 1917 the output of German machine tools was about $200,000,000, while the British output is estimated at only one-quarter of that amount. This tremendous output of German machine tools was necessary to keep up with the demand for munitions of war. Because of the British blockade on the seas the Germans were unable to draw machine tools from America as the British did, and were obliged to make everything for themselves in this particular line. As a result, a very important group of machine-tool makers may appear in the field after the war. (*The Iron Age*, vol. 102, no. 20, November 14, 1918, p. 1199)

Fuel-Oil Conservation Meeting at Chicago

A meeting was held on October 24, which was attended by about 300 representatives from fuel-oil and coal-burning plants in the Illinois district, assembled at the request of Nelson G. Phelps, District Engineer of the Bureau of Oil Conservation. The primary object of the meeting was how to arouse interest in the conservation of oil, to point out wasteful practices and to indicate where improvements might be made. Four technical papers relating to fuel-oil systems were presented.

Max Sklovsky gave information on the use of fuel oil in industrial furnaces and the results of experiments obtained over a period of years by the Deere Company, of Moline, Ill. He stated that improvements in efficiency had been secured by preheating the air of combustion by the waste gases from the furnace to a temperature approximating 700 deg. fahr. The oil was injected

into this air in a mixing receptacle, vaporized and thoroughly mixed with the proper proportion of air and was delivered to the furnace in gaseous form. The furnace should be airtight. A comparison between the old straight-type furnace and the new furnace burning the oil in the form of gas and preheating with waste heat, showed that the oil consumption was reduced to practically one-third of the quantity formerly required.

J. J. Connelly, in a paper entitled Oil Storage and Measurement, made practical suggestions in reference to storage tanks, pipe lines to the furnaces, and meters to measure the oil used. He emphasized the necessity of having some method of measuring the oil consumption, and called attention to the fact that by no means had all the plants provision for measuring the oil consumed or for determining what economy was being obtained.

Fuel-Oil Combustion in Industrial Furnaces was the title of a paper by Joseph W. Hays, Mem.Am.Soc.M.E. He compared fuel-oil firing with coal burning, enumerated in a general way the conditions required for efficient combustion, and made a strong plea for the use of CO_2 recorders. (Abstracted through *Power*, vol. 48, no. 19, November 5, 1918, pp. 684-685)

American Institute of Electrical Engineers

A meeting of the Institute was held in New York on November 8, 1918.

A paper was presented by R. B. Williamson, C. A. Kelsey, A. M. Dudley and H. Veichsel, acting as a sub-committee of the Industrial and Domestic Power Committee, appointed to compile a typical survey of the application of electric motors to a representative industry, standardizing methods for the selection of motors. This survey is expected to serve as a model for the survey of this phase of other industries.

The paper begins by giving a brief description of the process of manufacturing cement, which is followed by an outline of the various kinds of machinery used, together with data as to power requirements. From this outline it appears that the grinding of the clinker into finished cement requires more power than any other step in the process, as the clinker is, as a rule, much harder to grind than the raw materials. Further, there is at present a tendency to demand more finely ground cement, specifications for portland cement in the United States having been changed in 1916 from 75 per cent through 200 mesh to 78 per cent through 200 mesh. There is also a greater tendency to grind the raw material extremely fine, and it is claimed that the extremely fine grinding of raw materials has the advantages that fuel is saved, a better cement is produced, and the clinker is more easily ground.

As regards motors, it is stated that alternating-current motors are preferable for cement-mill operation. There are two main reasons for this: (1) A relatively higher voltage can be used—from 440 or 550 volts up to 2200 volts for some of the motors in large mills; and (2) the greater mechanical simplicity of the a. c. motor, particularly that of the squirrel-cage type. There are, however, a number of mills equipped with d. c. motors which give excellent service.

A number of recommendations are given for guidance in selecting motors for a cement mill. Among these are the following: Starting conditions are quite severe and make phase-wound rotor motors preferable or even essential; bearings should be made dustproof, as cement has a highly abrasive action; it is good practice to supply outboard bearings for belted motors of 75 hp. and larger; pulleys larger than usual in both diameter and length are often specified, since the cement dust causes more than normal belt slippage and makes necessary tighter belts and increased strain on bearings.

As regards the type of motor, it is stated that while the induction motor has been used almost exclusively in the past, there are indications that synchronous motors will be adapted to this work more in the future. This is especially so in the case of low-speed motors for geared tube mills.

The load factor of the average complete cement plant runs from 65 to 75 per cent taken through the entire year, and is probably the highest of any industry. It may be as high as 95 per cent, since the machines run at all times under constant full load.

An interesting description and discussion of the various types of crushers, crushing rolls, rotary driers and grinding machinery is presented, making the paper of considerable interest not only to electrical but also mechanical engineers.

The complete paper is published in the Proceedings of the American Institute of Electrical Engineers, vol. 37, no. 11, November 1918, pp. 1237-1273. The discussion has not yet been published.

Society of Naval Architects and Marine Engineers

The 26th annual meeting of the society was held in Philadelphia, Pa., on Thursday and Friday, November 14 and 15, 1918. Excursions were arranged to various shipyards on the Delaware River, and the following papers of special interest to mechanical engineers were presented:

Application of Buoyancy Boxes to S. S. *Lucia* for the U. S. Shipping Board, W. T. Donnelly, Mem.Am.Soc.M.E.

On Vibrations of Beams of Variable Cross-Section, N. W. Akimoff, Mem.Am.Soc.M.E.

Experiments Upon Simplified Forms of Ships, Prof. H. C. Sadler and T. Yamamato

Variation of Shaft Horsepower, Propeller Revolutions and Propulsive Coefficient with Longitudinal Position of the Parallel Middle Body in a Single-Screw Cargo Ship, Commander Wm. McEntee

The Application of Electric Welding to Ship Construction, H. Jasper Cox.

Abstracts of these papers will probably be published in an early issue of THE JOURNAL.

Society of Automotive Engineers

At a meeting of the Mid-West Section of the Society of Automotive Engineers, in Chicago, November 8, P. J. Dasey presented a paper on Lubrication and Fuel Tests on the Buda Tractor-Type Engines.

In this paper a statement was made that there would probably be commercially available in a short time a new fuel, a reworked petroleum product, which would cost much less than gasoline, but which, except for ease of starting and for extremely high-speed engines, is claimed to have as good power and fuel-economy characteristics as gasoline.

This product Dasey calls "synthetic crude," and his paper was devoted chiefly to reports of careful tests in the Buda laboratories of this fuel in comparison with four other fuels, namely, gasoline, cracked benzine, cracked gasoline and kerosene. These tests were made on the new Buda tractor engine model HTU, using a standard Stromberg carburetor.

Summarizing the tests on these fuels and averaging the results of five runs on each fuel for power and economy at different speeds, he found the following in brake horsepower-hours per gallon:

Commercial gasoline	7.80
Cracked gasoline	7.92
Synthetic crude	8.02
Cracked benzine	8.23

(*Motor World*, vol. 57, no. 7, November 13, 1918, p. 33)

Child Labor Increasing

Investigations recently conducted by the Children's Bureau of the Department of Labor show that there has been a great increase in child employment since the Federal child-labor law was declared unconstitutional last June. In twenty-four states, including Pennsylvania, the southern textile states and New England, except Massachusetts and Vermont, the reports indicate there has been a general return to the nine-, ten- and eleven-hour day for children under sixteen years of age. In these states the eight-hour day is not required by statute for children between fourteen and sixteen years of age. Philadelphia *Public Ledger*, Nov. 6, 1918, p. 10)

REVIEW OF ENGINEERING PERIODICALS

SUBJECTS OF THIS MONTH'S ABSTRACTS

For Articles on Subjects Relating to the War, see Aeronautics, Military Engineering, Munitions, Refrigeration, Testing, etc.

Aeronautics

Battle Acrobacy or Trick Flying, Capt. K. G. Pulliam, Jr., U. S. A. Description of the various forms of "stunt" flying written by the authority of Air Service Headquarters, A. E. F.

The object of training fighting pilots in stunt flying is to teach them how to meet dangerous conditions of flight which they may encounter (Gosport system of training).

At a field where trick flying is taught every student is given individual attention and instruction. Only one stunt at a time is explained and unless every movement is thoroughly understood by the student he is not permitted to attempt the work.

The Vrille. This is one of the most disconcerting of all stunts and is the first to be taught. In starting the pilot ascends to at least 1200 meters and after flying level for several minutes throttles his motor and just at the point where the machine stalls he pulls the control stick quickly back toward him and at the same time to the side, accompanying it by a sudden push of the rudder bar, using the foot corresponding to the side on which the stick is placed.

As a result the machine shoots suddenly up, losing speed, and falls sharply over to the side with a twisting corkscrew-like movement. In every case the twist commences sharply and the student is instructed to place his controls in neutral after the machine has made several turns and to *slowly* push the control stick forward a few inches. The machine ceases to whirl, points forward and dives straight down, the pilot at once redressing his control stick and bringing his machine again into horizontal flight, at the same time switching on the motor.

The Renversement. Although the use of this stunt in actual combat is questionable the student should be familiar with it, as any pilot who can manage it will be able to control his machine whether or not he is in an upside-down position.

To perform the renversement the pilot ascends to the height of 1200 meters, flies for a few minutes, then points the machine *very* slightly downward so as to bring the speed up to maximum, pulls the control stick back sufficient to raise the nose of the machine to an angle of 20 or 30 deg. If a left-hand renversement is desired the rudder should be pushed hard to the left. As a result of the above control motions the nose of the machine jerks sharply upward, followed by a roll of the entire machine to the left. Just before the machine is completely on its back the motor is cut and the pilot places his controls in neutral; the plane stops its roll and the pilot pulls back on the control stick, causing the machine to dive and almost at once resume the horizontal, at which time the motor is switched on, the stick placed in neutral and normal flight resumed.

Since the pupil when flying in the head-down position in which he hangs when the machine is on its back, is not likely to recognize the moment at which the controls should be placed in neutral, he is instructed to immediately neutralize the rudder after he has thrust the control to the left.

The Immelman Turn. This stunt was first used in combat by Lieutenant Immelman of the German Flying Corps. To perform the Immelman turn the pilot again ascends to the height of 1200 meters and after flying level for a few minutes he points the nose of the machine down very slightly and then pulls slowly back the control stick, causing the machine to climb almost vertically. Care should be taken not to pull enough on the stick to cause the plane to loop. The motor should be cut as soon as the machine starts to climb and as soon as excessive loss of speed is felt the rudder is pushed sharply to one side. The machine falls to the side on which the rudder is pushed and as soon as the machine reaches vertical the pilot places the rudder in neutral, switches on the motor and by pulling back on the stick resumes normal flight. A slight movement of the stick to the side corresponding to the rudder used will help the movement.

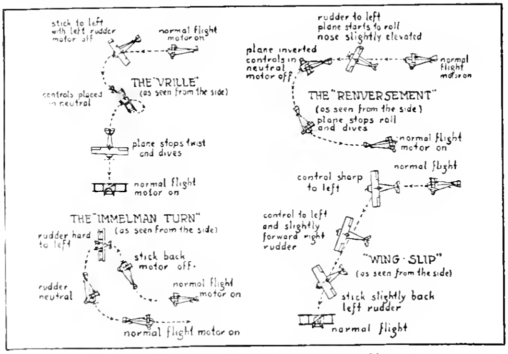


Fig. 1 Various Forms of Stunt Flying

When done properly the turn is a very pretty performance and no loss of altitude results. It can be performed to either side with uniform results, and after the pilot is thoroughly accustomed to the movement he may use his motor throughout the complete evolution with no loss of speed.

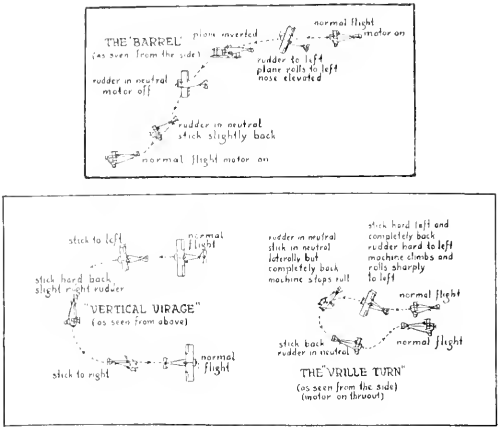
The Barrel. The "barrel" might also be called a horizontal vrille and it is performed exactly the same as the renversement, with the exception that the controls are not placed in neutral when the machine is upside-down, just before the machine again reaches normal line of flight. The first movements of the machine are identically the same as when in a renversement, but the roll continues until the plane has made one roll of 360 deg., at which time the motor is switched on and normal flight resumed.

The Vertical Virage. The vertical virage is nothing more or less than a turn in which the plane is banked until the wings are perpendicular to the ground and elevators are used for turning. It is used to turn quickly into the opposite direction without loss of either speed or altitude.

Flying level at full speed the necessity to turn suddenly is met by throwing the control stick to the side on which the turn is desired and accompanying it with a little corresponding rudder. When the position is reached in which the wings are perpendicular to the ground the stick should be placed in neutral and pulled hard back. The movement should be accompanied by opposite rudder sufficient to keep the nose of the machine from falling.

As a result of the above movements the machine banks sharply and as the stick is pulled back it seems to spin around, using the tip of the low wing as a pivot. As soon as the desired amount of turn has been made the pilot places his stick to the opposite side from which the machine is banked and the plane levels out and resumes normal flight.

The Side-Slip. Since the side-slip allows the pilot to lose an abnormal amount of altitude in proportion to the distance progressed forward, it is a very useful stunt. A pilot in making a forced landing may allow himself to overshoot his landing field and then side-slip off any surplus altitude, thus assuring his reaching the field.



Figs. 2 and 3 Various Forms of Stunt Flying

In aerial combat and in dodging anti-aircraft fire it is also very useful, as it is a method of losing altitude very rapidly, and since in a side-slip the direction of motion is not directly forward it is very disconcerting to an enemy firing at the machine.

A side-slip is accomplished by pushing the control stick all the way to one side and accompanying it by sufficient pressure of the opposite foot to hold the nose of the machine up. The control stick is at the same time pushed slightly forward and the machine descends sidewise at a terrific speed.

To recover from a side-slip the control stick is placed in neutral and the rudder corresponding to the direction of the slip is pushed. As a result the machine turns and dives into the direction of the slip and by redressing the stick straight-away flight is resumed.

The Vrille Turn. The vrille turn is very similar to the renversement, but, unlike the latter, it is very useful in air combat. It is performed with full motor and is a very rapid evolution.

The stick is pulled quickly all the way back and completely to the side, accompanied by a sharp kick of the rudder to the left. As a result the nose of the machine jerks up and the plane rolls to the left.

The rudder is immediately placed in neutral and the stick is brought back to the center but held completely redressed. The neutralizing of the rudder stops the roll and as the stick is held completely redressed the nose of the machine immediately climbs to level and normal flight is resumed. No loss of altitude results.

As the motor is used throughout the turn the motions are necessarily very rapid and rather disconcerting when first attempted, but one soon becomes accustomed to the rapidity of the twist.

The Loop. The loop is accomplished by putting the nose of the machine down slightly to obtain maximum speed and then pulling back on the control stick, slowly at first and more rapidly as the top of the loop is reached. Just after the top has been passed the motor should be cut, the machine being allowed to fall of its own momentum through the last half. When the loop is completed the stick should be placed in neutral, the motor switched on and normal flight resumed. When looping with a plane using a rotary motor some left rudder should be used at the top of the loop to prevent falling out of the loop to the right.

A loop improperly done may result in a vrille, and taken as a whole looping is of no value in a fight, for while a machine is inverted the pilot is quite helpless until the machine has passed the "dead point" and started downward, thus giving an enemy who is following a good target. The machine-gun belt is likely to become disarranged and cause the gun to jam.

If the loop is improperly done the reversals of pressure are very severe and are extremely hard on a finely adjusted and very fast machine, but a loop properly done causes very little strain.

The Tail-Slide. A real tail-slide should not be accomplished with a machine using either ailerons or wing flaps for lateral control, because when it is properly done the reversal of pressure may cause them to buckle.

A tail-slide should never be attempted by even the most experienced pilot unless he has an especially built exhibition plane, preferably a monoplane, which is equipped with warping wings and is constructed strong enough to withstand the tremendous reversal of pressure.

A stall accompanied by a slight drop of the tail, followed by a slipping off to the side into a vrille, cannot be called a tail-slide, for a well-performed tail-slide will extend for at least 300 meters.

The Time and Place for Acrobacy. Acrobacy at low altitudes is strictly forbidden at training schools and it should never be done close to the earth except in cases of emergency and actual combat.

A pilot cannot at all times be sure of the condition of the atmosphere which he cannot see and fatal falls often result when overconfidence meets with bad air conditions near the ground. (*Aerial Age Weekly*, vol. 8, no. 8, November 4, 1918, pp. 422-423, 3 figs., *d.*)

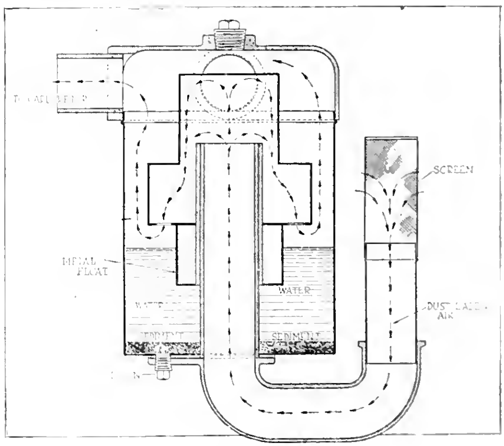


Fig. 4 Liquid Air Cleaner

Air Machinery

Air Cleaners, W. G. Clark. Analysis and comparison of various air cleaners such as used for washing the air on tractor engines.

The writer divides all cleaners now in use on tractors and trucks into four types: (1) cloth or screen type; (2) inertia cleaners; (3) liquid-type cleaners where water or some other liquid is used to wash the air, and (4) centrifugal or gravity

cleaners. The various types are briefly described and illustrated.

The disadvantage of the cloth- or screen-type cleaners lies in their being difficult to handle, ineffective and bulky. They must be very large in order to cut down the air velocity. The cloth or screen soon clogs and restricts the flow of air to the carburetor.

The action of inertia cleaners depends on the inertia of the dust in the air to carry it out of the air stream when the air flow is suddenly reversed or changed before passing to the carburetor.

The third type comprises those cleaners in which the liquid is employed to trap the dust. One such cleaner is shown in Fig. 4. It is said that this cleaner has the objection of employing a floating member with a large bearing surface exposed to the wearing action of the dust entering the cleaner.

Several types of centrifugal cleaners are described and illustrated.

The writer claims that the efficiency of the liquid and gravity types is approximately the same, but that the former may have an advantage in that the water entering by the air aids in the process of carburetion. (Paper presented at a recent meeting of the Minneapolis Section of the Society of Automotive Engineers, abstracted through *Automotive Industries*, vol. 39, no. 16, October 17, 1918, pp. 678-680 and 696, 8 figs., *cd*)

Fuel and Firing

Fuel Tests in Northern Saskatchewan. A series of tests was conducted at the Prince Albert Power Plant, Alberta, Saskatchewan, to determine the relative values of various fuels available locally.

The fuels tested were bituminous and lignite coals from the Province of Alberta, jack pine and poplar cordwood, spruce edgings, planing-mill shavings and hog fuel. The tests were carried out on a hand-fired 72-in. return tubular boiler 18 ft. long, normal rating 150 hp. The grates used were one-half herringbone pattern, having a total grate area of 36 sq. ft., with air spaces forming approximately 45 per cent of the total area.

TABLE 1. RESULTS OF TESTS WITH SASKATCHEWAN FUELS

	Bituminous Slack	Lignite 50 Per cent Nut 50 Per cent Slack	Jack Pine Cordwood	Poplar Cordwood	Spruce Edgings
Duration of test, hr....	6	6	6	6	6
Gage pressure, lb.........	125	125	125	125	125
Average temperature feedwater, deg. fahr..........	177	179	180	180	178
Average temperature flue gases, deg. fahr...................	490	495	500	485	490
Thickness of fire, in......	9	4	24	24	24
Draft, in.................	0.12 to 0.19	0.04 to 0.27	0.01 to 0.02		0.00 to 0.01
Total water evaporation, lb...	24,200	22,800	23,600	24,000	24,400
Total fuel fired, lb.......	2,600	4,100	5,565	6,830	8,022
Total fuel fired, cords of 128 cu. ft.			2.1	2.75	3.6
Total weight ash and clinker, lb.....	314	371	37	57	108
Per cent ash and clinker.	12	9	0.65	0.85	1.35
Water evap. per lb. of fuel as fired, lb.	9.3	5.6	4.3	3.5	3.0
Equivalent evaporation from and at 212 deg. fahr. per lb. of fuel	10.0	6.0	4.6	3.8	3.3
Equivalent evaporation from and at 212 deg. fahr. per cord of 128 cu. ft.			12,100	9,400	7,300

In tests with some of the lignites the fires were not cleaned, the boiler operating, roughly, not higher than at 80 per cent of its rated capacity. With other fuels the fires were cleaned about every two and a half hours. A fuel bed about 4 in. in thickness was found most suitable, and the best results were obtained when the clinker was left undisturbed; no slice bar being used. In fact, the use of the bar seemed to increase the amount of clinker even when the greatest care was exercised. This applies apparently especially to the case of burning lignite slag.

In the tests with wood the same herringbone grates were used as for coal, but the ends next to the bridge wall for a distance of 18 in. were covered with sheet iron protected by a layer of ashes. A poker was used occasionally to consolidate the fuel, and the furnace was kept as full as possible.

The quantity of ash with wood was very low, and the grates did not require any cleaning at all. It is stated that the firemen experienced in handling cordwood claimed it much easier work than firing coal. The results of the tests are given in Table 1. (*Power*, vol. 48, no. 18, October 29, 1918, pp. 624-625, *e*)

Heating and Ventilation

A Ventilation Paradox, Thos. R. Wilson. Description of air conditions in the Chicago freight tunnel.

The enormous quantities of various materials through which the tunnel is driven (including water) act as a great reservoir of heat, extracting heat from the tunnel air when the latter is warmer than the tunnel surface. During cold weather the opposite flow of heat takes place, the heat stored in the materials about the tunnel being given back to the air through the millions of square feet of tunnel surface. These conditions balance so accurately that the entire temperature variation throughout the year in the tunnel air is less than 10 deg.

This had a rather unusual result. In the summer months air is almost always in a saturated condition as the outside air is cooled to the dewpoint. This keeps the tunnel air practically free from dust, partly because the condensation of moisture on the dust particles causes their precipitation to the tunnel invert.

In the summer of 1916 a complaint was received respecting the use of tunnel air in a cold-meat storage room of a certain downtown hotel, the claim being made that such air is unsanitary. Various tests for air purity were made and revealed a remarkable freedom of the air from dust. (*Heating and Ventilating Magazine*, vol. 15, no. 10, October 1918, pp. 42 to 45, 4 figs., *d*)

Hydraulics

Hydraulic Tests of a 715-Hp. High-Speed Water Turbine of Swiss Construction, W. Schmid. Description of tests of a turbine built by Escher, Wyss & Company, of Zurich, Switzerland, and tested in 1917, after installation in the new hydroelectric plant at Thun.

The general construction of the turbine and its installation are apparent from Figs. 5 and 6. The tests were based on the following guarantees of the contract: Net hydraulic head $H = 5$ to 6.1 m. (16.4 to 20 ft.); water discharge $Q = 10{,}300$ to 11,000 l. per sec. (2720 to 2905 gal. per sec.); output N_e is 545 to 715 hp.; speed n 150 r.p.m.; efficiency η at 715 hp. 79 per cent, at 625 hp. 80 per cent, at 535 hp. 77 per cent, and at 447 hp. 73 per cent, with a tolerance of 2 per cent either way. The greatest permissible rise in speed over the respective speeds in the case of sudden removal of load was specified as 3, 6 and 15 per cent, respectively, for loads of 178.7, 357.5 and 715 hp. These contract values correspond to a specific speed of rotation of

$$n_s = \frac{n}{H}\sqrt{\frac{N}{\sqrt{H}}} = \frac{150}{6.1}\sqrt{\frac{715}{\sqrt{6.1}}} = 418$$

As regards the construction of the turbine, Fig. 6 is of particular interest as it indicates the new form of rotor with its large space between the Fink regulating buckets and the rotor buckets proper.

The ventilating pipes open into this intervening space and remain open during operation of the turbine (and also were kept open during the test runs described in the present article), the access of internal air being also allowed freely. This arrangement has been patented and is designed to improve the efficiency at partial load.

The oil-pressure governor of the type generally used by the company is installed here.

The actual tests were carried out on December 9, 1917, and only certain test points in the efficiency curve of the turbine were selected to be established: namely, a point near the peak of the output of the turbine, and about 447 hp.

At the beginning of the first continuous run it was found that

with the turbine under full load it was difficult to maintain constant conditions in the water flow and the gate was reduced to 90 per cent. Thereafter, five tests were carried out in the following order:

1 A two-and-a-quarter-hour run with the turbine gate open 90 per cent for the purpose of determining the efficiency of the turbine.
2 Run with the gate open 100 per cent to determine the maximum output of the turbine.
3 Load on the generator changed from full-load to no-load to determine the rise in potential.
4 A two-hour run with the turbine gate open 72 per cent to determine the efficiency of the turbine at that position.

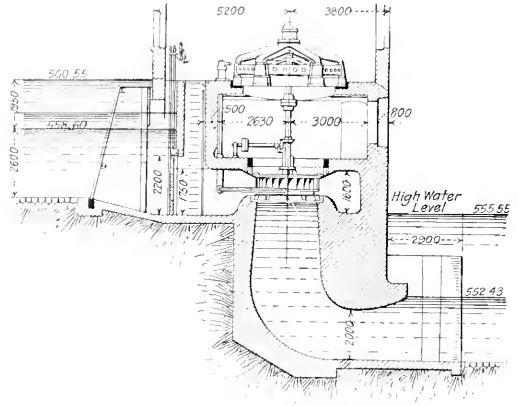


Fig. 5 Section through the New Engine Room of the Hydro-Electric Plant at Thun (scale 1 to 200)

5 Test of the governor control, consisting of observation of increase in speed with change of load on the generator and turbine from full load to no-load.

Efficiency of the Turbine

In Fig. 7 curve A indicates the efficiency of the turbine as a function of the output, on the basis of the guarantees of the builder of the turbine. The two points indicated by the present tests and indicated in that figure have been found by the following calculations:

For an opening of the turbine gate of 90 per cent, the volume of water Q delivered to the turbine was 10.113 cu. m. (357.02 cu. ft.) per sec. and the average actual head 6.067 m. (19.903 ft.). Hence, the available output was

$$N_a = \frac{Q.H.\gamma}{75} = 818.07 \text{ hp.}$$

On the other hand, the output measured at the generator with instruments of high precision and a water rheostat was

$$N = 463.6 \text{ kw.} = 629.89 \text{ hp.}$$

Hence, the overall efficiency of the turbine and generator was

$$\eta_{tot} = \frac{629.89}{818.07}\,100 = 76.997 \sim 77 \text{ per cent}$$

But from an efficiency curve of the generator reproduced in the original article, it appears that at a total output of 463.6 kw. it has a total efficiency of 92.5 per cent, which shows that the efficiency of the turbine alone is

$$\eta_T = \frac{77}{0.925} = 83.24 \text{ per cent}$$

and the output of the turbine

$$N_e = \frac{629.89}{0.925} = 680.96 \text{ hp.}$$

With a gate opening of 72 per cent, the volume of water discharged by the turbine was Q = 6.981 cu. m. (246.48 cu. ft.) per sec. and the actual average head 6.195 m. (20.324 ft.) which gave an available output of power of $N_a = 576.63$ hp. The power output measured at the generator was $N = 304.15$ kw. = 413.25 hp., which gave an overall efficiency of

$$\eta_{tot} = \frac{413.25}{576.63}\,100 = 71.66 \text{ per cent}$$

At that output the efficiency of the generator was found to be 90 per cent, which indicates an efficiency for the turbine alone of

$$\eta_T = \frac{71.66}{0.902} = 79.45 \text{ per cent}$$

and shows that the output of the turbine was

$$N_e = \frac{413.25}{0.902} = 458.15 \text{ hp.}$$

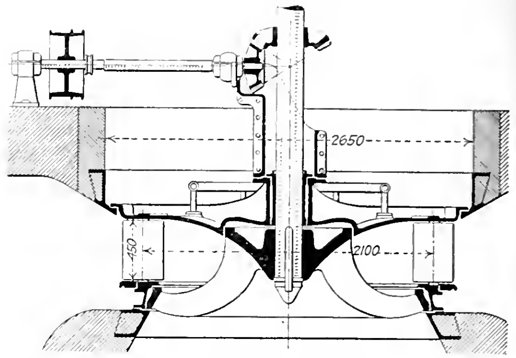


Fig. 6 Section through the High-Speed 715-Hp. Swiss Water Turbine (scale 1 to 40)

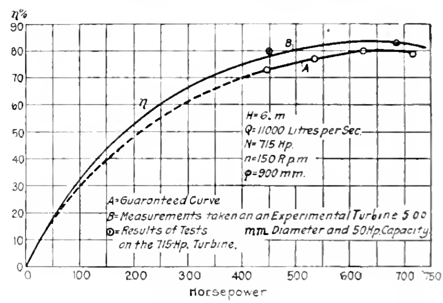


Fig. 7 Efficiency Curves of the High-Speed Turbine shown in Fig. 6

While these two points do not in themselves completely determine the efficiency curve of the turbine, they permit plotting it with a fair degree of approximation when the data of similar tests on other apparatus are taken into consideration. In particular, since the two control points determined by actual tests lie considerably above the guarantee curve, it is reasonable to assume that the entire performance curve is above the guarantee curve.

The values thus found are in fairly good accord with the curve B in Fig. 7, which expresses the conditions in the turbine under test. It is also stated that the measurements were sufficiently precise for all practical purposes.

Maximum Output of the Turbine

In test 2 with the turbine gate wide open the output as measured by the generator was found to be N = 495.9 kw. At this output the efficiency of the generator is 0.926 and the total output of the turbine is

$$N_{e\ max} = \frac{495.9}{0.736 \times 0.926} = 727.6 \text{ hp.}$$

However, during this test the head was only H = 6.014 m. (19.730

ft.), and was, therefore, less than the head specified by the builders of the turbine, or $H = 6.10$ m. (20.003 ft.). When the head varies slightly while the opening of the gate remains the same, the output of the turbine varies in accordance with

$$N_1 = N_0 \cdot \sqrt{\left(\frac{H_1}{H_0}\right)^3}$$

so that with the normal head $H_1 = 6.1$ m. (20.003 ft.) the maximum output would have been

$$N_1 = 727.6 \cdot \sqrt{\left(\frac{6.100}{6.014}\right)^3} = 743.3 \text{ hp.}$$

As a matter of fact, the guaranteed output was $N_e = 715$ hp. at a head of 6.1 m. (20.003 ft.) and an efficiency of 79 per cent, so that the actual performance was about 4 per cent better than the guaranteed performance.

During the test with the gate open 90 per cent, it was found that at maximum output the efficiency of the turbine is about 3 per cent higher than the guaranteed value, and from Fig. 7 it appears that at maximum output the efficiency is around 82.2 per cent. Hence, even if the turbine should take only as much water as was provided for in the designs of the builders, its maximum output would have been still around 743.9 hp., and the agreement of this value with the one calculated above shows the precision of the test with the 90 per cent gate.

To the maximum output corresponds a specific speed of

$$n_s = \frac{n}{H} \cdot \sqrt{\frac{N_{max}}{\sqrt{H}}} = \frac{150}{6.1} \cdot \sqrt{\frac{743}{\sqrt{6.1}}} \sim 427$$

CAPACITY FOR GOVERNING

When the load was suddenly thrown off and thus reduced from 480.1 kw. or 705 hp. to zero, the periodicity, as indicated from the frequency meter, changed from 50 to 56 cycles. Considering that within 10 sec. a constant state of 52 cycles was reached, this indicates a rise of

$$\frac{56 - 52}{52} \times 100 = 7.69\% \sim 8 \text{ per cent}$$

This amount is only a little in excess of one-half of the guaranteed maximum of 15 per cent.

These tests show how closely a large Francis-type turbine of modern construction can hold within guaranteed limits. The speed of 427 r.p.m. is to be considered as being very high, but is of advantage as it reduces materially the first cost of the plant. Also, notwithstanding this high speed, the efficiency of 79.45 per cent at five-eighths load is also very good and indicates that this new type permits utilizing very well the available water heads, even at partial load.

It is true that with the new type the efficiency on loads under half of the maximum decreases more rapidly than with the former standard types. This, however, is claimed to be compensated for by advantages in other directions. (*Schweizerische Bauzeitung*, vol. 72, no. 14, October 5, 1918, pp. 129-131, 4 figs., *eA*)

A PROPOSED HYDRAULIC EXPERIMENT, Lord Rayleigh. Stokes showed in 1850 that in the case of a homogeneous incompressible fluid whenever $udx + vdy + wdz$ is an exact differential, not only are the ordinary equations of fluid motion satisfied but the equations obtained when friction is taken into account are satisfied likewise. It is only the equations of condition which belong to the boundaries of the fluid that are violated.

In order to satisfy these conditions also it is only necessary to suppose that every part of the solid boundaries is made to move with the velocity which the fluid would there assume in irrotational motion.

The only way, however, to carry this into effect with tolerable completeness is by the two-dimensional motion of fluid between co-axial cylinders, which themselves are rotating in the same direction with the circumferential velocities which are inversely as the radii. Experiments upon these lines which are believed to have only partly satisfied the above conditions have been made by Conette and Mallock.

But the point of greatest interest is not touched in the above arrangement. It arises when a fluid passing along a uniform or contracting pipe or channel arrives at the place where the pipe expands. If the expansion is sufficiently gradual the fluid, generally speaking, follows the walls, or, as it is often expressed, the pipe flows *full* and the loss of velocity accompanying the increase in section is represented by an augmentation of pressure approximately according to Bernouilli's law.

On the other hand, if the expansion is made violently, the fluid refuses to follow the walls; eddies result and mechanical energy is lost by fluid friction.

According to W. Froude this is due to loss of velocity near the walls in consequence of fluid friction, which is such that the fluid in question is unable to penetrate into what should be the region of the higher pressure beyond.

The writer proposes a comparatively simple experiment, which, while not fully satisfying all conditions, might throw interesting light upon the subject. It is proposed to observe the flow of liquid between two cylinders *A* and *B*, Fig. 8 (probably brass

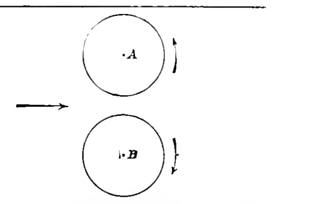


FIG. 8 DIAGRAM OF LORD RAYLEIGH'S PROPOSED HYDRAULIC EXPERIMENT

tubes) revolving about their axes in opposite directions. The circumferential velocity of the cylinders should not be less than that of irrotational fluid in contact with the walls at the narrowest place. The simple motion may be unstable, but the critical situation would be so quickly traversed that possibly the instability may be of little consequence. If no marked difference in the character of the flow could be detected by color streaks whether the cylinders were turning or not, the inference would be that Froude's explanation is inadequate. In the contrary event, the question would arise whether particular advantage could be taken by specially stimulating the motion of the fluid near the walls of expanding channels, as, for example, with the aid of steam jets. (*The London, Edinburgh & Dublin Philosophical Magazine*, vol. 36, no. 214, October 1918, pp. 315-316, 1 fig., *t*)

Internal-Combustion Engineering

INVESTIGATION OF THE GOVERNING OF A GAS ENGINE, Prof. A. Gramberg. The governing of a gas engine by throttling the mixture as shown diagrammatically in Fig. 9, differs fundamentally from the governing of a steam engine as described by the present author in another article. (See abstract in THE JOURNAL, November 1918, p. 967).

The governing of any power-producing engine is affected by the variation of the load on the engine. If the power-producing engine is a gas-engine generator set, as in the present instance, then the resistance W_A of the external circuit may be varied by introducing new resistances in parallel with the initial resistances. At the beginning of the no-load run the resistance of the external circuit is infinitely large, a fact which cannot conveniently be indicated diagrammatically. For this latter purpose, instead of the resistance it is more convenient to use the reciprocal of it $\frac{1}{W_A}$, or the conductance of the external circuit which at no load is equal to zero. In that case one measures the potential at the terminals of the generator in volts E and the current J.

With the increase in conductance, J and hence the output $N_{EL} = E\,J$ increase, and, therefore, the speed N in r.p.m. decreases.

The decrease of speed has as its consequence the decrease of the electromotive force of the generator with the increase of load, this electromotive force being proportional to the speed of rotation. The potential at the terminals decreases still more since the loss of potential in the armature of the dynamo increases with the current. The decrease of the terminal voltage E due to these two influences has to be equalized by manipulating the field rheostat and also by increasing the exciting current. This may continue until the field rheostat is entirely short circuited and the exciter winding is connected directly to the terminals. The exciting current in the generator under consideration may reach the maximum value $i_{max} = 1.05$ amperes at the terminal voltage of 220 volts.

The results of the tests are given in Figs. 10 and 11 and Table 2. In the first three tests, Nos. 89, 90 and 91, the transition was made in two broad steps from no load to full load and the rheostat had to be adjusted from contact point 3 to contact point 20 in order to maintain the potential, although the speed fell off from 192.0 to 186.7 r.p.m.

In the next test, No 92, the external conductance was raised only a little, viz., from 0.227 to 0.235 J_{E}, but although the rheostat was shifted previously the maximum output was exceeded. When in test No. 93 the rheostat was shifted from contact point 22 to 25, the desired potential could not be obtained. The governor went down and with it the speed of rotation, which brought the potential lower than the field rheostat was capable of handling.

If, finally, in tests 94 to 96 we set the field rheostat at its ultimate contact point 41 and then raise the conductance still more, we only succeed in reducing the speed, as the engine is then overloaded.

A peculiar feature of this whole phenomenon as compared with that of steam-engine governing is that only a small part of the stroke of the governor sleeve is utilized, viz., the heavy line in Fig. 10. At 192.0 r.p.m. the engine runs at no load and already at 186.7 r.p.m. the maximum load is reached while the governor is still 28 mm. above its lowermost position. Nevertheless, the further sinking of the governor does not produce any increase in load.

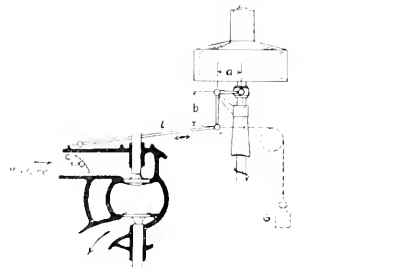


Fig. 9 Diagram of the Governor Arrangement on a Gas Engine

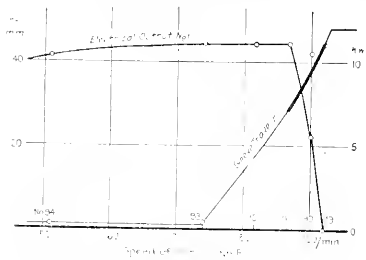


Fig. 10 Governor Curves Taken on Gas Engine

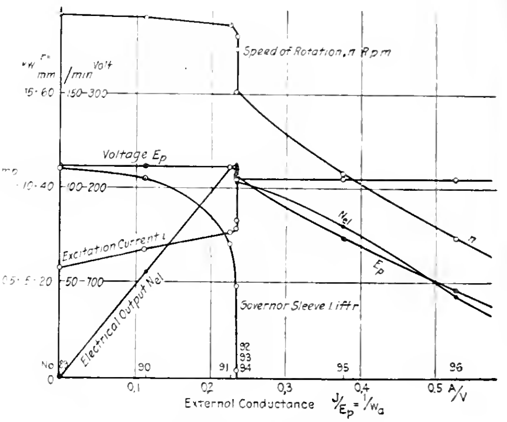


Fig. 11 Curves of Operation of an Automatically Governed Gas-Engine Generator Set

These facts represent the external appearance of the phenomenon; the inner reason wherefore the possible rise cannot exceed $\frac{1}{W_1} = 0.235$ is due to the transformation of energy. Up to test No. 91 the volumetric efficiency η_{vol} (as read from the indicator diagram) increases. In experiment 91 the volumetric efficiency is seen to be 0.985 and therefore cannot be materially increased. With the governor position $r = 28$ mm. above the lowermost position the throttle valve has already opened so far that the mixture does not meet with any material resistance, and the further opening of the throttle valve cannot produce any change in conditions. Hence, the further movement of the

TABLE 2 BEHAVIOR OF GAS ENGINE GOVERNING AT OVERLOAD (EXTERNAL EXCITATION ON DYNAMO)

No. of test		89	90	91	92	93	94	95	96
External conductance, $J/E_p = 1/W_a$	A/V	0	0.113	0.227	0.235	0.235	0.235	0.377	0.528
Field rheostat position	Contact No.	3	12	20	22	23	41	41	41
Exciter current i	A	0.57	0.67	0.76	0.78	0.82	1.05	1.05	1.05
Potential at terminals E_p	V	222	222	221	217	216	212	146	90
Electrical output, $N_{el} = E_p J$	kw	0	5.55	11.1	11.1	11.2	10.4	8.03	4.27
Speed of rotation, n	r.p.m.	192.0	190.1	186.7	181.7	174.1	151.0	107.8	73.6
Position of governor, r	mm	44	42	28	17.5	1.5	1	1	1
Volumetric efficiency, η		0.595	0.745	0.985	0.985	0.985	0.995	1	1
Mixture ratio, L/G_o	m $\left(\frac{0}{760}\right)$ per hr	12.0	10.4	9.3	9.3	9.25	9.2	9.35	10.7
Gas consumption, G_o		4.92	7.13	10.28	10.13	9.79	8.63	6.19	3.5
Coefficient of output, η_l		0.14	0.57	0.76	0.77	0.78	0.78	0.79	0.7
Timing of ignition, from dead center	deg.	−16.5	−10	−4	−5	−6	−11	−9	−17.5
Indicated pressure, p_i	atmospheres	2.07	3.41	4.84	5.16	5.11	5.39	5.28	4.51
Exhaust gas temperature, t_a	deg. cent.	348	374	419	422	420	396	354	288

governor is without effect: If the amount of fuel mixture introduced cannot be increased, a further supply of energy is made impossible.

Hence, in this instance, contrary to what happens in the case of the steam engine, the maximum output of the engine is governed not only by the governor and its appurtenances but by the engine itself.

Judging by Fig. 10 the governor is strongly static. It has a degree of lack of uniformity equal to

$$\frac{192.0 - 174.1}{\frac{1}{2} \cdot (192.0 + 174.1)} = 0.098$$

or 9.8 per cent. On the other hand, the governing itself is much less static, because it does not utilize the full range of the governor. Its coefficient of lack of uniformity is

$$\frac{192.0 - 186.7}{\frac{1}{2} \cdot (192.0 + 186.7)} = 0.028$$

or 2.8 per cent. It is therefore necessary to distinguish in this case the properties of governing from those of the governor.

One might presume that the governing, being practically astatic, would be subject to violent oscillations. This is not the case, however. Fig. 12 gives the tacho-diagram of the governing, which seems to be quite satisfactory, although at full load and no load the current interrupter was brought into play.

Lubrication

The Viscosity of Lubricating Oils, E. Oelschläger. (*Zeits. Vereines Deutsch. Ing.*, 62, pp. 422-427, July 6, 1918). The author, in this portion of his extended series of articles upon lubricating oils, deals with the relation between viscosity and temperature. He points out that it is customary to carry out the viscosity test at various temperatures according to the intended application of the oil, the usual test temperature for transformer oils being 80 deg. cent., and for bearing oils 50 deg. cent., and for cylinder oils 100 deg. cent. No formula or chart, however, has existed up to the present which would enable one to calculate the viscosity at any other temperature than that at which the observation was actually made.

As a result of an extended investigation of the results obtained with many oils, the author has constructed curve diagrams which overcome this difficulty. By aid of these, the viscosity of any oil can be ascertained for any temperature when one determination of it has been made. The only exceptions to the law governing the rate of change in the viscosity with temperature variations, are rape-seed oil, linseed oil, and blubber oil. (*Science Abstracts,* Section B—Electrical Engineering, vol. 21, pt. 9 (no. 249), Sept. 30, 1918, pp. 320-321. *eA*)

Machine Design (See also Internal-Combustion Engineering)

Efficiency of the Screw, Benjamin F. Groat, Mem.Am.Soc. M.E. An important article, for a complete abstract of which, unfortunately, there is not enough available space. It embodies an attempt to express in mathematical formulae the performance of various types of screws, so that a screw of given efficiency can be constructed from arbitrary dimensions.

Among other things, the writer tries to show that the torque upon a screw necessary to lift a given load cannot be determined by the use of a general coefficient and that each design has its own coefficient.

A screw is defined from the mechanical point of view as a machine which converts a torque into a thrust, or, inversely, a thrust into a torque. It acts as an intermediary between three external bodies, one of which may be considered to be a fulcrum and to be at rest. The mutual interactions between the other two bodies and the screw may then be considered under three different headings.

Case 1 (Fig. 13). The screw receives a torque from one of the bodies and converts a portion of that torque into an equivalent thrust, which it transmits to the other body. A jackscrew lifting a weight is an example of this case.

In Fig. 13 it should be understood that the nut is fixed while the screw turns and that θ = angle BPC and ϕ = angle CPA, which are respectively the angles of slope of threads and of friction.

In case 2 (Fig. 14) the screw receives a thrust from one of the bodies and converts a portion of that thrust into an equivalent torque, which it transmits to the other body. A "spiral" ratchet screwdriver affords one of the few examples of this case. The slope of the screw threads must exceed a certain minimum. Fig. 14 is generally similar to that of Fig. 13, but the angle of slope $\theta = BPC$ is numerically greater than the angle of friction $\phi = CPA$, and of contrary sense. There is a component AB of the resultant AP which *assists* the motion, and the motion must occur unless opposed by a torque upon the screw of sense contrary to the impending motion and to the component AB. A limit of this case is reached when $\phi = -\theta$, that is, when A falls upon B, which

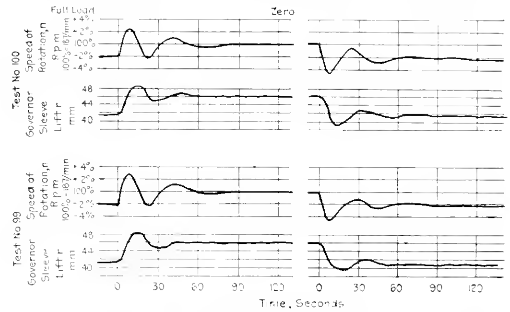


Fig. 12 Tacho-Diagrams of an Automatically Governed Gas-Engine Generator Set

implies that the screw locks and cannot turn unless assisted by an external torque.

Case 3 (Fig. 15). Here the screw receives a torque from one of the bodies and a thrust from the other, the combined work of both torque and thrust being consumed in friction. A jackscrew letting a weight down is an example of this case. The slope of the screw threads cannot exceed a certain maximum. In this case the point A falls to the left of B. The motion cannot occur unless assisted by an external torque upon the screw of the same sense as the motion, but, as in all cases, contrary to the component AB, which may be taken as a measure of the couple that must exist in the screw spindle in order to maintain uniform rotation; it should be remembered, however, that bearing friction is an additional element not yet taken into consideration.

The notation employed is as follows:

T = the thrust which is due to the reaction between the threads of the screw and the threads of the nut. It is not necessarily equal to the thrust delivered by the screw upon external bodies, considering the screw, nut and thrust bearing to be a self-contained unit. This is because the weights of parts of the screw may affect the action.

t = the thrust upon the thrust bearing. It is not necessarily equal to T, though, where the weights of the affecting parts of the screw are negligible, it is usually so considered. The relative values of T and t thus depend in each case upon the particular positions of the screw and the bodies acted upon.

M_t = the torque which is theoretically equivalent to the thrust, T, due to the reaction between the threads.

M = the actual torque passing between the screw or nut, as the case may be, and the body which receives or imparts torque.

M_s = the torque which exists in the body of the screw or of the nut, according as it is the screw or the nut which turns.

The writer calls attention to certain relations which may exist between M_t, M and M_s.

μ and ϕ are, respectively, the coefficient and angle of sliding friction for the threads. When thrust is being converted into torque (the weight descends) these quantities are both to be taken negative in the general formulæ. "It appears that for screws lubricated with oil, with pressures of $1\frac{1}{2}$ to 5 tons per square inch of projected area of screw thread, and for low speeds, the

coefficient is about 0.11 to 0.20 whether the screw or the nut are of steel, wrought iron, cast iron or bronze."—Unwin.

μ_1 and ϕ_1 are, respectively, the coefficient and angle of friction for the thrust bearing. They are probably somewhat less than the corresponding values for the threads. If the threads are not cut threads they may be considerably less. They are both negative in the general formulæ when the weight descends.

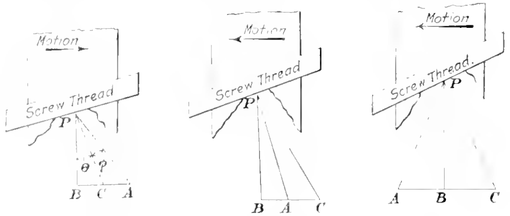
r = average radius of the screw threads or arm of frictional resistance acting upon the surface of the threads. No great error will be made if it is taken as the arithmetical mean of the inner and outer radii of the screw threads. If questions of elasticity are introduced, its exact determination becomes more difficult.

ρ = average radius (similar to that for r) of the pivot or collar.

n and θ are, respectively, the slope and the angle of inclination of the threads.

p = the axial pitch of the screw.

With the foregoing notation the following general formulæ concerning the square-threaded screw will be established:



Figs. 13, 14 and 15 Three Cases of Screw Operation

$$M_t = \frac{Tp}{2\pi} = Trn \qquad [1]$$

$$\frac{M_t}{M_s} = \frac{\tan\theta}{\tan(\theta+\phi)} = n\frac{1-\mu n}{m+\mu} \qquad [2]$$

$$\frac{M_s}{M} = \frac{1}{1+KA}$$

where $n = \tan\theta = p \div 2\pi r = p \div 6.283r$; and μ, μ_1, ϕ and ϕ_1 are to be taken negative when the weight is being let down or the screw slackened. Also in accordance with formula [3]:

$$K = \frac{\tan\phi}{\tan(\phi+\theta)} \qquad [4]$$

$$A = \frac{\mu_1}{\mu}\,\frac{t}{T}\,\frac{\rho}{r} \qquad [5]$$

The formulæ for the maximum compound efficiency of screw and thrust bearings are given as follows:

$$n = -D + \sqrt{D^2 + (D \div \mu)}$$

where

$$D = \frac{\mu(1+A)}{1-A\mu^2}$$

and $n = \tan\theta$ and the above formula gives the critical value of n.

Two tables are included in the original article giving the values of $\frac{M_t}{M_s}$, $\frac{M_s}{M_t}$ and K directly as functions of n and μ, and several cases where these formulæ can be applied are discussed in considerable detail. In particular the case of the application of these formulæ to V-threads and worm gearing is given.

In this latter connection the writer agrees fully with the conclusions arrived at by F. A. Halsey (Mem.Am.Soc.M.E.) in the *American Machinist* for 1898. At the same time he points out that both velocity and friction are vectors, that is, directed magnitudes, and unless they act in the same line it is only the projection of one upon the other which is effective. Because of this the writer believes that the compound thread friction and tooth friction of the worm and wheel are to be added geometrically and not arithmetically. In other words, the compound friction is less than the arithmetical sum of the thread and tooth frictions. In practice, the method described by the writer gives slopes much larger than are usually employed for the threads of worms, and this must be done, as far as practicable, where maximum efficiency is required.

In addition to this, the side thrust between the worm and worm-wheel should be taken into consideration. The side thrust of the wheel may be eliminated by employing right- and left-hand wheels and two worms. With two more wheels and worms the friction losses in the step bearings may be eliminated by properly disposing the right- and left-hand worms and wheels in neutralizing pairs.

Finally an arrangement is described which eliminates side thrust upon the journal bearings of the wheels, making it unnecessary to use ball bearings. This arrangement consists of two wheel shafts, four wheels, four worm shafts and eight worms, the efficiency being that of threads only.

Highly interesting test data which cannot be abstracted on account of lack of space are presented in the appendices. (*Proceedings of the Engineers' Society of Western Pennsylvania*, vol. 34, no. 5, June 1918, pp. 377-429, illustrated, *peA*)

Machine Shop

Manufacture of Transmission Chain, J. V. Hunter. Description of the plant and manufacturing processes of the Diamond Chain and Manufacturing Company of Indianapolis, Ind.

The company manufactures, in particular, a roller chain for drive between the various motors and lineshafts.

Part of the material used in the manufacture of roller chains comes in the form of rolled strips, but large quantities of round rod are used for pins and rollers, and figure-8-shaped cold rolled and drawn steel bars are used for block types of bicycle chains. Different grades of steel are used, depending on the part of the chain to be made, and also the service the chain must render. These grades vary from low-carbon dead-soft annealed steel to hard chrome-nickel steel.

An interesting operation, described in considerable detail, is the production of the side links. It is entirely a punching-machine job. The types of the links are shown in Fig. 16, where A illustrates the larger sizes used for truck drive and power transmission and B the smaller sizes for bicycle chain, etc. In the larger sizes, as A, a noticeable feature is the beveled edge, which one can see in the figure. In assembling, this beveled edge is turned inward on the inside links where it comes in contact with the sprocket teeth to avoid the tendency to cut and wear, and outward on the outside links, adding to the finished appearance of the chain.

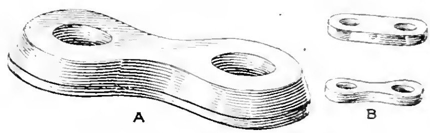


Fig. 16 Types of Side Links

A Bliss punching machine with an automatic feed attachment for advancing the stock after each stroke of the punch is used in the manufacture of these side links.

In the smaller sizes the holes are punched for the center of each link end before the links are blanked from the strip. In the larger sizes the links are blanked first, then beveled and in the last operation the holes are punched and shaved. All holes are shaved as the necessary clearance allowance on the dies results in a slightly tapered hole. The hole is purposely made from 0.012 to 0.015 in. under size and the shaving leaves the hole about 0.003 in. under the diameter of the pin that will be driven into it later.

For trimming the many millions of side links which are used in the manufacture of a lighter type of chain an automatic device illustrated in the original article is used. The links are fed into long tubes which act as a magazine in feeding these pieces to the trimming machines. To do this the links are poured into the funnel-shaped magazine, which, by means of a belt drive, is rapidly jolted up and down. In the center of this funnel is a tube which is forced up and down through the blanks contained

in it. This tube has an open end of the size of the end of the blank, and the jolting action forces these blanks to enter it one at a time, after which they slide lengthwise to a special mechanism. There a small ram pusher forces the blanks forward and into line with the magazine tube, into which another small pusher crowds them until the tube has been filled throughout its length. An extensive use of this magazine-filling device is made throughout the plant. (*American Machinist*, vol. 49, no. 15, October 10, 1918, pp. 643-647, 13 figs., *d*)

GENERATING CAMS AND IRREGULAR-SHAPED WORK, Douglas T. Hamilton, Mem.Am.Soc.M.E. Discussion of the capabilities of the gear shaper for generating cams or other irregular forms on a commercial basis.

The writer claims that the production of cams on the gear shaper is not only a simple proposition but is also accurate and fast, and that it is possible with the gear shaper to obtain, in a commercial way, cams that are very difficult to produce accurately by tool-making methods.

As shown in Fig. 17 the cutter used in producing the cam does not have anywhere near the same appearance as the cam itself. Fig. 18 shows, diagrammatically, how this form of cutter generates the cam. In operation the cutter and the cam blank are rotated in unison with each other and the rolling is done on two imaginary circles which are identical with the pitch circles of two gears in mesh. As the cutter and cam blank roll around in mesh with each other, the outline is generated on the cam as is illustrated by the fine lines in Fig. 18, these indicating the various positions of the cutter as it is rolled in contact with the blank. In connection

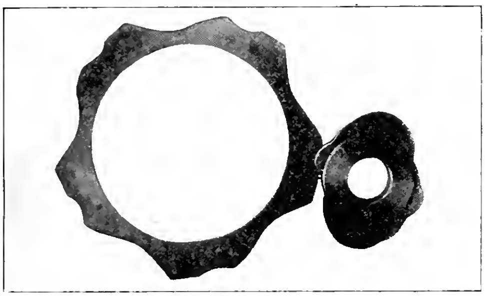


FIG. 17 EXHAUST CAM FOR GNOME ENGINE AND CUTTER USED IN PRODUCING IT

with this illustration, it is explained that the cutter has been rolled around the blank while the latter was stationary, this being done to simplify conditions and make the drawing clearer. In cutting these cam blanks a batch, preferably of eight blanks, is held in the fixture.

The article shows many interesting forms of cams, some of which would be very difficult to produce by milling, but are produced with comparative ease on the gear shaper. Among them is shown the breech block for a field gun upon which there is a series of interrupted gear teeth and a cam surface.

These examples are intended to show the successful application of the generating process, which is now used not only for cams proper but also for ratchets, milling cutters, etc., which were formerly produced by milling only. (*American Machinist*, vol. 49, no. 17, October 24, 1918, pp. 737-740, 12 figs., *pd*)

Machine Tools

SIMPLIFIED LATHE ADAPTED TO SHELL WORK. Description of the adaptation of the Gisholt 16 and 25 simplified lathes to munition work and of the various attachments used in that connection. An interesting feature of the new lathe is that, while it is made for a special purpose, the parts which enter into its several modifications have been standardized and reduced to a manufacturing basis.

The original article illustrates the machine in a rather interesting matter. First is shown what might be called a basic part: to wit, the bed, headstock, and parts always essential no matter for what operation the machine may be intended. Next is shown the machine equipped with a hand-operated collet chuck which may be mounted directly on the spindle nose close to the headstock in place of the faceplate and will accommodate work up to 6 in. in diameter. A carriage with a pillow-block support for the boring bar and center locking pin is also provided.

Then a semi-phantom view of the lathe is given. Shown in full size is the carriage with a 4-sided turret tool rest mounted on a right-angled compound cross-slide.

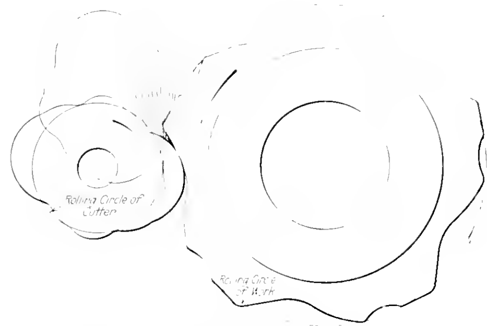


FIG. 18 DIAGRAM ILLUSTRATING HOW OUTLINE FOR CAM IN FIG. 17 IS DETERMINED

The other illustrations give the various attachments to the lathe. (*The Iron Age*, vol. 102, no. 16, October 17, 1918, pp. 945-948, 10 figs., *d*)

Measuring Instruments

COMBUSTION CONTROL METER. Description of a new system of instruments recently developed for facilitating the control of furnace combustion.

One of the features of this system is the application of a hollow tile to the bridge wall of a boiler. The principle of operation is as follows:

The hollow, self-cleaning tile is placed in the center of the bridge wall and near the top. Hot gases from the furnace are bypassed through the passage in the bridge wall to the rear of it. A hole is provided in the side wall of the furnace and extends into the hollow tile, and in it two base-metal thermocouples are inserted in such a manner that the ends of the thermocouples are out of the direct path of the flame and no ashes can accumulate in the pockets and around the couples.

One of the couples is connected to an indicating pyrometer placed on the boiler front in view of the fireman, and the other is connected to a recording pyrometer placed in the engineer's office or at some other point. On the same panel with this instrument is placed a 20-point rotary switch. The switch is so arranged that either the bridge wall or the uptake temperature may be read.

When a furnace meter indicates the temperature, it also indicates in an approximate manner the output of the boiler. With the damper wide open the maximum volume of the gas passes through the furnace. If there are holes in the fire, this volume is cooled and the pyrometer will register a lower degree of temperature. If the grate is clogged, the volume of air is reduced and the temperature is reduced, which is also registered on the chart of the recording pyrometer. Therefore, a high temperature registration on the chart not only indicates the degree of furnace efficiency, but gives a check on whether the boiler is producing a high or a low output.

The temperature graduations of the chart shown in Fig. 19 are in hundreds. The high peaks represent high furnace temperature. The chart record is composed of dots that are made at intervals of 30 seconds. When the furnace is fired at a point

below the peaks, less heat is lost and the average temperature is maintained at a high point. These dots show just what is taking place in the furnace.

The furnace meter gives a comparative temperature record of the gases in the furnace and the actual temperature of the gases in the uptake. The record of the uptake gases indicates the following: A high temperature shows one or all of three conditions; namely, dirty tubes, a hole in the baffles or excess of coal per square foot of grate surface. Low temperature indicates leaking setting, poor fuel or abnormal draft.

The record of the bridge-wall gases by comparative temperature shows the condition of the fire as indicated by the temperature line and spacing dots on the chart, the quality of coal used, method of firing the furnace and the opening and shutting of the damper. (*Power*, vol. 48, no. 17, October 22, 1918, pp. 599-600, 4 figs., *d*)

Military Engineering (See Refrigeration)

Munitions (See Machine Tools)

TABLE 3 VAPOR PRESSURE OF HYDROGEN BETWEEN ITS BOILING POINT AND CRITICAL TEMPERATURE

θ	T	ρ (in Cm.)	ρ (in Atmos.)	Δ T (Calc.-Obs.) Per Cent
Deg. K.	Deg. K.			
−248.50	24 59	219 92	2 8937	+0.05
247.48	25 61	267.99	3.5262	−0.04
246 65	26 44	319 80	4.2080	+0.02
245 87	27 22	370 65	4.8770	+0.02
245 80	27 29	376 30	4.9524	+0.03
245 68	27 41	384 32	5.0566	+0.02
244 70	28 39	475.46	6.2561	+0.25
243 22	29 87	601.52	7.9148	+0.17
241 73	31 36	748.42	9 8176	+0.05
241 07	32.02	822.6	10.825	+0.03
240.49	32.60	893.1	11.752	+0.01
240 16	32 93	936.4	12 322	0 00

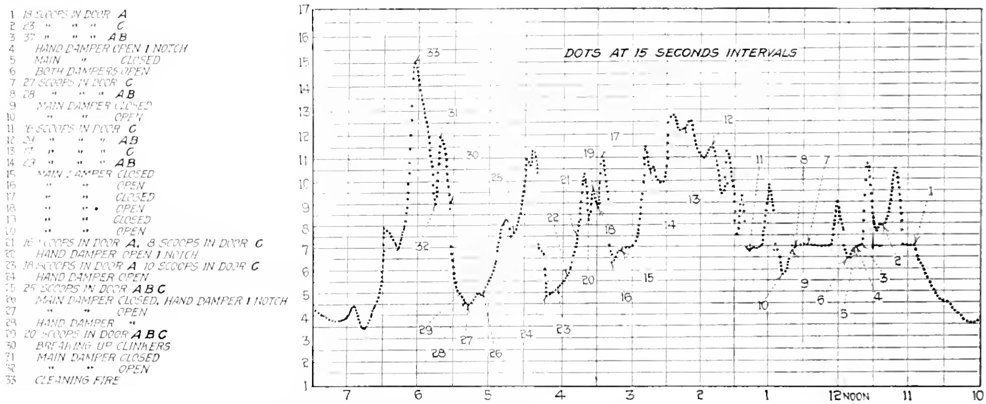


FIG. 19 CHART SHOWING THE VARIATION IN FURNACE TEMPERATURE

Physics

THE SPECIFIC HEAT AT LOW TEMPERATURES, IV, MEASUREMENTS OF THE SPECIFIC HEAT OF LIQUID HYDROGEN. PRELIMINARY RESULTS ON THE SPECIFIC HEAT OF SOLID HYDROGEN AND ON THE HEAT OF FUSION OF HYDROGEN, W. H. Keesom and H. K. Onnes. (*K. Akad. Amsterdam, Proc.* 20. 7. pp. 1000-1004, 1918. Comm. No. 153a from the Phys. Lab., Leyden)

The determinations were carried out as in the case of nitrogen. The results obtained were as shown in Table 4.

Preliminary determinations of the specific heat of solid hydrogen gave at T = 12.55 deg. K., the value 0.64. For the heat of fusion per gm. of hydrogen the mean value of 15 cal. (15 deg.) was obtained. (*Science Abstracts*, Section A Physics, vol. 21, pt. 9 (no. 249), Sept. 30, 1918, p. 379)

THE MEASUREMENT OF LOW TEMPERATURES, XXVII, VAPOR PRESSURES OF HYDROGEN IN THE NEIGHBORHOOD OF THE BOILING POINT AND BETWEEN THE BOILING-POINT AND THE CRITICAL TEMPERATURE. P. G. Cath and H. K. Onnes. (*K. Akad. Amsterdam, Proc.* 20. 7. pp. 991-999, and 20.8. pp. 1155-1159, 1918, Comm. no. 152a from the Phys. Lab., Leyden)

Previous determinations of the vapor pressure of hydrogen have been extended. For the measurement of temperature an improved helium thermometer was employed. The results obtained are summarized in the following table. The temperatures have been reduced to the absolute scale, using the corrections deduced from the Leyden determinations of the compressibility of helium.

In Table 3 the pressures are given in international cm. of mercury at 0 deg. cent., and in international atmospheres respectively, the international atmosphere at Leyden being taken equal to 75.9488 cm. Hg. at 0 deg. cent. The vapor pressure can be satisfactorily represented by the equation (ρ being expressed in international atmospheres).

$$T \log \rho = -56.605 + 3.8015\,T + 0.10458\,T^2 + 0.003321\,T^3 - 0.00005102\,T^4$$

In the measurements at $\theta = 244.70$ and $\theta = 243.22$, the deviations are greater than might have been expected, and it is assumed that some unexplained experimental error must be present. A redetermination of the boiling point gave the value T = 20.39 deg. K. (*Science Abstracts*, Section A—Physics, vol. 21, pt. 9 (no. 249), Sept. 30, 1918, p. 377, *eA*)

ULTRAMICROSCOPIC INVESTIGATION OF VERY THIN METAL FILMS OBTAINED BY EVAPORATION IN A HIGH VACUUM. W. Reinders and L. Hamburger. (*K. Akad. Amsterdam, Proc.* 20, 8. pp. 1135-1154, 1918).

This is a continuation of previous investigations, a method being here described by which the metal films can be protected by films of either calcium fluoride or Canada balsam or both while still in a vacuum. The elements investigated were W, Mo, Pt, Fe, Ni, Au, Ag, Mg, Zn, Cd, and C. The elements of high melting point, W. C, Mo. Pt. Ni, and Fe, give films which are optically either completely non-resolvable (W, C, Pt, and Fe), or for the most part non-resolvable with another part containing distinctly separate particles. The elements of lower melting point, Au, Ag, Cu, Mg, Zn, and Cd, show a far greater tendency to give a film consisting of a connected network of ultra-microns. The conclusion is drawn that in proportion as the temperature of incandescence required for slow sublimation is higher, the finer the structure of the sublimate (film) formed. Experiments in which the temperature of the glass on which the film was deposited

TABLE 4—SPECIFIC HEAT OF LIQUID HYDROGEN

Quantity of Hydrogen in Gm.	Mean Temperature	Specific Heat of Hydrogen in Cals. 15 deg. per degree K.	Atomic Heat in Cals. 15 deg. per degree K.
2.89	16.03$_5$	1.87	1.88
3.17	15.81	1.70	1.71
3.17	16.80	1.84	1.85$_5$
3.52	14.71	1.67	1.68
3.52	15.38	1.78	1.79
3.50	14.82$_5$	1.74	1.75
3.50	16.30	1.85	1.87
3.50	17.63	1.99	2.00
3.50	18.67	2.08	2.09
3.50	19.41	2.18	2.20
3.50	20.11	2.24	2.26
3.51	15.24$_5$	1.84	1.82
3.51	16.37	1.90	1.89
3.51	17.37$_5$	1.99	1.98
3.51	19.07	2.17	2.16

was varied, showed that the greater the vapor pressure of the metal at the temperature of the glass on which it is deposited, the coarser is the structure of the deposit. Various grades of coarseness can be observed, varying from deposits which are optically non-resolvable to deposits on which the smaller particles are distinctly separate.

W, Mo, C, Fe, Ni, and Pt give colorless films, whereas the other elements give colored films which, in the case of Ag, Au, and Cu, may show a great wealth of color. The color does not depend directly on the structure of the metal. For example, Au, Ag, and Cu show the same sequence of colors in mosaic deposits at room temperatures as in the structureless deposits formed at the temperature of liquid air. No coloring sets in with Pt, W and Fe when the structureless deposit is transformed into a mosaic deposit by local heating. The conclusion is drawn that the capacity for displaying color is an individual property of the metal and is determined by the selective absorption of the atoms. (*Science Abstracts,* Section A—Physics, vol. 21, pt. 9 (no. 249), Sept. 30, 1918, p. 350, *e*)

Power Plants

A New 25,000-Kw. Power Plant for Dayton, Ohio. Description of a station laid out to house 100,000 kw., but now having a capacity of 25,000 kw. in two units.

The turbines are of the nine-stage horizontal impulse type making 1800 r.p.m. At 200 lb. gage pressure, 125 deg. superheat and a vacuum of 29 in., these units are guaranteed to produce a kilowatt hour at half load on 12.4 lb. of steam; at three-quarter load, 11.95, and at full load, 12.4 lb.; (only the first value is apparently guaranteed).

The condensers are of the two-pass surface type, each containing 15,000 sq. ft. of tube surface, or 1.2 sq. ft. of surface per kilowatt of generator rating. The circulating pumps are mounted on the intake pipe, and are driven by a motor at one end of the shaft and a turbine with reduction gearing at the other end. Each drive may be used as dictated by exhaust-steam requirements to maintain the hot balance of the station.

An interesting feature in connection with the condenser installation is the arrangement for supplying circulating water. In this case, instead of the usual long, upstream intake, an intake basin has been constructed by the dragline method measuring 60 x 330 ft. and about 12 ft. deep. The mouth of the basic points downstream, so that the current of the river does not flow into it. This obviates much of the trouble usually encountered from gravel, driftwood and sewage, and also provides short intake tunnels.

The turbines are served by three boilers arranged in line along a firing aisle parallel to the turbine room, instead of at right angles to it, which gives a more symmetrical design. The boilers are of the cross-drum type, each having 13,730 sq. ft. of steam-making surface, so that one boiler horsepower supplies 6 kw. of generating capacity, a ratio exceedingly high, unless future provision is to be made for reserve capacity.

Special attention has been paid to the coal-handling apparatus, which consists of a steam hoist operating a clamshell bucket discharging into a hopper above the bunkers. From the hopper the coal passes through a motor-driven crusher into a cable car, where it is weighed before being passed to the steel bunker over the boilers. The system is rated at 90 tons per hour and is large enough to serve half of the ultimate plant. The ashes from the hoppers under the stokers are delivered by gravity into side-dump cars, which are hauled out to the low ground around the station by a gasoline-engine-driven tractor.

The water supply for the station is taken from wells, and, as it is unfit for boiler use without treatment, a hot-process water softener was installed to take care of the makeup, which was estimated to amount to about 2 per cent of the total water evaporated.

To keep down the size of the water-softening equipment a 10,000-gallon tank was placed on the roof of the building. It is supplied with condensate from a concrete tank in the basement by means of two 100-gallon-per-minute pumps, the operation of which is controlled by a float valve in the roof tank.

The water from the softener, which is heated to 200 deg. fahr., goes directly to the heater whenever the water level in the concrete overflow tank for the heater is lowered. The softener is of the Vater type, and is capable of treating 3000 gallons of water per hour as it comes from the wells (about 26 grains of hardness per gal). (*Power,* vol. 48, no. 18, October 29, 1918, pp. 620-624, 3 figs., *d*).

Railroad Engineering

The Locomotive Feedwater Heater. "The more extended use of the feedwater heater in locomotive service is awaited with confidence as to its ability to effect a saving of from 15 to 20 per cent in fuel, in accordance with results which have already been obtained in laboratory tests."

The editorial which starts with the above quotation makes a further claim that feedwater heating is especially adaptable to locomotive service.

On a locomotive the closed feedwater heater acts as a condenser used, however, rather for the purpose of condensing raw water to be used as boiler feed. The exhaust steam admitted to the heater is at such a low pressure that the greater portion of the heat contained therein is latent heat, which on being abstracted leaves the steam in the form of water at or near the boiling temperature. Were it not for the oil content in this water it would be of advantage to return it to the boiler, as then it would in itself constitute an increase of nearly one per cent in the overall efficiency of the machine. In time, with the improvement in the lubricating methods, it may, indeed, become possible to avail ourselves of this possibility.

In stationary feedwater heaters the condensation of steam on the surface of the tubes prevents the contact of additional steam with these tubes and serves to insulate them to an appreciable extent. In locomotive service the tubes are more rapidly freed of this condensation, because of the jarring of the engine as it passes over the track. This feature of rapidly freeing the tubes of condensation is of such importance that in stationary installations vertical instead of horizontal heaters are frequently used, and experiments are being made with heaters having lead-, zinc- and amalgam-covered tubes to which the water adheres less tenaciously than to steel or brass.

A feedwater heater also has an effect on increasing the output of a locomotive through reduction in back pressure. The abstraction of 14 per cent of the steam from the exhaust passage before the steam undergoes the choking effect at the nozzle, is equivalent to an increase in the size of the nozzle, since a lesser amount of steam (86 per cent instead of 100) is required to find its way through the passage. This phenomenon is unmistakably evident from indicator cards and dynamometer diagrams secured in locomotive tests. (Editorial in *Railway Review,* vol. 63, no. 15, October 12, 1918, p. 541, *gp*)

Refrigeration

Refrigerating Plant at the Intermediate Depot for the American Army in France, Robt. K. Tomlin, Jr. Description of the refrigerating plant at the Intermediate Depot for the American Army in France, designed to care for storage of 5000 tons of meat.

The plant is of a very large size, consisting of a group of twelve principal buildings, several miscellaneous buildings and a concrete reservoir 55 x 60 ft. in plan. The engine-, boiler- and pump-room equipment comprises eight 250-hp. horizontal tubular boilers, four refrigerating machines having a total capacity of 1100 tons of refrigeration, two 150 kva. electric generators and three turbine-driven centrifugal pumps, each with a capacity of 180 gallons per minute.

Refrigeration is by direct expansion of the ammonia circulating in coils hung from the ceiling of the building, which is divided into five rooms, each with a capacity of about 1000 tons of meat.

The designs for the plant were prepared at Washington, but simultaneously on the spot a so-called Ice Plant Company was organized of engineers, about 350 men strong, most of whom were recruited from the personnel of the large packing companies of the Middle West. The work was started in France in December, 1917, and, notwithstanding all the difficulties that surrounded construction work in France in those days, the plant was placed in operation on May 2, 1918, which is certainly an excellent record for a plant of that size.

There are certain features of construction which appear to be of special interest. Thus unusual pains have been taken to insure flexibility in the layout of the piping. A break in the piping would be especially serious, as in France ammonia losses would not be easy to replace. The ammonia lines are sectionalized by the installation of valves at frequent intervals, so that in case of a break a section of piping may be cut out of the system and ammonia losses thereby reduced.

Further, zero temperature is maintained in the freezing room. This fact, in connection with allowing meat to remain there for four days before shipment, makes it possible to dispense with special refrigerating cars and to forward the frozen meat in plain box cars. This feature of plant operation is of exceedingly great importance in view of the present car shortage in France and the undesirability of introducing special purpose rolling stock. (*Power*, vol. 48, no. 17, October 22, 1918, pp. 596-598, 4 figs., *d*)

Testing and Measurements

Electric Dynamometers for Aircraft Engine Testing. Description of very large dynamometers developed for testing the Liberty engine and other big aircraft power plants. Such dynamometers became necessary after it was found that the so-called club test (by means of a calibrated propeller) did not prove reliable. Two Sprague dynamometers are described in the present article. One size has a nominal rating of 300 hp. at 1325 r.p.m. and a maximum rating of 450 hp. at 1700 r.p.m. A smaller machine has also been developed with a nominal rating of 200 hp. at 1300 r.p.m. and a maximum rating of 300 hp. at 1650 r.p.m.

Combinations are frequently made of two of the smaller machines for testing up to 500 hp. and of two of the larger machines for testing up to 800 hp. For such combinations the electric control and torque-measuring system have been worked out so that the torque is read on a single scale and the load is controlled by a single handle just as in a single-unit machine.

In conducting dynamometer tests it is important that the loads at different speeds follow approximately the speed-horsepower curve of the propeller that would be used with the engine. This follows the cube law. It is claimed that results obtained on torque stands with clubs frequently vary as much as 10 or 20 per cent from the true horsepower output. With electric dynamometers much greater accuracy is secured.

A recent application of the electric dynamometer is for the making of efficiency and endurance tests on propellers. The dynamometer is used as a driving motor and the propeller is mounted upon a sliding shaft coupled to the dynamometer in such a manner that not only the torque required to drive the propeller is measured but the thrust or reaction is indicated. This arrangement is proving of great value in making overspeed tests on propellers. (*Automotive Industries*, vol. 39, no. 16, Oct. 17, 1918, pp. 675-677 and 696, 5 figs., *dp*)

0 Deg. or 20 Deg., or 0 Deg. and 20 Deg. (Pure Normal Temperature or Normal Temperature and Standard Temperature), F. Plato. (*Zeitsschrift Instrumentenk., Beib.* nos. 9, 10, pp. 49-54, May 5, 11, and 12, pp. 61-66, June 15, 1918) So long as instruments exist whose readings are dependent on temperature, there will be a need for fixing a particular temperature for reference. When the choice of this temperature is restricted to a select circle, then we speak of a standard temperature, but when state recognition is given, or international sanction is obtained, then the standard becomes a normal temperature. A large number of normal temperatures are in existence, but of these only two (of French origin) are not arbitrary, namely: the temperature of melting ice, and 15 deg. cent. (proposed by Gay-Lussac as the average temperature of the earth). The present paper contains a discussion of the various temperatures in the neighborhood of 15 deg. cent. which have been proposed from time to time. For many purposes 20 deg. has been found very convenient, and the advantages together with the drawbacks are dealt with at some length. The discussion includes that of other units in different systems. Section 1 considers the temperature of melting ice as a natural phenomenon. Section 2 treats the latter from the standpoint of requiring no thermal measure for its determination. In section 3 its independence with respect to temperature scales is examined. Here the various thermometric scales come under review. In section 4 the temperature of melting ice as a starting-point is shown as a safeguard against sign errors. In section 5 the possibility of international agreement to this temperature as normal temperature is discussed. The different national temperatures are here described. Following this comes an exhaustive discussion on the question of adopting 20 deg. cent. as a special standard temperature which would be especially beneficial to industry. (*Science Abstracts*, Section A—Physics, vol. 21, pt. 9 (no. 249), Sept. 30, 1918, pp. 377-378, *g*)

The Relationship of Impact Value to Maximum Stress, Elongation and Brinell Hardness, G. Berudt. (*Zeits. Vereines Deutsch. Ingenieure*, no. 62, pp. 421-422, July 6, 1918) The impact value was measured of some 40 samples of basic Siemens steels of which the elastic limit, maximum stress, percentage elongation, and Brinell hardness were all known. With the exception of the elongation these values at first increased as the impact value rose, reaching a maximum with an impact value of 1.3 kg-m., after which they decreased rapidly and became finally more or less stationary. The impact value, which is of all the properties measured the most sensitive in detecting brittleness, appears to increase with the ferrite content of the steel. Two photomicrographs are included. (*Science Abstracts*, Section A—Physics, vol. 21, pt. 9 (no. 249), Sept. 30, 1918, p 347, *t*)

Thermodynamics

The Joule-Thomson Effect and the Equation of State for Gases at Small Pressures, M. Jakob. (*Ann. d. Physik*, 55. 7. pp. 527-544, June 21, 1918. From the *Physikal-Techn. Reichanstalt*). From Planck's partial differential equation

$$\frac{10^4\,T^2}{427}\left(\frac{\partial\, v\,T}{\partial\, T}\right)_p = (c_p)_0\left(\frac{\partial\,\Delta}{\partial\, p}\right)T,$$

the equation of state of a gas may be derived if, besides its specific heat $(c_p)_0$ for $p = 0$, the integral Joule-Thomson effect Δ for an infinitesimal pressure is given as a function of the initial pressure p (kg./cm.²) and the temperature T, also an isothermal of the state is given for the determination of the arbitrary integration function when the integration is made with respect to T. From the throttle experiments of Bradley and Hale, and of Noell for air, the empirical equation $(\partial\Delta/\partial p)\,T = Ap^3 + Bp^2 + Cp + D$ was obtained, wherein A, B, C, D are simple rational func-

tions of T. From these equations and an isothermal by Amagat and Holborn and Schulze follows the equation of state: $v = \mathrm{R}\ \mathrm{T}/10^4 p + \mathrm{A}'\, p^3 + \mathrm{B}'\, p^2 + \mathrm{C}'\, p + \mathrm{D}' + \mathrm{E}'\ \mathrm{T}$, where R is the gas-constant, and A′, B′, C′, D′ are similar functions of T as A, B, C, D. E′ is a determined rational integral function of p. The author has found this equation of state valid at high pressures, *e.g.* at — 140 deg. cent. up to 30 atmos., at — 80 deg. cent. to 200, at 0 deg. to 700, at 200 deg. to 1000 atmos. The relations at very low pressures have been considered, and for $p = $ the following equation evolved: $\partial\,(pv)\ /\ \partial\, p = \mathrm{D}' = -\ 191310/\mathrm{T}^4 + 10229/\mathrm{T}^3 + 147.63/\mathrm{T}^2 + 0.08973\ \mathrm{T} + 0.00065708$. This equation is established in the present paper and compared with known experimental data. This comparison gives a sharp criterion as to the validity of the above equation of state for very small pressures, and between what temperature limits. It is shown that the last equation holds good for other gases after the introduction of the necessary data. Section 2 of the paper deals with the inadmissibility of the identification of an ideal and of a real but infinitely diluted gas. Section 3 develops the equations of state and the Joule-Thomson effect according to van der Waals and Berthelot are considered. The Joule-Thomson effect of infinitely dilute air according to theory and experiment, forms the subject of section 5. Section 6 deals with the derivation of a real but infinitely dilute gas from Mariotte's law. In section 7 the Joule-Thomson effect of other gases is calculated from that of air, according to the method of corresponding states. The equation of state is found to hold for very low pressures as for very high, and so to be of general applicability. (*Science Abstracts,* Section A—Physics, vol. 21, pt. 9 (no. 249), Sept. 30, 1918, p. 381)

NEW HEAT-TRANSMISSION TABLES, Wm. R. Jones, Mem.Am. Soc.M.E. A compilation of factors of heat transmission through various classes of building materials, with index of authorities quoted.

The materials considered cover glass, single, double and various types of skylights; various types of walls, such as brick, brick and plaster, concrete, as well as tiles, etc.

The tables represent apparently a very large amount of work and are of considerable interest. (*Heating and Ventilating Magazine,* vol. 15, no. 10, October 1918, pp. 36 to 41, *gpA*)

Varia

GOVERNMENT COMMISSION COMPOSED ENTIRELY OF ENGINEERS. During the past summer, the New Brunswick government appointed a commission to investigate the water-power situation in that province. The appointment of such a commission is, of course, not unusual, and would not warrant special notice except for the fact that this commission, contrary to the usual custom in appointing various government commissions, consists entirely of engineers. C. O. Foss, chairman of the commission, has been connected with the Canadian Society of Civil Engineers and The Engineering Institute for a great many years. He is chief engineer of the St. John and Quebec Railway. B. M. Hill, a member of the commission, is provincial engineer. Mr. Hill is an engineer who has taken considerable interest in public affairs, and at one time contested a seat in the local legislature. W. E. McMullen, secretary of the commission, is the engineer of the Crown Lands Department.

This commission is acting in coöperation with the Dominion Water Power Branch, so that the technical aspects of the water-power situation in both the provinces of Nova Scotia and New Brunswick are being handled by a single engineering organization, which results in maximum efficiency and economy. Although the New Brunswick Water Power Commission was not in a position to begin active operations until early in August last, already eleven stream-measurement stations have been established in various parts of the province and an adequate foundation laid for obtaining basic stream-flow data in various parts of the province. (*Journal of The Engineering Institute of Canada,* vol. 1, no. 7, November 1918, p. 336, *g*)

EFFECT OF AIR TOOLS ON WORKMEN. At the congress of the National Safety Council in St. Louis, September 18-19, a paper under the above title was presented by Francis M. Barnes, Jr., covering reports of several investigations carried out recently.

The following conclusions are drawn by the writer, and he himself acknowledges that they are subject to some limitations because they are drawn from a comparatively small series of observations:

1 Structural-steel workers, shipbuilders and stone cutters, as a class, enjoy good general health, and are not, because of their trade, especially susceptible to any particular disease.

2 Stone cutters are liable to a disorder affecting the hands, especially the left hand.

3 This disorder of the hands is of a vascular character, not due to organic changes in the circulatory system, but dependent upon vasomotor reactions.

4 These reactions are physiological in character and are occasioned by three factors incident to the work of stone cutting: mechanical irritation of the skin, continued muscular contraction of a cramping nature, and low temperature.

5 Of these three factors, cold is considered the most important because the condition only occurs during the severely cold weather and never in the summer, and warmth and measures to restore the circulation (rubbing, swinging the arms, and the like) cause its disappearance.

6 It cannot be caused by the effect of the air hammer alone, because it occurs in those who have not used the air hammer. It does not occur in warm weather when industry is at its height, and, therefore, when the air hammer is most in use. It occurs mostly in the left hand, and not in the right in which the hammer is held.

7 The vasomotor disorder is of temporary duration, and is not known to have resulted in permanent disability of the hand, nor itself to have been the cause of development of any other local or constitutional disease.

8 It is possible that once having occurred, the person is rendered more susceptible to its reappearance, just as is the one who has had his ears or fingers frostbitten by the cold.

9 There is no sufficient reason in the signs and symptoms presented in this disorder to conclude that one has to do with Raynaud's disease, acroparesthesia, neuritis or an occupational neurosis.

10 The institution of measures to warm the chisel before and while using, enlarging the shank of the chisel and covering it to make it possible to hold without so cramping a grip, the wearing of gloves, and the discontinuance of the prevalent custom of blocking the exhaust outlet, and thus forcing a draft of chilled air out along the chisel and onto the fingers of the left hand, would do much toward the prevention of this trouble. (*The Iron Trade Review,* vol. 73, no. 19, November 7, 1918, pp. 1071-1072, *g*)

NEW YORK-CHICAGO AIR-MAIL ROUTE. Postmaster-General Burleson announces that the New York-Chicago air-mail route will be inaugurated between December 1 and December 15. The exact time of the establishment of the service will depend upon the time of the receipt of the Post Office Department of the necessary airplanes to operate the line.

The route will be laid out in three legs; the first from New York to Bellefonte, Pa., a distance of 215 miles, with an emergency station and machine midway to Lehighton; the second leg from Bellefonte to Cleveland, a distance of 215 miles, with an emergency station at Clarion, Pa., a distance of 87 miles from Bellefonte; the third leg from Cleveland to Chicago, a distance of 323 miles, with an intermediary mailing station at Bryan, O. (*Official Bulletin,* October 25, 1918, p. 1)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Survey.

SOCIETY AFFAIRS

A Record of the Current Activities of the Society, Its Members, Council, Committees, Sections and Student Branches; and an Account of Professional Affairs of Interest to the Membership

The world war has changed for most every one his point of view of life, and it should particularly change the motives of the engineer. He has rendered indispensable service in the world war, and is properly receiving the credit therefor. The opportunity offered him by reconstruction is many fold greater than that he has had in the military operations.

Mr. Charles M. Schwab, at his reception in the Metropolitan Opera House, Philadelphia, to the members of the staff of the Home Office of the Emergency Fleet Corporation, said that "the measure of a man's worth is the service he renders." This was the rejoinder to a remark by the Secretary of the Navy, that Mr. Schwab was so rich that he didn't want any more money, whereas the Secretary of the Navy was so poor that he wouldn't know what to do if he had money.

Mr. André Tardieu, the Minister of Franco-American War Affairs in the French Cabinet, has just arrived again in this country, and frankly invites this nation to "assist France to her feet."

The Society is in receipt of an invitation from President Millerand, of the Congrés Général du Genié Civil, which is to take place in Paris the middle of December, to send a delegate and assist in conferences with respect to reconstruction problems. These problems obviously will be mainly of civil engineering, and it is probable that the representatives of that branch of engineering will form the largest part of the delegation, but there are numerous phases of particular interest to mechanical engineering on which our delegate can help, and the Secretary takes this means of soliciting suggestions and volunteers of service not only for this but any others on which the Society may call when occasion arises.

I have already mentioned in my previous letter the visit of the delegation from the Government of Belgium which has just returned. I have also had a call this month from the Governmental representative of Holland, who was seeking advice with respect to the development of water powers, and general information on opportunities in industrial development for Holland's colonies.

The spirit of the Society must be that of the individual. How can we render the greatest service to the world? At the Annual Meeting we are to have several addresses which will assist our members by way of suggestion.

Along these lines it is with particular satisfaction that I can announce the formation of the American Engineering Standards Committee, which in organization and scope of work is parallel to the wonderful British Engineering Standards Association. With the development of our relations with all countries, the need for standardization becomes still greater, particularly with our desire for foreign trade. Standardization is absolutely essential to trade, particularly of the type in which we in the United States are especially successful, namely, the production of articles in great quantities.

With the opening of the new hopes for all peoples for greater opportunity of self-development comes the same opportunity to the engineering profession in its peculiar and specialized work.

The Secretary solicits correspondence with members who are desirous of participating in this greater movement.

Calvin W. Rice,
Secretary.

Council Notes

A Meeting of the Council was held on the afternoon of Friday, November 8, 1918, in the rooms of the Society. There were present: Charles T. Main, *President*, H. de B. Parsons, R. H. Fernald, Arthur M. Greene, Jr., Spencer Miller, C. H. Benjamin, D. Robert Yarnall, Wm. H. Wiley, *Treasurer*, Ira N. Hollis, Charles T. Plunkett, D. S. Jacobus, George M. Forrest, *Chairman Finance Committee*, Jesse M. Smith, *Chairman Committee on Constitution and By-Laws*, George A. Orrok, *Chairman Publication and Papers Committee*, Calvin W. Rice, *Secretary*, and by invitation, George J. Foran, *Chairman Engineering Resources Committee.*

Business from the President

Rehabilitation of Wounded and Readjustment of Industries to Peace. The President was authorized to appoint a committee to take up the question of the way in which this Society can best assist in the reconstruction problems after the war, the readjustment of the industries, and coöperation in war relief work, including the American Red Cross.

Invitation to Paris Conference. The President reported an invitation from the Société des Ingénieurs Civils de France, to this Society to send a delegate to an Engineering Congress to be held in Paris, in December. As announced elsewhere, by subsequent action of the Executive Committee, President Main was appointed to represent the Society at this conference.

Standing Committees on Administration

The annual reports of these committees were received and ordered printed. They appear elsewhere in this issue of The Journal.

Membership Committee. Under By-Law 16 the remission of dues of the following members who have either paid for 35 years or reached the age of 70 and paid for 30 years was recorded:

Albrecht, Otto.	Emery, A. H.	Sellers, C., Jr.
Alden, Geo. I.	Forsyth, R.	Smith, A. W.
Allen, F. B.	Forsyth, W.	Smith, G. H.
Angstrom, Carl.	Halsey, F. A.	Smith, Oberlin.
Baldwin, Wm. J.	Henry, Wm. T.	Stangland, B. F.
Ball, F. H.	Herrick, J. A.	Stearns, T. B.
Bancroft, J. S.	Higgins, Geo. F.	Stratton, E. P.
Barnes, W. F.	Hill, Wm.	Suter, Geo. A.
Barrus, Geo. H.	Hollerith, H.	Swain, G. F.
Betts, A.	Howard, C. P.	Tallman, F. G.
Bilgram, Hugo	Hugo, T. W.	Taylor, Stevenson.
Bond, Geo. M.	Hunt, R. W.	Thomas, E. W.
Brooks, E. C.	Landreth, O. H.	Thorne, Wm. H.
Burdsall, E.	Lanza, Gaetano.	Townsend, David.
Byllesby, H. M.	McEwan, J. H.	Trump, E. N.
Capen, Thos. W.	McFarland, W. M.	Walworth, A. C.
Carpenter, R. C.	Martens, F.	Warner, W. R.
Cheney, W. L.	Marx, Henry.	Webber, H.
Clarke, Chas. L.	May, DeCourcy.	Webster, H.
Cloud, John W.	Miller, L. B.	Weston, E.
Cogswell, Wm. B.	Mullen, John.	White, J. J.
Coon, J. S.	Newcomb, Chas. L.	Whitham, J. M.
Cox, J. D.	Porter, H. F. J.	Wiley, W. H.
Dean, F. W.	Raynal, A. H.	Wood, W.
Durand, W. F.	Scheffler, F. A.	Worthington, C. C.

Finance Committee. The Secretary reported the death of Mr. R. M. Dixon, *Chairman*, and the following resolutions were ordered entered on the minutes:

Resolved: That in the death of Robert M. Dixon, for ten years a member of the Finance Committee and for more than eight years its Chairman, the Society has lost one of its most valued members, and a leader whose wise counsels and mature judgment contributed in a most conspicuous manner to the present sound financial condition of our Society, which is in itself a most flattering tribute to the financial and executive ability of the engineer, the citizen, and lovable companion, whose loss we mourn. And be it further

Resolved: That a copy of these resolutions be spread upon the minutes of this meeting and a copy properly amplified with historical data be engrossed for presentation to the family of Mr. Dixon, and for publication in The Journal and Transactions of the Society.

On recommendation of the Publication Committee, approved by the Finance Committee, the purchase of "The Engineering Index" from Industrial Management, was authorized.

The President announced that the Committee had selected Mr. George M. Forrest to act as Chairman and he had appointed Mr. Frank E. Law to fill the unexpired term of Robert M. Dixon.

Meetings Committee. On the recommendation of this committee, the status of the sub-committee on Protection of Industrial Workers was changed to that of a special committee.

Standing Committees

The annual reports of the Standing Committees on *Library, House, Research, Standardization and Public Relations* were received.

Standardization Committee. The Secretary reported the appointment of Clifford B. LePage, Assistant Professor of Physics at Stevens Institute of Technology, as Acting Secretary of the American Engineering Standards Committee, in addition to the work which Mr. LePage was doing in the Society as secretary of all the technical committees.

Professional Committees

Patents Committee. The report of Mr. E. J. Prindle, representative of the Society on the Patents Committee of the Engineering Council, was received.

Refrigeration. The progress report of Dr. D. S. Jacobus, Chairman of the Refrigeration Committee, was received.

Power Test Committee. The resignation of Mr. George H. Barrus was accepted. Mr. Barrus was thanked for his services to the Society.

Sub-Committee of Fuels. On the recommendation of Prof. Charles Russ Richards, this committee, which was appointed to act in an advisory capacity to the Bureau of Mines, was discharged with thanks.

Boiler Code. This committee as now constituted was continued for one year.

The Council received a delegation from the National Boiler and Radiator Manufacturers' Association in the matter of Par. 363 and 374 of the Code relating to heating boilers.

The Boiler Code Committee was requested to keep before them these two articles, and should the state of the art prove that either of them is inadvisable, action is to be taken by the committee to rectify them. This action was ordered communicated to the representatives of the Association.

Interpretations Nos. 200 to 206 were approved.

Increase of Membership. The report of this committee was received. This report carried with it the appointment on this committee of Mr. G. M. Forrest, Chairman of the Finance Committee.

Special Committees

Emergency War Training. This committee was discharged with thanks.

Engineering Education. The report of the Committee on Engineering Education, as given in A Study of Engineering Education, by Dr. Charles R. Mann, printed under the auspices of the Carnegie Foundation for the Advancement of Teaching, was received and the committee of this Society discharged with thanks.

Appointments

By the President. W. W. Macon, H. L. Aldrich, A. J. Baldwin on a delegation of technical editors to England as the guests of the British Ministry of Information.

F. R. Low, Chairman, George H. Barrus and H. L. Gantt, to prepare a memorial to the late Mr. William Kent.

By the Council. Walter M. McFarland to fill the unexpired term of two years of R. M. Dixon, as Trustee of United Engineering Society.

The Council approved the principle of the appointment on the Engineering Council of the President of the Society during his term of office.

M. E. Cooley, nominee for President, was appointed for one year.

George J. Foran, reappointment on the Engineering Council for three years.

Adjournment. To meet in New York City, on Tuesday, December 3, 1918, at 2 p.m., in connection with the Annual Meeting.

Calvin W. Rice,
Secretary.

President Main to Go to France

The American Society of Civil Engineers some time ago received an invitation coming through the Société des Ingénieurs Civils, and the Committee of the French Engineers' Congress, with the official approval of the French Minister of Armament, Public Works and Commerce, requesting it to arrange for a delegation of American engineers to study with French engineers certain problems involved in the rehabilitation of France after the war.

This delegation was invited to come to Paris to examine in joint conference questions of utilization of commercial ports, development of navigable waterways, development of water power, and improvement of road systems. These were the only specific subjects mentioned, but it is known that the Congress will take up many other questions of development in which the mechanical, electrical and mining engineer is directly interested.

Upon receipt of this invitation a cable was forwarded by the A.S.C.E. accepting the invitation, and stating that they would organize such a delegation in coöperation with the other American National Societies.

The American Society of Mechanical Engineers, through its Executive Committee, designated President Main to become a member of this official delegation.

Index to the 1918 Journal

An index to Vol. 40 of The Journal is now being prepared, but, owing to the shortage of paper, it is not being included with this issue, as has been the custom in former years. A copy of this index will be sent to any member or subscriber whose request is received prior to January 15, 1919.

There is a possibility that the delegation will not have to sail until the latter part of the week of the Annual Meeting, in which case President Main will be in attendance at least during the opening sessions.

Bulletin on Fuel Saving in House Heating Boilers

The need for saving coal in the domestic sizes is still very urgent, particularly in view of the drop in coal production during the period of influenza, and makes of timely interest a bulletin issued by the Bureau of Mines on Low-Rate Combustion in Fuel Beds of Hand-Fired Furnaces. This is known as Technical Paper No. 139, intended to supplement Technical Paper No. 137, which covers higher rates of combustion, such as burning coal under power-plant and locomotive boilers. Both of these papers are based on the results of actual tests. Those for Paper No. 139 were divided into three groups, according to the method of charging the fuel and of feeding the air under the grate. The tests of the first group were made in a way to be comparable to those of the high rates of combustion. The tests of the second group were made under similar conditions as regards feeding of air, but the fuel was charged in large quantities at long intervals to simulate the feeding of coal in house-heating apparatus. In the third group of tests all access of air through the grate was shut off, the object being to parallel conditions when running with the fire banked and the furnace closed during the night. The pamphlet discusses the results very fully under the conditions of tests outlined.

COMPLIMENTARY DINNER TO AMBROSE SWASEY

THERE was recorded in the last number of THE JOURNAL the gift by Ambrose Swasey, Past-President and Honorary Member of the Society, of an additional $100,000 to the Engineering Foundation. As known to our members, this foundation was established by the United Engineering Society, representing the four founder societies, as the result of an initial gift by Mr. Swasey of $200,000.

In recognition of these splendid gifts to the cause of research, the United Engineering Society on November 14 gave Mr. Swasey a complimentary dinner at the Engineers' Club of New York. There were about 70 guests present, among whom were 22 past-presidents of the Founder Societies, members of the boards of government of the Engineering Foundation and the Founder Societies, members of the Library Board and officers of the Engineers' Club, making one of the most distinguished gatherings of engineers which has ever been brought together.

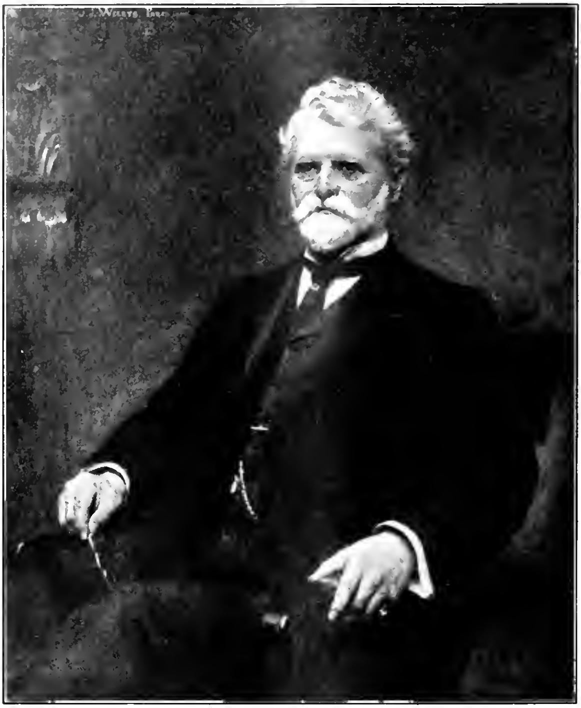
The addresses were by Mr. Swasey's life-long friends, Dr. Robert S. Woodward, President of the Carnegie Institutions of Washington, Dr. Robert W. Hunt, Past-President of this Society, and by the Chairman of the Engineering Foundation, Dr. Michael I. Pupin, with a response by Mr. Swasey. Dr. Woodward spoke in an especially happy vein, stating that he was a silent partner with Mr. Swasey, assisting by advice in the development of the gift.

The desire of Mr. Swasey to contribute so liberally to the cause of research is but a reflection of the spirit and motives which have always entered into his life work in the field of science and engineering. In the manufacture of machine tools of the finest type, the construction of instruments of precision and in the production of astronomical and optical instruments, comprising the mountings for the largest and best known of the world's telescopes, the manufacture of meridian circles, transits, range finders, etc., the results of research and investigation have been constantly required.

His interest in scientific attainments and in instruments of refinement and precision was further shown in a presidential address before the Society upon the subject of Some Refinements of Mechanical Science. In this he reviewed the development of dividing engines, of both the linear and circular types, including the remarkably accurate instrument developed at his own plant for astronomical work, besides other apparatus of a like character.

Appreciation of the need for research is greater now than at any time in the history of industry and the engineering profession and those connected with the industries generally are to be congratulated on having a foundation so thoroughly established for the promotion of scientific investigation in engineering and technology.

Besides his gifts to the Engineering Foundation, Mr. Swasey has given a great deal of pleasure and satisfaction to his friends by presenting to the United Engineering Society earlier in the year a remarkably fine portrait of himself painted by the famous French artist, Jean-Joseph Weerts. A reproduction of this painting is given herewith, taken from a photograph of the original which hangs in the Library of the United Engineering Society. Mr. Swasey sat for this portrait in Paris in 1906.



PORTRAIT OF AMBROSE SWASEY REPRODUCED FROM PAINTING BY WEERTS OF PARIS; PRESENTED BY MR. SWASEY TO THE UNITED ENGINEERING SOCIETY

The artist Weerts received his training in the studio of Cabanel and has exhibited every year in the Salon. While several beautiful paintings of a general character stand to his credit, he has excelled in portraiture through his rare talent in securing perfect resemblance, an abundant of detail and excellent finish.

Meetings of the Screw-Thread Commission

In the November issue of THE JOURNAL on page 972 reference was made to the organization of the National Screw Thread Commission and an abstract was given of the meeting of October 7. On October 21 a second hearing was held in New York and the topics for discussion at this meeting are listed below:

Pipe Threads: (1) As a national standard, is there any objection to the adoption of the American Briggs pipe-thread sizes for both taper and straight pipe threads as accepted by The American Society of Mechanical Engineers? (2) In view of the experiments on the form of pipe threads conducted by the Pennsylvania Railroad in connection with the American Society of Testing Materials which tend to show the desirability of the U. S. Standard form with flat top and bottom 1/8 of the pitch; do you consider it advisable to adopt the U. S. Standard form instead of the present form which specifies a thread depth of 0.8 of the pitch with a resulting flat at the top and bottom of the thread which is quite small? (3) In your shop practice to what extent do you employ gages for checking pipe threads and what do you consider a satisfactory tolerance for ordinary commercial work stated in turns either way from the gaging notch?

Brass Tubing: (1) What is your shop practice in connection with threads cut on various forms of brass tubing? (2) To what extent do you consider it possible to standardize the general practice on the threads used on brass tubing?

Hose Couplings: (1) As a national standard, is there any objection to the adoption of the hose-coupling sizes now known as the National Standard hose couplings in the sizes from 2½ in. to 4½ in. as recommended by the National Fire Protection As-

sociation; Bureau of Standards; American Society of Mechanical Engineers, and other organizations? (2) What is your shop practice in the manufacture of hose-coupling threads on sizes below $2\frac{1}{2}$ in? (3) To what extent do you consider it possible to standardize commercial practice in the manufacture of hose-coupling threads on the sizes below $2\frac{1}{2}$ in?

Acme and Other Special Threads: (1) What is your shop practice in the manufacture of Acme threads and other special threads used in machine construction? (2) To what extent do you consider it possible to standardize the form of thread and pitches used in the manufacture of Acme threads and to standardize other special threads used in machine construction? (3) To what extent do you consider it possible to standardize the general practice with reference to the diameters used for Acme thread pitches?

Instrument Threads: (1) In your shop practice in the manufacture of instruments, to what extent do you use the A.S.M.E. threads; the British Association threads; metric threads; or your own special threads; and to what extent do you consider it possible to standardize commercial practice for this class of work?

Hearings were also conducted in Washington on November 8, in Detroit on November 11 and in Dayton on November 13, of which further mention will be made in an early issue of The Journal.

THE ANNUAL MEETING IS AT HAND

By the time this number of The Journal reaches many of its readers the thirty-ninth Annual Meeting will be under way, with every promise of being one of the most successful of the Society's conventions.

Coming at a time when world peace promises to be an early reality and when engineers will be called upon to lead in the readjustment of industry to peace conditions, this meeting assumes even greater importance than the war conventions at Cincinnati, New York and Worcester which have preceded it. These were the largest, most enthusiastic and most significant meetings ever held by the Society and predicate still greater success for the one that is about to be held.

Among the broader problems to be dealt with during the period of reconstruction is that of labor, or human relations in industry. With rare foresight the Committee on Meetings and Programs planned last spring for an all-day session at the Annual Meeting on the Engineering of Men. This will be the subject of the Keynote Session, which will be addressed by some of the foremost authorities in the country.

In view of the important work of standardization undertaken by the Congressional Screw-Thread Commission, a session will be devoted to Screw Threads and Screw-Thread Gages, with contributions by representatives of the British Engineering Standards Association, the National Physical Laboratory, our own Bureau of Standards, and the Congressional Commission.

At the opening session on Tuesday evening President Main's address will be given—on the Broader Aspects of the Work of the Engineer; and the Secretary is pleased to announce that on the same evening Honorary Memberships will also be conferred on Messrs. Charles M. Schwab and Orville Wright.

Besides the usual business, with reports of Standing and Special Committees, etc., at the first morning session, there will be an important preliminary report by the newly formed Committee on Aims and Organization, with representatives from each of the Sections and from the Society at large.

On Wednesday and Thursday evenings there will be illustrated lectures of the greatest interest on the engineering work of the Army and Navy in the war. A luncheon will be held on Wednesday noon, with an address by George W. Kirchwey on a Message from the Legal Profession.

Besides these features there will be various entertainment features, excursions, luncheons, etc., tea and entertainment for the ladies, and an opportunity for dancing. Members and guests from other cities are cordially invited to join with the New York members in these events.

The following is a list of the papers to be presented, besides which there will be several addresses:

For presentation, Wednesday morning, December 4

Report of Committee on Standardization of Flanges and Pipe Fittings

For presentation, Wednesday afternoon, December 4

The British Engineering Standards Association, C. le Maistre

Work of British Engineering Standards Association on Screw Threads and Limit Gages, Sir Richard Glazebrook

Present Practice in Thread-Gage Making, F. O. Wells

The Measurement of Thread Gages, H. L. Van Keuren

Standards for Large Taper Shanks and Sockets, L. D. Burlingame

Refrigerating-Plant Efficiency, Victor J. Azbe

For presentation, Thursday morning, December 5

Industrial Organization as It Affects Executive and Workers, C. E. Knoeppel

Non-Financial Incentives, R. B. Wolf

For presentation, Thursday afternoon, December 5

Employment of Labor, Dudley R. Kennedy

Labor Dilution as a National Necessity, Frederick A. Waldron

Intensive Training, C. R. Dooley

Properties of Airplane Fabrics, E. D. Walen

Industrial Power Problems, W. F. Uhl

Daylight vs. Sunlight in Sawtooth-Roof Construction, W. S. Brown

Factory Stairs and Stairways, G. L. H. Arnold

The Weights and Measures of Latin America, Frederick A. Halsey

Efficiency and Democracy, H. L. Gantt

For presentation, Friday morning, December 6

The Conservation of Heat Losses from Pipes and Boilers, Glen D. Bagley

Chemical and Physical Control of Boiler Operation and the Application of Simple Formulae for Estimating the Heat-Loss Items, etc., E. A. Uehling

The Cooling Losses in Internal-Combustion Engines as Affecting Design, C. A. Norman

Discussion of Certain Problems in Regard to Marine Diesel Oil Engines, J. W. Anderson

Valves and Fittings for High Hydraulic Pressures, W. W. Gaylord

The Relative Corrosion of Alloys, R. B. Fehr

The Relative Corrosion of Cast-Iron, Wrought-Iron and Steel Pipe in House-Drainage Systems, Wm. P. Gerhard

Determination of Stresses in Wire Rope as Applied to Modern Engineering Problems, J. F. Howe

Mechanical Features of the Vertical-Lift Bridge, Horatio P. Van Cleve

A STUDY OF ENGINEERING EDUCATION

REPORT BY DR. CHARLES RIBORG MANN[1]

IN 1907 the Society for the Promotion of Engineering Education invited the American Society of Civil Engineers, The American Society of Mechanical Engineers, the American Institute of Electrical Engineers and the American Chemical Society to join it in the formation of a joint committee to examine into all the branches of engineering education. The next year the Carnegie Foundation for the Advancement of Teaching was invited to appoint delegates to the committee, and subsequently the Carnegie Foundation undertook to carry out the work on a large scale, and selected Dr. Charles R. Mann to make a careful investigation and report. The committee has kept in close association with Dr. Mann during the progress of the work.

Dr. Mann's researches have been published by the Carnegie Foundation in a special bulletin of 138 pages. They have also been published rather extensively in the September issue of the *Bulletin* of the Society for the Promotion of Engineering Education. Both accounts have been consulted in preparing this abstract.

Dr. Mann's report is divided into three parts. The first part states what present practices and conditions are, and describes the situation that needs analysis. It treats of the development of the engineering schools in the United States, their early history and the aims and curricula of the old schools. Because of the failure of the engineer to recognize that engineers could be trained in school, the engineering schools had to overcome many obstacles before they were acknowledged by the profession. Up to that time engineers had been merely trained by the apprenticeship method.

This part also deals with the changes of curricula from the beginning to the present time, and discusses the methods of administration in engineering schools, faculty control, student elimination and progress. It then takes up types of instruction in engineering schools, and indicates briefly some of the common practices in teaching the standard or fundamental subjects such as physics, mathematics, chemistry and English.

The second part discusses the problems of engineering education.

The development of entrance requirements has been away from the control of individual judgment and toward a system of committee control, as is evidenced by the creation of the College Entrance Examination Board. In order to indicate how entrance tests could be developed and what reliance could be placed on them, a series of experiments were made for the Carnegie Foundation by Professor Thorndike, of Columbia University.

Attention is directed to the fact that the current practice in making curricula is for the faculty to discuss only the time to be allotted to each subject, and not the degree of skill an engineer is expected to acquire in that particular subject.

In regard to the question of testing and grading, it is pointed out that an objective test, in which every one must agree to its finding, is a real measure of achievement; whereas the current methods are subject to the fallacies of individual judgment, because every department sets its own examinations and passes its own judgment.

Special consideration is given to the problem of shopwork. The original type of shopwork was merely to send the boy out to observe what was going on in shops. Later, the idea was to make the boys build something salable. At present the common plan in most of the schools is to teach the physical manipulations required in the fundamental shop operations without insisting on the acquisition of any construction experience.

There is also the type, developed at the University of Cincinnati, where the boys spend half of their time in a real shop, doing production work for pay, and the other half in school, discussing the problems which they have discovered in the shop.

No judgment is passed on the relative merits of these plans, but the question is raised as to whether the scheme where the students spend part of their time in a real industrial plant, there meeting the real problems of industry and thence carrying them back to the school for discussion, does not offer a clew to a fruitful solution of the shopwork problem.

The third part of the report suggests solutions of the problems that have been discussed.

It is recommended that the number of credit hours per week be less than eighteen, preferably sixteen, in order that the students may do their work more thoroughly. Also, in constructing a curriculum, it is suggested that the number of simultaneous courses be limited to four or five at the outside.

The adequate provision in the first two years for contact with real engineering projects and the interrelation between the concrete and the abstract are considered as essential in all engineering curricula.

The report advocates that the first step in framing a course of study is to define the common basis of all engineering as clearly as possible; that is, to make a list of all the facts, principles and processes that are essential elements in the equipment of every engineer. Theoretically this is the plan on which present curricula are founded, for they all have a common core made up of three distinct parts, namely, science (mathematics, chemistry, physics and mechanics), mechanic arts (drawing and shop), and the humanities (English and foreign languages). All of this common core is usually explicitly required of every student, no matter what specialty he may choose.

In the current organization of the common core of all engineering, however, the report recognizes no inherent or intrinsic relationships among the three categories under which the classification is made, and indicates that in designing curricula, the fundamental aim of engineering should be kept in mind. There must be actual participation in real industrial work; there should be engineering laboratory work, including drawing and descriptive geometry; mathematics and science should be developed systematically in logical order so as to furnish the backbone of the course; and the instruction in the humanistic studies should be presented with a view to develop skill in expression, interest in literature, and an appreciation of the human relation involved in engineering.

Throughout the entire course a great deal of attention must be paid to the testing and sorting of the men. Testing and sorting processes were in a very vague state a year or two ago. But an enormous amount of experience is being developed and collected at the present time by the efforts of the War Department to test and sort men for the Army mobilization. The Department now has psychological laboratories for testing all the men in two of the camps. They have personnel officers in all of the camps, and the work is making rapid progress. An enormous amount of information as to the meaning of these tests and their validity in sorting out ability is being gathered and digested and trade tests are being devised to pick out specific ability for certain lines. The results of their investigations as to valid methods of using objective tests will be of importance in selecting students for admission to engineering schools and in sorting young men during the first year or two of their course, so as to decide whether a boy ought to go into the civil engineering or some subhead under civil engineering, or into mechanical or electrical engineering. In other words, the experiences with the students in their common work that extends over two or three years should be utilized not only to train the man's ability to know and do things, but also as a means of vocational guide to select men and steer them, in the latter part of their course, into the special lines of work for which they are fitted. So the latter part of the course will be made up of large groups of specialties. Those who have been selected by the first two or three years' work as qualified for civil engineering will be put in a group where for the next year or so they will deal first with all the materials of civil engineering not included in the first two years, but which are essential to all the sub-specialties of civil engineering. Then they will proceed from that into some particular specialty.

The report recognizes that the teacher is the crux of the situation, and that the present organization of universities is not well qualified to encourage teachers to experiment and undertake

[1] Professor of Education and Director of Educational Research, Massachusetts Institute of Technology; Director of Committee on Education and Special Training, War Department.

the sort of investigation that is going to be necessary in order to put the suggested plan into operation. Hence it recommends that an organization be made at the school for the purpose of studying the teaching problem, and the school and faculty recognize at the start that it is some business of the professor of physics what the professor of mathematics is doing; and it is some business of the professor of electrical engineering what the professor of chemistry is doing. With such an organization in existence, a spirit of coöperation will be developed among the faculty. The professor of mathematics, for example, if he goes into it in the right spirit, instead of feeling that his interests have been sorely trampled upon when the professor of physics or engineering presumes to tell him what they want done, will find his work in mathematics has become enormously more inspiring to him and to the students. It will engender good feeling of the very best sort and result in a release of creative energy among the whole faculty. Thus conditions will be developed at the schools that will make the teachers want to study their problems together, instead of those which discourage the undertaking of anything that is not according to an established practice.

The system in vogue in the universities to make research work and the publication of the results of research the measure of success and the criterion of promotion for teachers, is pertinently criticized in the report. In this connection it says:

It is unquestionably true that research, as at present treated, does interfere seriously with teaching. Hundreds of college instructors whose interests lie in the human problems of education, rather than in the material problems of natural science, are now being diverted from a study of the teaching problem and induced to undertake research because academic promotion so obviously depends on the latter. Many a young man with promise of making an excellent teacher is sidetracked by the requirements for the Ph.D. degree and becomes instead, a mediocre researcher. Yet though much that is done under the name of research is but pseudo-research, the university is clearly right in its position that the spirit of investigation is an essential factor of university life.

The difficulty does not lie in research itself, but in the limitations that still cling to the common interpretation of it. Because research has been developed in the field of natural science and has wrought such marvels there, its activities have unconsciously been thought of as restricted to the problems of the material world. Because the technique of research and the units and methods of measurement have been so perfected in the domain of natural science that great accuracy and definiteness of conclusion are now possible, the early struggles for objectively defined standards and scales have been forgotten. Hence it seems to many grotesque to talk about research in education and the impersonal measurement of the vaguely defined and elusive qualities of human beings. The fact that such measurements have as yet been rather crude and inconclusive is no reason against trying to improve them, especially now when the greatest need of education is a technique and a terminology that will make the results of experiments in teaching intelligible to every one. . . .

If university trustees, presidents, and faculties will unite in insisting on a scientific study of their educational work, they will create the conditions needed to release teaching power in the engineering schools. The professors who have teaching interest and ability will welcome the opportunity to win recognition in work that arouses their enthusiasm and stirs their imagination to creative effort just as the professors who are interested in natural science have responded to the opportunity to promote research. This should not result in a diminution of output in research, but in a decided increase, because it tends to give each man the work he is best fitted to do, and therefore leads ultimately to maximum efficiency.

An understanding of the spirit of Dr. Mann's study and the line of reasoning which has led to his conclusions is obtained from the part of his report entitled The Professional Engineer. He remarks in explanation of the purpose of his work:

The statement that individuality counts for as much as learning for the engineer, just as it does for the lawyer or the physician, seems like a veritable platitude. Yet because the engineering schools have always made it their chief aim to impart the technical information needed in industrial production, and because both scientific knowledge and industrial practice have grown so rapidly, the attention of technical schools has been focused chiefly on keeping up to date in science and practice. The university emphasis on research in natural science has also tended to magnify the importance of technique and to minimize the importance of personality; until curricula have become so congested with specialized courses that students generally regard literature and sociology as unnecessary chores, to be endured rather than enjoyed. Therefore it seemed necessary to consider the question whether this emphasis on technique is producing a new and higher type of engineer, or whether the engineering profession still stakes its faith on the fundamental thesis that personal character is, after all, the real foundation for achievement.

To arrive at the requirements of the engineering profession, circular letters were sent to engineers throughout the country, asking them what they deemed the most important factors in determining probable success or failure in engineering. The result of their replies, in which personal qualities were numbered seven times as frequently as knowledge of engineering science and the technique of practice, was sent to the thirty thousand members of the four large engineering societies, and each was asked to number six groups of qualities headed respectively character, judgment, efficiency, understanding of men, knowledge, and technique, in the order of importance which he gave them in judging the reasons for engineering success and in sizing up young men for employment and promotion. Their votes placed the character group at the head of the list by a majority of 94.5 per cent, while technique was voted at the bottom by an equally decisive majority.

Thus it appears that there is a keen appreciation of the importance of the personality of the engineer. Dr. Mann thinks that recent events have brought out that need still more clearly.

Further in this part he summarizes the situation as follows:

The ultimate aim of engineering education has always been and still is more intelligent industrial production. Technical schools were founded when industrial evolution had progressed so far as to create a pressing demand for men who knew how to utilize the new and rapidly expanding knowledge of natural science to increase and improve production. Science was then little taught in high schools and colleges, so that both the public and the manufacturers were ignorant of it. Under these conditions the obvious need was for scientific enlightenment; and this the engineering schools were organized to supply . . .

The schools . . . . have thereby contributed enormously to the achievement of two striking results; namely, the extension of science instruction into the school system generally, and the development of public recognition of engineering as a profession, coördinate with theology, medicine, and law. At the present day an encouraging fraction of the people are reasonably intelligent in science, the worker in applied science has become socially respectable, and there has been developed a large conception of the engineering profession. Meanwhile the methods of dealing with the material problems of industry in a scientific way have been in a measure established, while the more intricate problems of organizing and managing men are rapidly pressing forward and demanding engineering treatment.

The net result is that the curricula and methods of instruction that were devised to supply the intellectual element in production by imparting knowledge of natural science must be recognized to meet the new industrial demand for engineering administrators and the larger professional demand for men of strong personality. The general plan of the proposed reorganization is based upon an analysis of engineering practice into its three essential factors; namely, knowledge of engineering science, skill in technique of application, and judgment in the appraisement of values and costs. In every engineering project the overlapping claims of these three essential factors must be harmonized with respect to the two fundamental elements of production, namely, materials and men. Surely every engineer should have some conception of the present conditions and problems in at least the general aspects of all these essential factors and elements. If this be granted, it is easy for any school to discover where its curriculum is overloaded and where it is deficient.

This analysis also indicates how the present organization of school work can be modified so as to furnish a more vital training for professional engineers. Thus, with regard to materials, the schools do give careful instruction in the laws of physical science and in the properties and uses of materials. Students are taught the relative strengths of substances in the materials laboratory, kinematics teaches the principles of gearing, the shapes of gear teeth are worked out in the drawing room, the chemical properties are taught in chemistry, mechanics deals with the forces required to overcome inertia, machine work is relegated to the shop, and so on. But seldom is all this information coördinated in a single practical problem, such as determining whether mild steel, nickel steel, or phosphor bronze is the best thing to use in making a particular gear wheel; nor is the student ever asked to judge what combination is likely to produce the most valuable result for the price. Yet this balancing of value and cost is the controlling factor in all intelligent production.

. . . . An adequate treatment of the first element in production involves not only a scientific presentation of the laws of nature and the properties of materials, but also an estimation of the values and costs from both the material and the human points of view. The chasm between the school and practical life is due largely to a failure to appreciate this fact. The introduction of the study of values and costs in all their phases is the most direct method by which the schools can bridge this chasm. Such study is also one of the most potent means of liberating creative energy and of developing the spirit of investigation.

REPORTS OF STANDING COMMITTEES OF ADMINISTRATION

THE reports of Standing Committees of Administration[1] of The American Society of Mechanical Engineers will be presented at the forthcoming Annual Meeting as an appendix to the Annual Report of the President of the Society's activities for the year. The reports are published below.

Report of Finance Committee

The Finance Committee reports that the income of the Society for the year ending September 30, 1918, was $240,086.70. After reserving $15,000.00 for obligations undertaken but not yet completed, the total expenditures chargeable to income were $223,701.21, leaving an excess of income over expenditures of $16,385.49.

Based on a membership of 8720, the average of the total membership on October 1, 1917, and that on October 1, 1918, the average income of the Society per member for the fiscal year just closed is tabulated below. The corresponding income for the preceding year is included for comparison.

AVERAGE INCOME PER MEMBER

	1916-17.	1917-18.
Membership Dues	$14.57	$14.06
Sales—Gross Receipts	1.90	1.61
Advertising	8.42	9.31
Interest and Discount	.62	.50
Initiation Fees (one-half)	.90	1.02
	$26.41	$26.50

One-half of the initiation fees are put into reserve each year, so that the figures given above represent that portion.

Based on the same average membership, the expenditures of the Society per member for the fiscal year just closed are also given below, together with the corresponding expenditures for the previous year for comparison.

AVERAGE EXPENDITURES PER MEMBER

		1916-17.		1917-18.
Meetings, Annual and Spring		$1.39		$1.41
Publications:				
Journal	$9.01		$7.29	
Condensed Catalogues			2.19	
Transactions	1.75		2.22	
Year Book	.68		.79	
		11.44		12.49
Membership and Increase of Membership		1.37		2.09
Office Administration		2.85		3.00
Upkeep of Headquarters		.32		.32
Employment Bulletin		.27		.33
Government Employment Work		.19		.20
United Engineering Society:				
Assessment to U. E. S.	.85		.55	
Library	.53		.46	
Engineering Council	—		.42	
		1.38		1.43
Local Sections		1.06		1.59
Council Contingencies, Mileage		.56		.52
Student Branches		.16		.07
Cost of Publications, Pamphlets, etc.		1.08		.99
Engineering Committees:				
Standardization, Research, Boiler Code, Screw Threads, etc.		.45		.93
Other Activities		.23		.28
Total		$22.75		$25.65
Additions to Building.				

(Journal and Condensed Catalogues together: $9.01 in 1916-17.)

The Budget Appropriation recommended by this Committee and approved by the Council for the year 1918-1919 is as follows, being 87 per cent of the estimated income:

Finance Committee:		
Office Administration	$26,100	
Occupancy of Building and Engineering Council	8,800	
Library	4,800	
		$39,700
Membership Committee		5,000
Council:		
Contingencies	3,500	
Committees not otherwise provided for	9,200	
Mileage	2,500	
Employment Bulletin	3,500	
		18,700
Sections Committee		13,500
Increase of Membership Committee		10,000
House Committee		5,650
Meetings Committee		12,750
Publication Committee		117,000
Research Committee		2,000
Students' Committee		1,000
Junior and Student Prizes Committee		75
Sales Expenditures		9,500
John Fritz Medal Board of Award		75
Engineering Resources Committee		800
Public Relations Committee		500
Total		$236,250

In addition, $10,000 was aproved by the Council, to be taken from surplus, for initiation of the Engineering Index.

The estimated income for the year 1918-19 is $270,730.

Appended will be found reports of the accounts of the Society as shown in the books for the fiscal year ending September 30, 1918.

DEATH OF MR. ROBERT M. DIXON

At a special meeting of the Finance Committee of The American Society of Mechanical Engineers held November 7, 1918, the following resolutions were adopted on the recent death of Mr. Robert M. Dixon, an honored member of the Society for the past thirty years and Chairman of the Finance Committee more than eight years:

Whereas, it has pleased an Allwise Providence to remove from us our fellow member and leader, therefore be it

Resolved, That in the death of Mr. Robert M. Dixon, for ten years a member of the Finance Committee and for more than eight years its Chairman, the Society has lost one of its most valuable members and the Finance Committee a leader whose wise counsels and mature judgment contributed in a most conspicuous manner to the present sound financial condition of our Society, which is in itself a most flattering tribute to the financial and executive ability of the Engineer, the Citizen and lovable companion whose loss we mourn.

And be it further Resolved, That a copy of these resolutions be spread upon the minutes of this meeting, and a copy properly amplified with historical data be engrossed for presentation to Mr. Dixon's family, and for publication in THE JOURNAL and TRANSACTIONS of the Society.

Respectfully submitted,

GEORGE M. FORREST, *Chairman*,
THEO. STEBBINS,
ALFRED FORSTALL,
W. E. SYMONS,
Finance Committee.

REPORT OF ACCOUNTANTS

FINANCE COMMITTEE,
THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

DEAR SIRS:

In accordance with your instructions, we have examined the books and accounts of The American Society of Mechanical Engineera for the twelve months ended September 30, 1918.

The results of this examination are set forth in the three exhibits attached hereto, as follows:

Exhibit A Balance Sheet, September 30, 1918.
Exhibit B Income and Expenses for the twelve months ended September 30, 1918.
Exhibit C Receipts and Disbursements for the twelve months ended September 30, 1918.

We certify that, in our opinion, the accompanying Balance Sheet is a true exhibit of its financial condition as of September 30, 1918, and that the attached statements of Income and Expenses, and Receipts and Disbursements, are correct.

Respectfully submitted,

(Signed) WM. J. STRUSS & Co.,
Certified Public Accountants.

EXHIBIT A

BALANCE SHEET, SEPTEMBER 30, 1918.

ASSETS

Equity in Society's Building (No. 25 to 33 West 39th Street)	$365,846.62	
Equity in one-third of Cost of Land (No. 25 to 33 West 39th Street)	180,000	
		$545,846.62
Library Books	13,000.00	
Furniture and Fixtures	5,000.00	
		18,000.00
Stores, including plates and finished publications		28,861.39
Trust Fund Investment:		
New York City 3½'s, 1954 (par $45,000)	39,696.81	
St. L., Peoria & N. W. 1st 5's. 1948 (par $10,000)	10,613.89	

[1] Owing to the restrictions placed by the War Industries Board, Paper and Pulp Division, on the use of paper only the reports of the Standing Committees of Administration are being printed this year.

Trust Fund Investment (Continued):		
United New Jersey Canal Co. (par $1,000)	$970.00	
Cash in Banks representing Trust Funds	4,789.93	
		$56,070.63
City of East Orange, Loan Certificate.		21,371.95
Liberty Bonds		30,000.60
Accounts Receivable:		
Members' Dues	13,879.73	
Initiation Fees	8,682.50	
Sales of Publications, Advertising, etc.	41,573.00	
		64,135.23
United Engineering Society, Loan		15,000.00
Advance Payments		4,745.65
Cash: In Banks for General Purposes	23,489.14	
Petty Cash on hand	500.00	
		23,989.14
		$808,020.61

LIABILITIES

Trust Funds:		
Life Membership Fund	$45,874.57	
Library Development Fund	4,902.71	
Week's Legacy Fund	1,957.00	
Melville Fund	1,127.36	
Hunt Memorial Fund	208.99	
Juniors' and Students' Prize Fund	2,000.00	
Total		$56,070.63
Dues paid in advance		2,546.14
Initiation Fees uncollected		8,682.50
Replacement Fund		1,163.18
Accounts Payable		4,140 53
		$72,602.98
Unexpended Appropriation 1917-1918	15,780.79	
Unappropriated Revenue	15,604.70	
		31,385.49
Capital Investment	551,346.62	
Surplus and Reserve	152,685.52	
		704,032.14
		$808,020.61

EXHIBIT B

Income and Expenses for the Twelve Months Ended September 30, 1918

INCOME

Membership Dues	$122,608.13	
Sales—Gross Receipts	14,076.88	
Advertising	81,207.27	
Interest and Discount	4,339.17	
Initiation Fees	17,855.25	
Total		$240,086.70

EXPENSES

Finance Committee:			
Office Administration	$26,175.83		
Occupancy Building	4,800.00		
Engineering Council	3,999.97		
Library	3,600.00		
		38,575.80	
Membership Committee		5,281.49	
Council:			
Contingencies	3,211.24		
Mileage	1,335.85		
Committee Miscellaneous	7,524.67		
Employment Bulletin	2,908.69		
		14,980.45	
Increase of Membership Committee		12,969.69	
House Committee		3,935.75	
Sections Committee		13,887.51	
Meetings Committee		11,119.03	
Publication Committee:			
Advertising	39,754.09		
Journal Text	42,023.86		
Revises	289.90		
Transactions	19,357.72		
Year Book	6,879.56		
Engineers' Index	606.47		
		108,911.60	
Sales Expenditures		8,968.36	
Research Committee		258.69	
Students' Committee		671.73	
Junior and Student Prizes		48.52	
John Fritz Medal		34.69	
Engineering Resources		$1,758.75	
Public Relations		7.91	
Unexpended Appropriation 1916-1917		2,291.24	
[1]Total			$223,701.21
Excess of Income over Expenses			$16,385.49

EXHIBIT C

Receipts and Disbursements for the Twelve Months Ended September 30, 1918

RECEIPTS

Membership Dues	$116,883.99	
Initiation Fees	35,710.50	
Membership Dues paid in advance	3,087.45	
Sales of Publications, Badges, Advertising, etc.	90,387.35	
Interest	6,039.17	
Liberty Bond Account	1,603.80	
United Engineering Society	2,500.00	
	256,212.26	
Cash on hand and in banks, General and Trust Funds, September 30, 1917	36,901.15	
		$293,113.41

DISBURSEMENTS

Disbursements for General Purposes	$226,834.34	
Liberty Bonds	20,000.00	
United Engineering Society	17,500.00	
	264,334.34	
Cash on hand and in banks, General and Trust Funds, September 30, 1918	28,779.07	
		$293,113.41

Report of Committee on Meetings and Program

As the financial year of the Society does not correspond with the calendar year, it becomes necessary for this Committee to consider two general meetings in retrospect and one in prospect, yet of the former, only one was planned for by the Committee as now constituted.

The Annual Meeting held in December 1917 was the largest in the history of the Society in point of registration. The total number was 1965, of which 1115 were members and 850 guests. The number of members exceeded the registration at the Annual Meeting of 1915 by 88.

Because of the unsettled conditions due to the war activities of so many of our members, the 1917 Annual Meeting was given over to a larger number of addresses than usual and to fewer professional papers. However, the established practice of holding a keynote session was followed, the topic being Service of the Engineer to the Public in Times of National Crises.

The Spring Meeting of 1917 held in Cincinnati broke all previous Spring-Meeting records in regard to attendance, but the high record was again surpassed at the Worcester meeting of this year, the total registration being 986, of which number 472 were members and 511 guests. These numbers compare with 868, 410 and 458 respectively, the record at Cincinnati.

These increasing numbers in attendance at our meetings are significant of the broader field of activity that our Society is entering.

The situation brought about by the few papers offered for the Annual Meeting of 1917 existed at the time of the Spring Meeting of this year. But during the past few months a decided change has taken place in this particular. At the September meeting of your Committee not only was there a prospect of many more professional papers than can be presented in December, but nearly enough papers were ready for final approval at that time. It is possible that this change is an evidence of the stimulating effect of the war, which we are told has had a remarkable influence upon British engineering literature.

Some Features of the 39th Annual Meeting

Four features of the forthcoming December meeting deserve mention. A year ago an innovation was introduced into the program by providing for a luncheon at which time an address was given by Professor Dexter S. Kimball. A similar luncheon is planned for the forthcoming Annual Meeting, and at the request of the newly appointed Committee on Aims and Organization, that Committee has been given the privilege of providing the speaker and selecting the topic of his address.

The keynote session will have for its general theme Engineering of Man Power.

A joint session with the Society of Refrigerating Engineers has been scheduled. A part of the professional papers will be supplied by each society. Your Committee has been very willing to enter into this arrangement, which is in keeping with the Society's general policy

[1] Note: The item of total expenses includes $15,000 not yet paid, to complete work already in process and chargeable to this year's activities.

in maintaining close coöperation with other engineering organizations.

The fourth feature for the Annual Meeting that should be mentioned here is the giving of a prominent place on the program to the Committee on Aims and Organization, namely, that period of the session on Wednesday morning immediately following the regular business meeting of the Society.

WORK OF THE SUB-COMMITTEES

The work of the sub-committees of the Committee on Meetings and Program has, in the main, been exceedingly satisfactory. Without seeming to single out any one of these before another, it is a pleasure to acknowledge the unbroken record of successful sessions planned for by the Textile Sub-Committee under the chairmanship of Mr. Charles T. Plunkett.

The activities of the Sub-Committee on Protection of Industrial Workers having assumed more of the character of a special committee, the Committee recommended to the Council that the status of this committee be changed to that of a special committee. The recommendation was accepted.

The Committee favors a policy of appointing temporary sub-committees to investigate specific matters and assist in preparing special parts of the program of the meetings. However, it has not had opportunity to put this plan into full effect.

ACKNOWLEDGMENT

To an increasing degree during the past year the Committee has submitted professional papers to members of the Society who are especially conversant with the topics discussed, in order to have their opinions when the papers were considered for final disposition. It is a pleasure to acknowledge the uniform cordial coöperation that all of these requests for assistance and advice have evoked.

Respectfully submitted,

L. P. ALFORD, *Chairman*,
JOHN W. UPP,
DEXTER S. KIMBALL,
A. L. DE LEEUW,
WILLIAM G. STARKWEATHER,
Meetings and Program Committee.

Report of Publication and Papers Committee

The chief development of the Society's publications during the past year has been the establishment in THE JOURNAL of a comprehensive indexing of engineering periodical literature with particular reference to mechanical engineering subjects. This feature is one that has been consistently advocated by the Committee for many years and in fact was first proposed by the original committee appointed by the Council to report upon the establishment of THE JOURNAL. The actual accomplishment of the index feature has only awaited the time when it was felt by the Council that the Society was in a position to undertake it.

Coincident with this development, there has been under consideration an offer by the publisher of *Industrial Management* to sell its long-established Engineering Index, the purchase of which the Publication Committee now recomends to the Council. It is believed by the Committee that the indexing of engineering articles can best be accomplished by a professional organization, such as ours, through the facilities afforded by our magnificent library, which regularly receives over 1000 periodicals from all parts of the world. The purchase of the Index would bring to THE JOURNAL the prestige, name and other rights and privileges of what has been regarded as the leading index in the field, and establish this as a Society activity on a secure and non-competitive basis.

The addition of the index feature to THE JOURNAL brings this publication to as large a size as can advantageously be handled in monthly issues. Further increases to make THE JOURNAL more valuable to the profession will necessitate more frequent publication. Such development, however, must obviously be left until industrial conditions return to normal.

In compliance with the wishes of the War Industries Board that the tonnage of paper required for periodicals be curtailed, THE JOURNAL will for the present use a larger type page with more closely spaced type.

The annual volume of Transactions has been issued as usual with no material change, except that the subject matter has been influenced by the engineering work which so many of our members are doing in connection with the war.

There has been a considerable gain in the size and comprehensiveness of the annual volume of Condensed Catalogues for the current year. Four hundred and fifteen firms, including a majority of the leading manufacturers in their respective lines, are represented in its pages of catalogue data. The directory section has been extended and improved and to the mechanical engineering data section there has been added a subject list of Transactions papers, beginning with the first volume issued in 1880. The compiling and printing of this list was considered desirable, because the Society has not yet been able to issue the comprehensive index to Transactions which the Committee has several times recommended and for which the preparation of the index cards was completed two years ago. It is strongly urged by the Committee that this index be issued as soon as conditions allow.

At the last Spring Meeting, certain changes in the Constitution of the Society were effected, one of which designates this Committee as the "Publication and Papers Committee." In this connection, it is interesting to note that the Publication Committee was originally responsible for the approval of the papers which were to be presented at the Society's meetings, and printed in its Transactions. In 1904, the Committee on Meetings was organized to relieve the Publication Committee of certain of its burdens in respect to meetings, and since then the main function of the Publication Committee has been to pass upon papers referred to it by the Committee on Meetings and more lately also by the Local Sections Committees for use in the Society's publications. The Publication Committee has taken no initiative in procuring papers.

The obvious intent of the constitutional change is to express the desirability of the Publication and Papers Committee taking up the solicitation of papers and contributions for the publications. The Committee respectfully requests that By-Laws be formulated with respect to this function and expressing a clear policy for the handling of papers both for general and Sections meetings and for publications.

The past year has been most successful financially, the gross income from advertising having exceeded $81,000. The financial statement covering the Committee's activities will be found in the report of the Finance Committee.

Respectfully submitted,

GEORGE A. ORROK, *Chairman*,
J. W. ROE,
H. H. ESSELSTYN,
GEORGE J. FORAN,
RALPH E. FLANDERS,
Publication Committee.

Report of the Membership Committee

The Membership Committee held twenty-four meetings during the year 1917-1918, as against nine during fiscal year 1916-17.

The number of applications considered in the transaction of its work and a summary showing the action taken follow:

Applications pending October 1, 1917	863
Applications received during the fiscal year	1901
Total	2764
The following action was taken on these applications:	
Recommended for membership	1769
Recommended for membership (special cases)	36
Deferred indefinitely	20
Deferred	42
Denied promotion	13
Remission	8
In regular course of procedure	844
Foreign deferred for period of war	32
Total	2764
Reinstatements and reconsiderations pending	30

Those recommended for membership were divided into the following grades:

Members	486
Promotion to Member	60
Associates	104
Promotion to Associate	2
Associate-Members	575
Promotion to Associate-Member	64
Juniors	478
Total	1769

The Membership Committee has been most careful in the scrutiny of applications and no names of candidates have been recommended to the Council unless they are citizens of the United States or of one of the Allies. Action on application from foreigners has been deferred until the conclusion of hostilities.

Respectfully submitted,

HOSEA WEBSTER, *Chairman*,
S. D. COLLETT,
FREDERICK A. WALDRON,
W. S. TIMMIS,
R. F. JACOBUS,
Membership Committee.

Report of Committee on Local Sections

At the Spring Meeting of the Society in Worcester, May, 1918, a Constitutional Amendment was passed which changed the status of the Committee on Local Sections from a Special Committee to a Standing Committee of Administration and to one of the six Fundamental Committees of the Organization of the Society.

Your Committee has held the following meetings during the year:

Date	Place
October 11, 1917	Philadelphia
November 28, 1917	Philadelphia
January 8, 1918	New York
February 11, 1918	New York
March 12, 1918	New York
April 15, 1918	New York
May 13, 1918	New York
July 18, 1918	New York
August 28, 1918	Philadelphia

By-Laws Governing Sections

At its October meeting the Committee reviewed the final revision of the proposed By-Laws governing Local Sections and recommended them to the Council for adoption. They were subsequently adopted and now appear as B-48 and B-49 in the By-Laws.

These By-Laws have since been published in The Journal and the following Sections have now adopted constitutions and by-laws in conformity with them: New York, Indianapolis, Minnesota and Birmingham.

Sections Meetings

During the active season, upwards of 120 meetings were held by the various Local Sections. At a large proportion of these the speakers discussed subjects of interest in the winning of the war.

Finances

The Committee on Local Sections was apportioned a sum of $10,750 for its year's expenses, and this the Council augmented in May 1918 by an additional grant of $3,500. The total expenditures for the year amount to $13,887.51.

New Sections

At its October 1917 meeting your Committee received a petition for the establishment of a section for the State of Connecticut with branches at Bridgeport, Hartford, Meriden, New Haven and Waterbury, the New Haven Section being merged in the new State Section and becoming a branch of it, a type of Section developed in coöperation between the Connecticut members and your Committee. The petition was referred to the Council, which approved it.

At its August 1918 meeting your Committee received a petition from Cleveland, Ohio, and this was referred to the Council, which approved it.

At this time local Sections are in process of formation, notably at Pittsburgh, Washington, etc.

Your Committee is continually endeavoring to carry the Local Sections idea into territories which are strong in membership and in activities, and with that object in view is watching its opportunity to spread the gospel of organization in all centers of the country not now included in the already organized Local Sections of the Society.

Coöperation of Sections Committee with Other Committees

In coöperation with the Publications and Papers Committee of the Society your Committee recommended to the Local Executive Committees the appointment of Local Papers Committees. The purpose of these committees is to secure papers for presentation at the meetings of the sections and for forwarding to the Publication and Papers Committee for possible publication in The Journal and for presentation at General Meetings and inclusion in Transactions.

Similarly in coöperation with the Research Committee, your Committee recommended to the Local Executive Committee appointment of sub-committees on Research to ascertain what researches were being carried on or contemplated in the industrial laboratories and in the institutional laboratories in the territory of the Sections.

To date a number of the Sections have appointed sub-committees for both these purposes.

In coöperation with the Membership Committee your Committee is considering ways and means of fostering relations with local societies by means of some plan of joint membership in the National Society and the Local Society. The petition received from the Cleveland Section especially asked this Society to see what could be done to provide such joint memberships, and in accepting this petition the Council obligated itself to consider a practical plan.

In coöperation with the Meetings Committee your Committee arranged for a Session at the Annual Meeting in December, 1917, to be conducted by the Committee on Local Sections. Unfortunately, however, the program of the meeting was so full that very little time could be given to this innovation and it resolved itself into a conference of the Local Sections delegates.

Visits by the Committee and by Officers to the Sections

Beginning October 21, 1917, your Committee visited the Sections at St. Louis, Milwaukee, Chicago and Detroit. The November, 1917, meeting of the Committee was followed by a visit to the Philadelphia Section. An invitation to visit Birmingham was received with thanks and the Committee hopes to take advantage of this within the near future.

It was suggested that it would be well to develop a scheme to take care of visits by officers to the Sections by arranging visits to those Sections located in the part of the country in which the officers reside.

Nominating Committee

In accordance with a suggestion received from President Main, your Committee had a report prepared on the various methods in vogue with other engineering societies of selecting nominees for elective offices, and it devised a plan of placing the selection of the Nominating Committee into the hands of the membership by having it consist of delegates elected by the Sections. This plan was outlined in a report submitted to you by your Committee. The Council referred this matter to the Committee on Constitution and By-Laws, which proposed an amendment to the Constitution so as to provide for the election of said Nominating Committee by the Society membership in place of the present practice, leaving the formulation of all details in connection with this election to the by-laws which it will submit presently to provide for the selection of the Nominating Committee through the machinery of the Sections.

Conferences of Delegates

An important conference of delegates of the Sections was held in New York, December, 1917, in connection with the Annual Meeting, and this was reported in full in the January 1918 issue of The Journal.

Delegates were present from Atlanta, Baltimore, Birmingham, Boston, Buffalo, Chicago, Cincinnati, Connecticut, Erie, Indianapolis, Milwaukee, Minnesota, New Orleans, New York, Philadelphia, Providence, St. Louis, San Francisco and Worcester.

A conference of delegates was also held in connection with the Spring Meeting at Worcester, June, 1918, and reported in the July Journal.

Joint Meetings

During the Summer plans were laid to hold a joint meeting of the Mid-Western Sections in the Fall in some Mid-Western city. In coöperation with the several Local Committees of these Sections the meeting was assigned to Indianapolis and the date fixed as October 25 and 26. The Council decided to meet in Indianapolis at the same time also and at the moment of writing this report the program of said joint meeting is almost completed.[1]

Your Committee hopes that this will prove to be the inauguration of a series of joint Local Section meetings.

Coöperation with Sections of Other Societies and with Local Societies

In San Francisco there has been formed the Joint Council of Sections of the National Societies and the San Francisco Section of our Society participated in this movement. The purposes of the new organiation have been published in the technical press.

In Cleveland our new Section has been formed as the Mechanical Section of the Cleveland Engineering Society. This opens up a new field of coöperation between our Societies and local organizations and we look forward with open but conservative minds to the development of the Cleveland plan.

In many of the centers we have continued our coöperative plan as before. For example, in New Orleans we have coöperated effectively with the Louisiana Society; in Philadelphia we have continued our plan of coöperation with the Engineers' Club; in Chicago several joint meetings have been held under the auspices of the Western Society of Engineers, etc.

War Industries Readjustment Committee

President Main utilized the machinery of the Local Sections organization in appointing representatives of the Society's Committee on Readjustment of War Industries to coöperate with the Regional Committees of the Resources and Conversion Section of the War Industries Board. This Committee is issuing its own report.

Acknowledgment

The Committee desires to express its sincere appreciation of the coöperation of all the Local Committees and recommends that the thanks of the Council be extended to them for their efforts in furthering this important activity of the Society.

We also desire to record our special appreciation of the untiring energy and help which the Society's staff has at all times given to the Sections and our Committee.

Since the formation of our Committee four years ago, Mr. Ernest Hartford has acted as its Secretary and most acceptable have been his services; although we regret his withdrawal from these duties, we are

[1] The meeting was later postponed indefinitely on account of the epidemic of Spanish influenza.

glad that our government will have the advantage of his efficient help.

Respectfully submitted,

D. ROBERT YARNALL, *Chairman*,
LOUIS C. MARBURG,
WALTER RAUTENSTRAUCH,
CHAS. RUSS RICHARDS,
H. B. SARGENT,
Local Sections Committee.

Report of the Committee on Constitution and By-Laws

The Committee records with sincere regret the death on May 14, 1918, of its Chairman.

At its meeting on May 21 the Committee approved the following resolution:

> The Committee on Constitution and By-Laws of the American Society of Mechanical Engineers in parting with its Chairman, Frederick Remsen Hutton, realizes the great loss which it has sustained.
>
> The Committee will greatly miss his wise counsel, his broad vision, his high ideals, his genial bearing and friendship.
>
> The Committee desires to extend to his wife and family its very sincere sympathy in their great affliction.

The Council, at its meeting on October 12, 1917, referred to this Committee the question of the remission of the dues of members who entered the service of the United States for the war with Germany and also the question of the remission of the dues of persons who had been members of the Society for many years, with the view of amending By-Law 16.

The Committee, after careful consideration of the question, presented the following as a substitute for By-Law 16 at the meeting of the Council on November 16, 1917:

> B 16a. The Council may in its discretion restore to membership any person [illegible]ed from the rolls for non-payment of dues, or otherwise, u[illegible]ch terms and conditions as it may at the time deem best for [illegible] interests of the Society.
>
> B 16b. The Council may in its discretion remit the dues of any member of the Society in any grade who is engaged in military or other patriotic service of the United States during the continuance of the war conditions and for a period thereafter.
>
> B 16c. The Council shall permanently exempt from dues any member of the Society who has paid dues for thirty-five years or who shall have reached the age of seventy years after having paid dues for thirty years.

This substitute was approved by the Council at its meeting on January 18, 1918, and went into immediate effect.

At the same meeting the Council approved a recommendation of the Membership Committee as follows:

> *Voted*, That the members who have honored the Society by entering the military service of the United States receive all privileges of their membership, and, upon request, may have current dues remitted.

The Council at its meeting on February 15, 1918, referred to this Committee an elaborate report of the Committee on Local Section, under date of February 11, on the Selection of Officers and Appointment of Nominating Committees.

This Committee gave very careful consideration to the whole subject and submitted to the Council at its meeting in Philadelphia on April 23, 1918, proposed amendments to sections 47 and 48 of the Constitution by which the Nominating Committee would be taken out of the list of Committees to be appointed by the President, and proposing a new form of C 48 to read as follows:

> C 48. There shall be one or more Committees to nominate candidates for the elective offices of the Society, as the By-Laws shall provide.

The Committee took the position that the Constitution should only provide for the fundamental establishment of Nominating Committees and that the details of the number of Committees, the number of members on each Committee, their tenure of office and the mode of their election should be provided for in the By-Laws, where they could be changed as conditions changed. The Council did not approve of the recommendation of this Committee and referred the matter back to the Committee.

This Committee again took the whole subject into consideration and submitted a report to the Council at its meeting in Worcester, Mass., on June 4, 1918.

This Committee proposed that C 47 be amended by striking out the words "A Nominating Committee appointed by the President" and amending C 48 so as to read as follows:

Nominating Committees

> C 48. There shall be a Nominating Committee whose duty shall be to select candidates for the elective offices to be filled at each election This Committee shall be elected by the voting membership of the Society.
>
> Other Nominating Committees having the same power may be constituted by the voting membership.
>
> The number of members, the election, organization and procedure of all Nominating Committees shall be as the By-Laws shall provide.

These proposed amendments to C 47 and C 48 were approved at the same meeting by the Council after amending the proposed C 48 by inserting the word "annually" after "elected" in the second sentence.

These proposed amendments as amended by the Council were sent out in printed form to the membership as provided in C 57, by being published in the July issue of THE JOURNAL, page 53. This matter will come up for discussion at the Annual Meeting in December next.

Respectfully submitted,

JESSE M. SMITH, *Chairman*,
IRA H. WOOLSON,
JAMES E. SAGUE,
GEORGE M. BASFORD,
D. ROBERT YARNALL,
Constitution and By-Laws Committee

AMONG THE LOCAL SECTIONS

THE Annual Report of the Committee on Local Sections for the fiscal year ending September 30, 1918, is printed elsewhere in this issue. The report covers the subjects of by-laws, meetings, finances, new Sections, coöperation of Sections Committee with other committees, visits to the sections by officers, the selecting of the Nominating Committee, conferences of delegates, joint meetings, and coöperation with sections of other societies and local societies.

The report discloses that after only four years of operation the Committee on Local Sections has succeeded in establishing its work on the basis of intimate coöperation with the other committees of the Society, which the Committee thinks is just as essential as developing its own field of activities individually.

The relations of the Committee with the proposed Constitution and By-Laws changes are, in the matter of selection of the Nominating Committee, quite a fundamental change in the government of the Society, have been most satisfactory, and the Committee on Local Sections is justly proud in having taken part in the democratization of the Society by placing the power of appointing the regular Nominating Committee in the hands of the voting membership.

Members might be interested to know to just what extent the Committee on Local Sections carries out this plank of committee coöperation in its platform. At each of its meetings (as the annual report shows, frequent meetings were held during the past year) the committee sits down to a regular order of business, of which the following is a schedule:

ORDER OF BUSINESS

1 Reading the minutes of the previous meeting.
2 Statement of condition of finances:
   (a) Main committee
   (b) Local committees
3 Sections' Officers:
   (a) Recording of new officers of local committees
   (b) Confirmation of changes in local committees
4 Actions of Council and committees affecting Local Sections Committee:
   (a) Council
   (b) Meetings and Program Committee
   (c) Publication and Papers Committee (Sections' Sub-Committees on Papers)
   (d) Research Committee (Sections' Sub-Committees on Research)
   (e) Employment Department
   (f) Membership Committee
   (g) Increase of Membership Committee
   (h) Constitution and By-Laws' Committee.
5 Sections' By-Laws, Rules and Records:
   (a) Proposed amendments to By-Laws
   (b) Progress of adoption of By-Laws
   (c) Record books.
6 Report of Sections organization development:
   (a) Important developments in existing Sections centers

(b) Developments in connection with Sections petitions received
(c) Requests for Sections, and developments in centers where Sections are desirable.
7 Sections coöperation with local organizations of other societies and with local societies.
8 Reports and requests from Local Committees.
9 Relations with Publication Committee:
(a) Technical Section of JOURNAL.
(b) Society Affairs Section of JOURNAL. .. ..
10 Deferred Business.
11 New Business.
12 Adjournment.

A glance at this order of business will show that it aims to cover not only the usual duties of such a coöperative committee as the Committee on Local Sections, but also to emphasize that this committee is subject at all times to the direction of the Council, and is but one factor in the organization of the Society.

In other words, the broad plan on which the Committee on Local Sections works is that while there is strength in an organization of committees assigned to definite tasks, the closest intercommittee relations are at the same time necessary for cohesion and for the development of a coördinate will.

The Committee on Local Sections urges all Section executive staffs to place before it their real problems and constructive criticisms; for through such an interchange of ideas are Society and professional unity and progress assured.

Section Meetings

ATLANTA SECTION

The members of the Atlanta Section were entertained at dinner by the Chairman of the Executive Committee of the Section, Mr. Robert Gregg, at the Druid Hills Golf Club, October 17. After the dinner a paper was presented by E. L. Brooks, Associate Member, Am.Soc. M.E., on the subject Uniform Boiler Code.

The speech was followed by a discussion on the advantage of having the A.S.M.E. Boiler Code adopted by the State of Georgia, and a motion was carried instructing the Chair to appoint a committee of four members to draft the proper bill to be presented to the next legislature.

WILLIAM J. NEVILLE,
Secretary.

BIRMINGHAM SECTION

On November 20, its anniversary day, the members of the Birmingham Section met for dinner in the rooms of the Civic Association. The dinner was followed by a general, informal discussion.

JAMES W. MOORE,
Secretary.

BOSTON SECTION

Mr. A. Douglas Wardrop, Managing Editor of *Aerial Age*, delivered a lecture before the members of the Boston Section on Saturday evening, November 9, the subject being his recent trip to France, and experiences on the fighting line.

The Section is now planning a meeting on the timely subject of Reconstruction.

The report of the October 17 meeting given in the last issue of THE JOURNAL was incorrect. The meeting was held on October 29, and the speakers were F. P. Fish of the General Electric Company, who spoke on the Elements of the Labor Problem. Mr. Fish gave a general résumé of the development of the labor situation both in this country and in England during the last few years. He pointed out the strength and also the weakness of the organized labor movement, and suggested ways in which the engineers could coöperate to alleviate some of the weakness.

Mr. W. E. Freeland, of the Winchester Repeating Arms Co., presented a paper entitled Government Activity Toward the Solution of the Labor Problem. He dealt specifically with the Bridgeport case summarizing the work of the National War Labor Board there, and comparing the award made by this Board with the actual rulings of the examiner appointed by the Board.

Mr. Perry described the plan under which the Emergency Fleet Corporation was adjusting labor difficulties by means of shop committees.

WILLIAM G. STARKWEATHER,
Secretary.

BUFFALO SECTION

The A.S.M.E. Section of the Engineering Society of Buffalo conducted the meeting on November 27. The address of the evening was delivered by C. H. Bierhaum, on the subject of Bearings.

W. W. BOYD,
Secretary.

CHICAGO SECTION

A joint meeting of the Chicago Section of the A.S.M.E. and A.I.E.E. with the Western Society of Engineers was held in the rooms of the Western Society on Tuesday, November 12. The subject was Industrial Lighting and the War, and Professor C. E. Clewell, of the University of Pennsylvania, delivered an address, illustrated by lantern slides.

A joint meeting of the War Committee of Technical Societies of Chicago was held on November 25 in the rooms of the Western Society of Engineers. Fuel Conservation was the subject of addresses by Preston Millar and Harold A. Almert.

ARTHUR L. RICE,
Secretary.

CONNECTICUT SECTION

The fall meeting of the Connecticut Section was held at New Haven on November 20. The members assembled at the Mason Laboratory at 2:30 p. m. for a trip by automobile to the power plant of the Marlin-Rockwell Corporation and to the new central heating plant of Yale University.

Upon the return of the party a dinner was held at the Mason Laboratory, at 6 p. m., followed by a meeting at Lampson Lyceum, Yale University. The address of the evening was given by Mr. W. H. Blood, of the American International Shipbuilding Corporation, on the Building of Hog Island Shipyard, illustrated by slides and motion pictures.

The Winchester Engineering Club and the Yale University Student Branch of the A.S.M.E. participated in the evening session.

E. H. LOCKWOOD,
Secretary.

NEW YORK SECTION

Albert C. Ritchie, counsel for the War Industries Board and Attorney General of Maryland, spoke at a joint meeting of the New York Section and other technical bodies, held in the Engineering Societies Building, 29 West 39th Street, on November 20. He told of America's part in supplying steel for war needs of this country and the Allies, and predicted an unprecedented demand from Europe for reconstruction purposes.

J. Leonard Replogle, Director of Steel Supply of the War Industries Board, had been announced as the principal speaker of the evening, but J. E. Johnson, Jr., who presided, said that Mr. Replogle had been detained in Washington and delegated Mr. Ritchie to discuss the steel situation.

The speaker, after reviewing at length the achievements of the steel industry in the war, said that the War Industries Board would retain control hereafter over a given industry only when all interests asked for such supervision.

Captain P. E. Dulieux of the French High Commission said that immediate French requirements in the steel line called for 8,000,000 tons. He predicted that, with Alsace-Lorraine back in possession of France, his country might "at a not very distant date be your competitor."

Julius Kahn of Youngstown, Ohio, made an address on the larger uses of reinforced concrete in building operations of the immediate future.

H. D. EGBERT,
Secretary

PHILADELPHIA SECTION

A meeting of the Philadelphia Section was held at the rooms of the Engineers' Club on November 26. J. F. Johnson of the Westinghouse Electric & Manufacturing Co. delivered an address on Large Steam Turbine Design.

J. P. MUDD,
Secretary.

PROVIDENCE ENGINEERING SOCIETY

On November 5, at the Society's rooms, a joint meeting was held, Mr. C. J. Carter of Boston giving an informal talk on Gas Engines for Sea Sleds before the Machine Shop Section. The Power Section was entertained by Talks on Coal—its Production, Distribution and Storage.

The speakers of the evening were Mr. L. D. Moore, Superintendent of Castner, Curran & Bullitt, Inc.; Professor W. H. Kenerson, Director of Conservation for the Rhode Island Fuel Administration, and Mr. A. N. Sheldon, of F. P. Sheldon & Sons, Mill Engineers.

Mr. A. Douglas Wardrop, Managing Editor of Aerial Age, delivered the address on November 8, at Memorial Hall, the subject being My Flight Over the Hindenburg Line, and Latest Developments in Aerial Warfare.

Mr. Edson F. Gallaudet, of the Gallaudet Aircraft Corporation, delivered an address before the Designing and Drafting Section on November 12, the subject being The Application of Some Principles of Airplane Design.

On November 19, Major F. B. Gilbreth, Mem.Am.Soc.M.E., delivered an interesting lecture on the mechanical action of the new designs of Lewis and Browning machine guns, illustrating his lecture with moving pictures of the parts in action.

The Chemical Section heard an interesting address on Some Problems of Gas Warfare by Prof. E. B. Spear, of Massachusetts Institute of Technology.

WILLIAM A. KENNEDY,
Secretary.

NECROLOGY

WALTER ANTOSCH

Walter Antosch was born in New York City on March 17, 1896. He attended the city schools and later Stevens Institute of Technology, from which he was graduated in 1917 with the degree of M.E. For about six months after his graduation he was connected with the Standard Aircraft Corporation, Elizabeth, N. J., serving first in the drafting room, then in the engineering department and finally as assitant superintendent in the production department, where he had charge of routing material through the shops. He resigned his position at the end of that time and enlisted in the United States Naval Reserve Force and was assigned to the Naval Engineering School, where in a very short time he won the rating of machinist. He was then assigned to the U. S. S. *Westbridge*, which was torpedoed on August 15, when he was instantly killed. He was buried on August 28 in the Kerfautras Military Cemetery, Brest, France.

WALTER ANTOSCH

Mr. Antosch also served in the recent Mexican border trouble and was at that time connected with the First Field Hospital of the New York National Guard. He became a junior member of the Society in 1918.

SERGEANT ARTHUR HENRY BERGES

Arthur H. Berges was born on July 28, 1886, in Burlington, Iowa, and was educated in the schools of that city, later attending Purdue University, from which he was graduated in 1910 with the degree M.E. His first employment was with the Chicago & Northwestern Railway Co., Chicago, Ill., as special apprentice. In the early part of 1911 he became connected with the International Harvester Co., and had charge of the production in the tractor works, Chicago. His next position was with the H. W. Schott Co., engineers in Chicago, where his duties gave him charge of construction on the power house of a hydroelectric proposition at Ballville, Ohio. For a short period in 1913 he worked in the mechanical department of Sargent & Lundy, an engineering firm in Chicago, leaving to become draftsman in the shop-engineering department of the Chicago and Western Indiana Railroad Co. At the outbreak of the war he was employed as mechanical draftsman in the Rock Island Arsenal, Ill. He resigned from this position to enlist in the 23rd U. S. Engineers. He was killed in action in France on September 13, 1918.

Sergeant Berges became a junior member of the Society in 1914.

GEORGE GOODWIN CALDWELL

George G. Caldwell was born on June 22, 1857, in Peoria, Ill. He was educated in the public schools of Michigan and at Olivet College, Olivet, Mich. He served an apprenticeship as machinist with the Benjamin & Fischer Co., Chicago, Ill., from 1878 to 1880 and then worked for the next five years in various shops in Massachusetts and Rhode Island, gaining general experience on the construction of steam engines and boilers. About 1890 he became engineer for the Calumet Electric Street Railway Co., Chicago, and installed its plant. Subsequently he went into business for himself as construction engineer. From 1907 to 1909 he was connected with the Wheeler Condenser & Engineering Co., Chicago, erecting and operating machinery. In July, 1910, he entered the employ of H. M. Byllesby & Co. as construction superintendent on installations covering buildings and general power-plant machinery, and remained in that capacity except for a short interim until his death, July 27, 1918. While in this position he had complete charge of the installation of important works for the Oklahoma Gas & Electric Co., Oklahoma City, Okla.; the Northern State Power Co., Minot, N. D.; the Union Light, Heat & Power Co., Fargo, N. D.; the Interstate Light & Power Co., Galena Ill., and the Ottumwa Railway & Light Co., Ottumwa, Ia.

Mr. Caldwell became an associate member of the Society in 1916.

STANLEY SHIELDS COOKE

Stanley S. Cooke was born on August 9, 1893, in Denver, Col., and was educated in the public schools there. He attended the University of Colorado and was graduated in 1915 with the degrees of B.S. and M.E. Upon graduation he was connected for short periods with the following firms: the American District Steam Co., Tonawanda, N. Y., on steam-heating main installations; the Denver Gas & Electric Light Co., Denver, Col., in the transformer department, repairing irons and fans and testing transformers; the Union Pacific Railroad Co., as special apprentice in the motive-power and construction department. He worked for about a year for the Union Metallic Cartridge Co., Bridgeport, Conn., and then took a position with the Lake Torpedo Boat Co., in the same city, on the construction of submarines.

Three weeks after our declaration of war he enlisted in the Navy Coast Guard Service and was sent to Fort Trumbull, New London, Conn., for training and afterwards assigned to the cutter *Tampa*, which left in October to engage in patrol and ascort duty in European waters. In June of this year Mr. Cooke was made first gunner and in August appointed coxswain, and the following month received orders directing his transfer to the Naval Academy to attend the Officers' Training School. On the night of September 26, however, while the *Tampa* was in the British Channel doing escort duty with the fleet, a violent concussion was felt but the cause was not then ascertained. Upon reaching port it was discovered that the *Tampa* was missing. Destroyers immediately set out to hunt for the vessel but apart from a little wreckage, some life preservers marked *Tampa* and two bodies in uniform, nothing else was discovered. The *Tampa* during her year's service abroad had made eighteen trips between Gibraltar and English ports and may be said to have rendered a real service to the Allied cause.

ARTHUR H. BERGES

LIEUTENANT PAUL HENRY CORDES

Lieut. Paul H. Cordes, who was killed in action on the western front in France on September 12, 1918, was born in Altona-Hanover, Germany, on February 17, 1887. He came to this country when he was about eleven years old and was educated in the public schools, later attending evening school, where he took the technical course.

In 1906 he became associated with the Henry R. Worthington Co., Harrison, N. J., works of the Worthington Pump & Machinery Corporation, where he was assistant to the superintendent of the erecting department. His duties there gave him charge of the erecting and testing work on steam and centrifugal pumps, surface condensers, etc. He also assisted in the supervision of the outside construction work. In 1913 he was transferred to the Chicago office as engineering salesman, assisting and having charge of the testing work on large triple-expansion pumping engines, centrifugal pumps and condensers, as well as making experimental and research tests of such machinery, which position he was holding at the time of his enlistment, May 1917. He held the rank of First Lieutenant in Company C, 30th Engineers, Gas and Flame Division.

Lieutenant Cordes became an associate member of the Society in 1916.

SAMUEL AMBROSE FRESHNEY

Samuel A. Freshney was born in January, 1867, in London, England. He was brought to this country when but a child and the family settled in Ohio. His first work was in connection with the electrical business when he was employed by the Brush Electric Co., Cleveland, Ohio. He spent his apprenticeship in the shops of this company and was then promoted to the engineering department. After seven years' service he left to become manager of the Electric Light & Power Co., Muskegon, Ill., where he remained until 1900. For the next two years he was branch manager of the Wayne Electric Works at Cincinnati, Ohio, and Grand Rapids, Mich. In 1902 he was made general manager of the Muskegon Traction & Lighting Co., operating street railway, electric and gas properties, and continued in that capacity until 1905, when he was offered and accepted the position of secretary and general manager of the Grand Rapids Board of Public Works, where he had charge of the water works, electric-light systems, public improvements, streets, sewers, flood protection, etc. In 1912 he resigned from the Board of Public Works to become general manager of the Consumers Power Co., Grand Rapids, Mich., which position he held up to the time of his death, September 16, 1918.

Paul H. Cordes

Mr. Freshney became a member of the Society in 1913.

MAJOR WILLIAM R. KING

Major William R. King, Ordnance, U. S. Army, died at the Post Hospital, Army Proving Ground, Aberdeen, Md., July 18, 1918. A military funeral was held at the Post on the morning of July 20 with the full honors due to his rank and service amid the surroundings which so fully typified his brief but most useful military service.

Prior to the entrance of the United States into the European War, Major King had been an active advocate of preparedness and published an article, A National Factor of Safety, in the *Engineering Record* of January 20, 1915, one of the first comments on the indispensable function of the engineer in modern war and the duty of technical schools to teach military engineering.

Major King was graduated from Stevens Institute of Technology with the class of 1886 and was chairman of the special committee which organized the battalion of 400 Stevens alumni and students in the Preparedness Parade, May 13, 1916. Later he was chairman of the Stevens Alumni Military Committee, placing 250 mechanical engineers in the reserve and civilian service. He, himself, applied for a commission on March 22, 1917.

On October 6, 1917, he was selected for the exceptional duty of Chief of Design and Construction of the new Army Proving Ground at Aberdeen, with its great variety of structures—railroads, highways, docks, power plant, machine shops, gun emplacements, ammunition storehouses and dwellings. He had supervised the erection of a part of the permanent structures and completed much of the temporary work at this proving ground when, on July 17, he was informed of prospective transfer to command at another proving ground and of recommendation for his promotion to the rank of Lieutenant Colonel. Early in the evening of the same day Major King was shot in his room by a man who had apparently no motive except a fancied grievance. The wound proved fatal in twenty-four hours.

William R. King

The following is a record of his principal engineering responsibilities: His first important position was that of assistant superintendent with R. Hoe & Co., New York City, 1886 to 1890; from 1890 to 1894 he was manager and engineer of the Empire State Phosphate Mining Co., an interest of Cooper Hewitt & Co. in Florida; he was next consulting engineer of companies developing respectively an air brake and the King Wyatt resistance type of electric furnace, 1894 to 1897; from 1897 to 1901 he was superintendent and manager of construction of the Oxnard Construction Co., erecting the beet-sugar factories at Oxnard, Cal., at Ames, Neb., and at Rocky Ford, Cal. Thereafter, from 1901 to the time of the war his work was in the field of hydraulic engineering; in particular, the electric plant of the Stanislaus River in California, the Klickitat River development in Washington and the irrigation and electrification projects of the Northern Pacific Railroad Co.

Major King became a member of the Society in 1914.

FRANK E. GETTS

Frank E. Getts was born in Fort Wayne, Ind., in June, 1870, and was educated in the public schools there. From 1887 to 1892 he served his apprenticeship as machinist in the Wabash Railway Shops, Fort Wayne, and for the next three years was connected with the Fort Wayne Electrical Works, first as electrical apprentice and later as construction foreman. His next position was with the Siemens & Halske Electric Co., where he had charge of building and installing electrical generators. He was also with the Northwestern Elevated Railway Co. for a short while. When he became associated with the Chicago Edison Co. in 1903 he was given charge of the installation of all steam turbines at the Fisk Street Power Station. The success of this work was due in great measure to Mr. Getts' personal efforts and his engineering ability. From 1910 to 1913 he had direct charge of all steam work for the General Electric Co. in the Middle West. In October 1913 he resigned from that company to become general manager of the Chicago office of the Alberger Condenser & Engineering Co., and in April 1915 he became general manager of the Electrical Engineers Equipment Co., Chicago, which position he held at the time of his death, May 7, 1918.

Mr. Getts was a member of the American Institute of Electrical Engineers, the Electric Club and the Press Club, Chicago. He became a member of our Society in 1913.

HARRY SHELDON LEONARD

Harry S. Leonard was born on October 21, 1865, in Washington, D. C. He was educated in the public schools of that city and later attended Yale University, from which he received in 1886 the degree of Ph. B. He was connected for about eight years with the New Haven Wire Manufacturing Co. as manager and then spent about a year with the Trenton Iron Co., Trenton, N. J., as sales manager. For the next three years he conducted his own business in Boston as a manufacturers' agent. In 1899 he became manager of the Boston office of the Westinghouse Electric & Manufacturing Co., leaving that firm to become associated with the Winchester Repeating Arms Co., New Haven, Conn., where he remained till about a year ago, when ill health compelled him to resign from the vice-presidency of the company with which he had been connected for eighteen years.

Mr. Leonard became a member of the Society in 1916. He died in New York City on July 26, 1918.

ALBERT THEODORE LEONHARD

Albert T. Leonhard, secretary of the Paterson Parchment Paper Co., Passaic, N. J., died on September 29, 1918, a victim of Spanish influenza.

Mr. Leonhard was born on March 4, 1887, in Haledon, N. J. He attended high school in Passaic and later Stevens Preparatory School from which he went to Stevens Institute of Technology, receiving his M.E. degree in 1908. He became associated in the same year with the Paterson Parchment Paper Co., where he designed and supervised the construction of paper-making and other machinery, improved old and devised new processes for the manufacture of paper; he also designed and supervised the construction of new mill buildings and had general charge of the mechanical department. At the time of his death he held the position of secretary of the firm.

Mr. Leonhard became an associate member of our Society in 1916.

DALE McCARTY

Dale McCarty was born in Gosport, Ind., on January 19, 1892, was educated in the public schools there and later attended Purdue University, from which he received the degree of M. E. in 1911 Upon graduation he worked for a short period with the Western Electric Co., Chicago. In September, 1911, he became connected with the Santa Fe Railroad Co., Chicago, where his duties consisted of steel detailing, layouts, freight and steel passenger-car designs, inspection of material and sketching of foreign-design cars. In the early part of 1914 he resigned from this position to become draftsman with the Enterprise Railway Equipment Co. His work there in the drafting room called for steel hopper, ore, steel and composite ballast, and drop-bottom gondola car designs, stress diagrams and estimates of weight having to be prepared for all cars designed. As mechanical representative of the company he had charge of the general inspection and oversight of deliveries of malleable and steel castings. He was also responsible for the inspection and approval of sample cars in conjunction with the representatives of railroads.

Mr. McCarty had expected to enter the Central Officers' Training Camp in January. He was stricken with Spanish influenza while on a business trip and died in Indianapolis, Ind., on October 18. He became a junior member of the Society in 1916.

WILLIAM EARLE MOSHER

William E. Mosher, who died of pneumonia in Washington, D. C., on October 12, was assistant superintendent engineer of the Army Transport Service, and had been recommended for a commission as Major in the Quartermaster Corps. He was born in 1888 and attended the schools of Mechanicville, N. Y. In 1909 he received the degree of Ph. B. from Syracuse University and in 1911 the degree of M. E. He then attended the Graduate School of the University of Illinois and obtained his M. S. in 1913, having specialized in refrigeration and thermodynamics. From September 1913 to June 1916 Mr. Mosher was assistant refrigeration technologist, U. S. Department of Agriculture, and had charge of the portable precooling plant. His next position was with the Fruit Dispatch Co., New York, as consulting engineer. In January 1918 he obtained leave of absence that he might offer his services to the Government.

Mr. Mosher was a member of the honorary societies of Phi Beta Kappa, Sigma Xi and Tau Beta Pi. He was also a member of the American Society of Refrigerating Engineers. He became a junior member of our Society in 1912.

CAPTAIN WALTER MARANTETTE WILHELM

Capt. Walter M. Wilhelm was born in Defiance, Ohio, on November 13, 1884. He was graduated from the United States Military Academy at West Point, N. Y., in June 1906, and from the School of Ordnance Engineering, Sandy Hook Proving Ground, in July 1909. In August of that year he became assistant and general superintendent at the Watervliet Arsenal, Watervliet, N. Y., the commanding officer being Col. W. W. Gibson. He was in charge of the operation of construction of field and coast guns, specializing in the subject of relining the latter type. He was also responsible for the installation of the Taylor System of manufacture at the Watervliet Arsenal. In 1913 he was transferred to Frankford Arsenal, Bridesburg, Philadelphia, where he was assistant to the officer in charge of the optical department dealing with the manufacture and design of sea-coast instruments. Later he became assistant to the officer in charge and then himself officer in charge of the artillery department at Frankford, where his duties gave him charge of the manufacture and design of shrapnel, shell, time and detonating fuses, hand grenades, rifle grenades, etc., used in the Army and Navy. In November 1915 he resigned from the Army to become vice-president and general manager of the Eddystone Ammunition Corporation, Eddystone, Pa., where he had full charge of the manufacture of 2,500,000 complete rounds of Russian shrapnel. He was holding this position at the time of his death, October 3, 1918.

Captain Wilhelm became a member of the Society in 1916.

ROLL OF HONOR

DIED IN THE SERVICE

Stanley S. Cooke, Coxswain, U. S. S. Tampa, U. S. Navy.

Paul H. Cordes, First Lieutenant, Company C, 30th Engineers, Gas and Flame Division, A. E. F., France.

The following list of those in the Service is made up of the names of members of the Society sent in during the month of November.

Alden, H. W., Lieutenant Colonel, Ordnance Department, U. S. Army; stationed at Washington, D. C.

Anderson, H. W., Private, Chemical Warfare Service, U. S. Army.

Babcock, F. R., Captain, Ordnance Department, U. S. Army.

Bayer, L. C., Coast Artillery Corps, U. S. Army.

Barbieri, Cesare, Lieutenant, Royal Engineers, 2d Regiment, Italian Army, with the Italian High Commission, Washington, D. C.

Beehler, W. P., Commander, U. S. Navy; stationed at U. S. Naval Experimental Station, New London, Conn.

Beekman, Henry M., Second Lieutenant, Ordnance Department, U. S. Army; stationed at Sandy Hook Proving Ground, Fort Hancock, N. J.

Beerbaum, Arthur J., Machinist's Mate, Second Class, U. S. Navy; Steam Engineering, Co. 5, Reg. 17, Great Lakes, Ill.

Bixby, William H., Brigadier General, U. S. Army (Retired); on War Service in U. S.

Bleckley, Logan, Private, 7th Service Co., Signal Corps, U. S. Army; assigned to Ellington Field, Houston, Tex.

Boehnlein, C., Chief Quartermaster, Aviation Co. 31, Naval Aviation Detachment, Massachusetts Institute of Technology, Cambridge, Mass.

Bowen, William S., Second Lieutenant, Signal Corps, U. S. Army; stationed at School of Meteorology, College Station, Tex.

Boyles, Ralph R., Private, 1st Co., 161st Depot Brigade, Camp Grant, Ill.

Bradley, E. P., Captain, Engineering Section, Construction Division, Quartermaster Corps, U. S. Army.

Brizzolara, Robert T., Second Lieutenant, Aviation Section (Aeronautics), U. S. Army; stationed at Park Field, Millington, Tenn.

Brooks, Frederick A., First Lieutenant, Air Service, Aircraft Production, American Expeditionary Forces, France.

Brown, Arthur L., Captain, Engineering Division, Ordnance Department, U. S. Army.

Brown, Owsley, Major, 172d Infantry, American Expeditionary Forces, France.

Bruback, T. M., Second Lieutenant, Research Division, Engineers' Corps, U. S. Army; stationed at Ellington Field, Tex.

Buckingham, J. E. E., First Lieutenant, Co. D, 87th Engineers, U. S. Army; assigned to Fort Benjamin Harrison, Ind.

Burke, Walter S., Lieutenant-Commander, U. S. Navy (Retired); stationed at U. S. Navy Yard, Boston, Mass.

Bursley, Joseph A., Major, Ordnance Department, U. S. Army.

Campbell, E. Gordon, Captain, Engineers' Corps, U. S. Army.

Carter, H. D., Captain, Ordnance Department, U. S. Army.

Carver, E. M., Captain, Engineering Division, Ordnance Department, U. S. Army.

Childs, J. N., Lieutenant, U. S. Naval Reserve Force; stationed as Senior Engineer Officer, U. S. S. *Camden*.

Clancy, W. L., Ensign, U. S. Naval Reserve Force, Line of the Navy, Temporary Staff Duty, Aviation Division, Bureau of Construction and Repair, Washington, D. C.
Conner, B. F., Chief Machinist's Mate, U. S. Navy; stationed at the New York Navy Yard.
Cowles, Clifford A., Jr., Private, Second Class, 5th Service Com. Detachment, Signal Corps, U. S. Army; stationed at Gerstner Field, Lake Charles, La.
Cowperthwait, Allan, Major, Inspection Division, Ordnance Department, U. S. Army.
Cox, James W., First Lieutenant, Quartermaster Corps, U. S. Army.
Crook, W. Ralph, First Lieutenant, Construction Division, Quartermaster Corps, U. S. Army; stationed at Camp Holabird, Md.
Curtis, Allen, Captain, Spruce Production, Air Service, U. S. Army; stationed at Vancouver Barracks, Washington.
De Lany, E. H., Commander, U. S. Navy.
Devine, Charles P., First Lieutenant, Air Service, U. S. Army.
Dismukes, A. R., Co. B, Motor Transport Corps, Unit No. 305, U. S. Army; stationed at Camp Jessup, Atlanta, Ga.
Edwards, G. Middleton, Chief Machinist's Mate, Marine Engineers' Training School, Stevens Institute of Technology, Hoboken, N. J.
Estabrook, Charles B., Captain, Ordnance Department, American Expeditionary Forces, France.
Fischer, Louis A., Major, Gage Section, Engineering Division, Ordnance Department, U. S. Army.
Flewelling, M. F., Jr., U. S. Navy; assigned to U. S. Naval Steam Engineering School, Stevens Institute of Technology.
Fliegner, Carl G., Candidate, 10th Train Battery, Field Artillery Corps, Field Artillery Officers' Training School, Camp Taylor, Ky.
Flynn, John H., Captain, Conservation and Reclamation Division, Quartermaster Corps, U. S. Army; assigned to Camp Johnston, Fla.
Fusselman, P. A., Captain, Co. A, 314th Infantry, American Expeditionary Forces, France.
Gardner, Douglas M., Ensign, U. S. Naval Reserve Force.
Gardner, Thomas, Machinist, Naval Engineering School, Stevens Institute of Technology, Hoboken, N. J.
Garrison, W. L., Second Lieutenant, 301st Mobile Ordinance Repair Shop, American Expeditionary Forces, France.
Grobli, Walter A., Private, First Class, Detached Quartermaster Service, Medical Department, U. S. Army; assigned to General Hospital No. 12, Biltmore, N. C.
Grunert, Arthur E., Captain, Co. D, 4th Engineers, American Expeditionary Forces, France.
Grunwell, Paul C., First Lieutenant, Engineering Division, Ordnance Department, U. S. Army.
Hall, Charles A., Private, Provisional Post Headquarters Co., Training Detachment, Fort Benjamin Harrison, Ind.
Hawkins, Robert D., Lieutenant Colonel, Russian Railway Service Corps, U. S. Army; stationed at Harbin, Manchuria, Asia.
Hazzard, W. S., U. S. Navy; assigned to U. S. Naval Steam Engineering School, Stevens Institute, Hoboken, N. J.
Henszey, Joseph M., Major, Inspection Division, Ordnance Department, U. S. Army.
Hicks, George C., Jr., Major, Ordnance Department, U. S. Army.
Hider, George T., Private, Battery F, 36th Regiment, Coast Artillery Corps, U. S. Army; stationed at Camp Eustis, Va.
Hill, E. Logan, Captain, Engineers' Corps, U. S. Army.
Hill, Herbert M., Private, Science and Research Division, Air Service, Aircraft Production, U. S. Army; stationed at Carnegie Institute of Technology, Pittsburgh, Pa.
Hoopes, Edgar M., Jr., Captain, Utilities Detachment, Quartermaster Corps, U. S. Army; assigned to Camp Meade, Md.
Howard, Cecil D., First Lieutenant, Engineers' Corps, U. S. Army.
Hubbell, Richard L., Second Lieutenant, 109th Infantry, U. S. Army; stationed at Watertown Arsenal, Watertown, Mass.
Hunt, James L., First Lieutenant, Trench Warfare Section, Ordnance Department, U. S. Army.
Imeson, C. V., Captain, Construction Division, Quartermasters Corps, U. S. Army; assigned to Fort Barrancas, Fla.
Jackson, E. E., Private, First Class, Co. M, 22d Regiment Engineers, N. Y. Guard.
Jensen, James A., Second Lieutenant, Research Division, Chemical Warfare Service, U. S. Army; assigned to American University Experiment Station.
Johnson, George A., Major, Construction Division, Quartermaster Corps, U. S. Army.
Jones, Leon B., Candidate, Engineer Officers' Training School, Camp Humphreys, Va.
Kales, W. R., Captain, General Engineering Staff, American Expeditionary Forces, France.
Karcher, Harry E., Private, Co. A, 5th Training Battalion, Signal Corps, U. S. Army; stationed at Fort Leavenworth, Kan.
Kenyon, John T., Major, Ordnance Department, U. S. Army.
King, M. L., Major, Air Service, U. S. Army; stationed at Air Service Flying School, Post Field, Fort Sill, Okla.
King, W. G., Ensign, U. S. Navy.
Knight, Earl L., Sergeant, Co. A, 8th Battalion, Ordnance Department, American Expeditionary Forces, France.
Knox, Carlos C., U. S. S. *Carola IV*, U. S. Navy.
Kouwenhoven, Frank W., Private, Air Service (S.), U. S. Army; assigned to Air Service School for Radio Operators, University of Texas, Austin, Tex.
Lunn, John A., Second Lieutenant, Engineers' Corps, Headquarters Services of Supply, Office of Chief of Chemical Warfare Service, American Expeditionary Forces, France.
Lyons, Karl M., Captain, Oil Branch, Fuel and Forage Division, Quartermaster Corps, U. S. Army.
McLaren, Lewis L., Private, Co. A, Fourth Training Battalion, Signal Corps, U. S. Army; assigned to Fort Leavenworth, Kan.
MacCart, R. D., Ensign, Naval Reserve Flying Corps; assigned to Massachusetts Institute of Technology, Cambridge, Mass.
Malone, J. G., Chief Machinist's Mate, Student, U. S. Naval Steam Engineering School, Pelham Bay, N. Y.
Maloney, Charles A., Ensign, Submarine Unit, New London Base, U. S. Navy; stationed at U. S. Naval Academy, Annapolis, Md.
Meeker, L. A., Captain, Gas Defense Division, Chemical Warfare Service, U. S. Army.
Mills, Harold H., Warrant Machinist, Naval Auxiliary Reserve, U. S. Navy.
Mitchill, George L., Corporal, Co. A, 302d Engineers, Headquarters 77th Division, American Expeditionary Forces, France.
Monahan, W. H., Jr., First Lieutenant, Inspection Division, Ordnance Department, U. S. Army.
Mott, C. S., Major, Quartermaster Corp, U. S. Army; Chief of Production, Detroit District Office.
Moxham, Egbert, Lieutenant Colonel, Ordnance Department, U. S. Army.
Muir, Leonard S., Second Lieutenant, Air Service, Aeronautics, U. S. Army; assigned to Wilbur Wright Field, Dayton, O.
Mullergren, A. L., First Lieutenant, Quartermaster Corps, U. S. Army; assigned to Camp Funston, Kan.
Nash, Douglas E., Ensign, Naval Aviation, U. S. Navy; stationed at Key West, Fla.
Naumburg, Robert E., Second Lieutenant, Air Service, U. S. Army; Engineer Officer First Reserve Wing, stationed at Hazelhurst Field, Mineola, L. I.
Nofsinger, L. E., Private, Air Service, U. S. Army.
Phillips, Leon R., Captain, Construction Division, Quartermaster Corps, U. S. Army.
Philpot, N. E., Chief Machinist's Mate, U. S. Naval Reserve Forces.
Porter, L. L., Ensign, U. S. Naval Reserve Force; stationed at U. S. Naval Academy, Annapolis, Md.
Pratt, Merrill E., Second Lieutenant, Coast Artillery Corps, U. S. Army; assigned to Coast Artillery School, Fort Monroe, Va.
Preston, R. A. D., Lieutenant, Bureau of Construction and Repair (Aviation), U. S. Navy.
Proctor, Redfield, Captain, Engineers' Corps, U. S. Army.
Prussing, R. E., Captain, Quartermaster Corps, U. S. Army.
Purdy, A. R., Private, Air Service, Aircraft Production, U. S. Army; assigned to Second Detachment, N. Y. City.
Roe, J. W., Major, Bureau of Aircraft Production, Air Service, U. S. Army.
Rouse, John E., Candidate, 13th Observation Battery, Field Artillery Corps, Officers' Training School, Camp Taylor, Ky.
Scott, T. Wayne, Sergeant, 111th Infantry, American Expeditionary Forces, France.
Seligman, W., First Lieutenant, Coast Artillery Corps, U. S. Army.
Seth, George L., Lieutenant, Chemical Warfare Service, U. S. Army.
Shepard, F. J., Jr., First Lieutenant, Engineering Division, Ordnance Department, U. S. Army.
Sherry, Samuel E., Jr., Chief Machinist's Mate, Sea-Plane Hangar Co., U. S. Naval Aviation; stationed at U. S. Naval Air Station, Rockaway, L. I.
Sinclair, A. F., Major, Ordnance Department, U. S. Army; stationed at U. S. Ammonium Nitrate Plant, Perryville, Md.
Smith, Cameron C., Major, Production Division, Ordnance Department, U. S. Army.
Smith, Victor J., First Lieutenant, Ordnance Department, U. S. Army; stationed at Frankford Arsenal, Philadelphia, Pa.
Solomon, Gabriel R., Major, Construction Division, Engineers' Corps, U. S. Army.
Spackman, Henry S., Lieutenant-Colonel, Engineers' Corps, American Expeditionary Forces, France.
Stinson, K. W., Second Lieutenant, Air Service (Aeronautics), U. S. Army; assigned to U. S. School of Military Aeronautics, Princeton, N. J.
Swain, Wilbur A., Candidate, 1st Co., Machine Gun Officers' Training School, Camp Hancock, Ga.
Tenkonohy, Franklin V., Captain, 301st Regiment Tank Corps, American Expeditionary Forces, France.
Thompson, John R., Captain, Engineers' Corps, American Expeditionary Forces, France.
Tuvin, J. H., Lieutenant, Utility Co., Construction Division, Army Base Hospital, U. S. Army; assigned to Camp Dix, N. J.
Wadd, Roy J., Second Lieutenant, Chemical Warfare Service, U. S. Army; assigned to Edgewood Arsenal, Edgewood, Md.
Walker, F. W., Jr., First Lieutenant, 4th Anti Aircraft Battalion, Coast Artillery Corps, American Expeditionary Forces, France.

LIBRARY NOTES AND BOOK REVIEWS

REVIEWS of books of special importance to mechanical engineers by members of the Society and those particularly qualified, brief descriptive notes of accessions to the Library of the United Engineering Society, items of interest relating to the Library's activities, etc.

AIRPLANE CHARACTERISTICS. A Systematic Introduction for Flyer and Student and for All Who Are Interested in Aviation. By Frederick Bedell. First edition. Taylor and Co., Ithaca, N. Y., 1918. Cloth, 6 x 9 in., 123 pp., 65 illus. $1.75.

The art of flying, the author states, has progressed so far that the principles of flying can in the main be set forth definitely, and a collection of the essential elements be made that will apply to all airplanes, irrespective of type or structure. He has therefore tried to present a codification of the well-known groundwork, which will give a direct, simple statement of the principles of airplane sustentation and stability and the characteristics of an airplane in flight. The present work only partially covers the subject, but has been issued in its present form to meet the need of the moment.

AMERICAN ASSOCIATION OF ENGINEERS DIRECTORY. Containing Lists of Members Arranged Alphabetically, Geographically and According to Professional Work. Corrected to July 1, 1918. American Association of Engineers, Chicago (copyright, 1918). Cloth, 6 x 9 in., 190 pp., 2 diag., 1 map. $2.

The directory contains an account of the history, aims and organization of the society, with lists of the members arranged alphabetically, geographically, and according to their professional experience.

THE AMERICAN HOSPITAL OF THE TWENTIETH CENTURY. A Treatise on the Development of Medical Institutions, both in Europe and in America, since the beginning of the Present Century. By Edward F. Stevens. Architectural Record Publishing Co., New York, 1918. Cloth, 7 x 10 in., 274 pp., 454 illus. $5.

Mr. Stevens presents plans of and information concerning a number of typical modern institutions, which show various solutions of the problems of housing and treating the sick. He adds also to his illustrations a summary of the results of his own experience in hospital construction and his study of European institutions.

THE ARBITRAL DETERMINATION OF RAILWAY WAGES. By J. Noble Stockett, Jr. Hongton Mifflin Co., New York, 1918. Cloth, 5 x 8 in., 198 pp. $1.50.

This volume of the Hart, Schaffner and Marx Prize Essays is a study of the principles of wage determination and of wage increase advanced by the employees and employers in the course of arbitration proceedings, with a view to ascertaining some fundamental principles which may serve as the basis of a fair and reasonable wage or of a just principle of wage increase. The arbitration proceedings examined number 65 and include those settled under the provisions of the Erdman Act and the Newlands Act, the railway cases under the Industrial Disputes Investigation Act, the Eastern Engineers' Arbitration of 1912 and the Western Engineers and Firemen's Arbitration of 1915.

THE BLUE BOOK OF FACTS OF MARINE ENGINEERING. Including new questions and problems with answers that are required for all grades of Marine and Gas Engine License. Third edition, revised 1918. Ocean Publishing Co., New York (copyright, 1917). Cloth, 4 x 6 in., 116 pp. $2.50.

This quiz compend gives the necessary information for obtaining marine engineers' licenses, in the form of questions and answers. These are classified according to the different grades of licenses.

BOMBS AND HAND GRENADES, BRITISH, FRENCH AND GERMAN. A Handbook Showing Their Construction and Technicalities, Giving Full Instructions as to How to Use and How to Render Useless. By Captain Bertram Smith. E. P. Dutton and Co., New York (copyright, 1918). Cloth, 5 x 8 in., 90 pp., illus., $2.

Descriptions of the types used by the different armies are given, with instructions for their use. Clear outline drawings of each type are included.

DESCRIPTIVE GEOMETRY. By William H. Ames and Carl Wischmeyer. Fifth edition. McGraw-Hill Book Co., Inc., New York. 1918. Cloth, 5 x 8 in., 112 pp., 197 illus. $1.

A condensed course for students in colleges of engineering, in which 72 problems are explained and illustrated, and 400 exercises for solution are presented. The book accords with drafting-office practice by using the third quadrant.

THE FLOTATION PROCESS. By Herbert A. Megraw. Second edition, revised and enlarged. McGraw-Hill Book Co., Inc., New York, 1918. Cloth, 6 x 9 in., 359 pp., 74 illus., 1 pl., tables. $3.50.

Although litigation over patent rights still continues and there is still no agreement on the theory of the flotation process, the author has thought it advisable to issue a second edition of this work. In it the development of the process, both in theory and practice, is summarized, and an endeavor has been made to present as true a record of present conditions as is possible. Most of the original edition is retained, although some portions that later developments have made valueless are omitted, and considerable new matter has been added.

FUEL ECONOMY IN BOILER ROOMS. A Development of Fuel Economy and CO_2 Recorders Published in the Engineers' Study Course from Power. In two parts. Part I: Fuel Economy and CO_2 Recorders, by A. R. Manjer and Charles H. Bromley. Part II: Fuel Economy in Boiler Rooms, by Charles H. Bromley. Second edition. McGraw-Hill Book Co., Inc. New York, 1918. Cloth, 6 x 8 in., 308 pp., 92 illus., 18 tables. $2.50.

The volume before us contains a revised edition of the book formerly published as Fuel Economy and CO_2 Recorders with the addition of matter on other subjects of interest in connection with efficiency in power-plant operation. The authors have tried to provide a work that will explain in simple language the proper means of attaining fuel economy. For use by firemen and power-plant operating engineers.

GAGES, GAGING AND INSPECTION. A Comprehensive Treatise Covering the Limit System, Measuring Machines, and Measuring Tools and Gages for Originating and Comparing Measurements in the Manufacturing and Inspection Departments, Including Means for Measuring and Inspecting Screw Threads and Gears. By Douglas T. Hamilton. First edition. The Industrial Press, New York, 1918. Cloth, 6 x 9 in., 295 pp., 175 illus. $2.50.

This is the first book, the author says, which deals exclusively with the subject, describes the principles and practical application of the limit system of interchangeable manufacturing and the principal tools and gages in use, comprehensively enough to meet the requirements of today.

GEORGE WESTINGHOUSE. His Life and Achievements. By Francis E. Leupp. Little, Brown and Co., Boston, 1918. Cloth, 6 x 9 in., 304 pp., 5 pl., 6 portraits. $3.

In this account of George Westinghouse, the inventor and the man, the author has gathered his material from such contemporary sources as old newspapers and magazines, corporate reports, court records, local traditions and the personal recollections of the friends and neighbors of Mr. Westinghouse. The trials and failures of his early life, his perseverance in the struggle for the recognition of his air-brake, and his later successes are pictured in detail. The numerous personal anecdotes which are scattered through the book add greatly to the interest of the biography as a human document.

INTERPOLATION TABLES OR MULTIPLICATION TABLES OF DECIMAL FRACTIONS. Giving the Products to the Nearest Unit of All Numbers from 1 to 100 by 0.01 to 0.99 and from 1 to 1000 by 0.001 to 0.999. By Henry B. Hedrick. Carnegie Institution, Washington. 1918. Cloth, 10 x 14 in., 139 pp. $5.

These tables are of especial use in all problems involving the multiplication of decimal fractions of two or three digits where the product is required to no more significant figures than are contained in the smaller factor. Their use may be extended to decimal fractions of three and four digits. As the tables are more accurate than the slide-rule or graphical methods, and more convenient than logarithms, they are of value for many computations where those methods are ordinarily employed.

Life in a Large Manufacturing Plant. By Charles M. Ripley. General Electric Co., Schenectady, N. Y.

A series of pamphlets describing the systematic plans which have been developed for selecting an efficient working force for the General Electric Company and for maintaining a high physical, mental and moral standard.

MacRae's Blue Book. America's Buying Guide. Vol. IX., 1918. MacRae's Blue Book Co., Chicago (copyright, 1918). Cloth, 9 x 12 in., 1345 pp. (advertising pages included). $10.

This directory contains a list of thirty thousand American manufacturers of machinery, tools, and other supplies used by railroads and manufacturers, a list of manufacturers' representatives, a classed directory of makers of different products, an index of trade names, a collection of data useful to purchasing agents, tables of standard prices and a discount computer.

A Manual of Engineering Drawing for Students and Draftsmen. By Thomas E. French. McGraw-Hill Book Co., Inc., New York, 1918. Cloth, 6 x 9 in., 329 pp., 556 illus. $2.50.

A method of instruction, based upon the conception of drawing as a language, with varied forms of expression, a grammar and style. New chapters on lettering, screw threads, bolts and fastenings, and structural drawing have been added; the chapters on working drawings and architectural drawing have been enlarged, and the text generally revised.

Mechanisms and Mechanical Movements. A Treatise on Different Types of Mechanisms and Various Methods of Transmitting, Controlling and Modifying Motion, to Secure Changes of Velocity, Direction, and Duration or Time of Action. By Franklin D. Jones. First edition. The Industrial Press, New York, 1918. Cloth, 6 x 9 in., 310 pp., 164 illus. $2.50.

The author has classified a variety of mechanical devices representing different types of mechanisms and illustrating important fundamental principles. He has also attempted not only to explain how various mechanical motions may be produced and controlled, but also to show the relation between the theoretical and practical sides of the subject.

Metallurgy of Lead. By H. O. Hofman. First edition. McGraw-Hill Book Co., Inc., New York, 1918. Cloth, 6 x 9 in., 664 pp., 705 illus., 1 folded pl., 153 tables. $6.

This work replaces the author's former treatise on The Metallurgy of Lead and the Desilverization of Base Bullion, but has been so largely rewritten and altered that it has become practically a new book. Only the chapters on reverberatory smelting and German cupellation have been retained in about their original forms. The author has prepared for the new edition by a careful review of the technical literature and by visiting the leading lead plants of the United States and Canada, and has attempted to represent modern practice thoroughly and accurately.

Methods of Measuring Temperature. By Ezer Griffiths. With an Introduction by E. H. Griffiths. Charles Griffin and Co., Ltd., London; J. B. Lippincott Co., Philadelphia, 1918. Cloth, 6 x 9 in., 176 pp., 81 illus., 48 tables. 8s 6d.

This monograph, intended for those concerned with the measurement of temperature in scientific investigations or in the control of industrial operations, is chiefly devoted to the experimental basis of the methods in use, the calibration of the instruments and the precautions necessary in practice. The volume is intended to extend the general treatment given in standard textbooks and to be complete in itself. References to the important literature are given with each chapter.

Mine Tracks. Their Location and Construction. Treating briefly on the Materials Used and the Principles Involved in the Design and Installation, with a Set of Rules for a Standard Practice. By J. McCrystle. First edition. McGraw-Hill Book Co., Inc., New York, 1918. Flexible cloth, 5 x 7 in., 105 pp., 23 illus., tables. $1.50.

The adaptation of mechanical haulage and the successive increases in the weight of mine locomotives and rolling stock are making closer attention to mine tracks imperative, the author says. He has prepared this treatise to furnish a summary of the methods of several companies where systematic attention has been given to the subject, in convenient form for use by those responsible for the planning and maintenance of track work.

Modern Hot Water Heating, Steam and Gas Fitting. By William Donaldson. Frederick J. Drake and Co., Chicago (copyright, 1918). Cloth, 5 x 8 in., 256 pp., 11 illus., 30 tables. $1.50.

An elementary description of apparatus and methods of installing it.

Modern Management Applied to Construction. By Daniel J. Hauer. First edition. McGraw-Hill Book Co., Inc., New York, 1918. Cloth, 6 x 9 in., 194 pp., 19 illus., 1 folded chart. $2.50.

Describes the application of the principles of scientific management to engineering and architectural construction, in the light of the author's experience. An appendix outlines the American and Canadian organizations for war construction.

The Motor Truck as an Aid to Business Profits. By S. V. Norton. A. W. Shaw Co., New York (copyright, 1918). Cloth, 7 x 10 in., 509 pp., 335 illus., 5 folded charts. $7.50.

A collection of plans for using motor trucks in various businesses, showing what has been accomplished in actual practice. The adaptation of the motor truck to a business, its effective and economical utilization, its maintenance and its part in developing the business are discussed in detail.

My Reminiscences. By Raphael Pumpelly. Henry Holt and Co., New York, 1918. Cloth, 844 pp., 57 pl., 24 por., 13 maps, 2 vols. 7.50.

Born in 1837, the author studied geology and mining engineering in Paris and Freiburg, and later led a busy life as a geologist, mining engineer and explorer for over half a century. His professional activities in Asia and America provided an abundance of information on these lands and many adventures and anecdotes, which are presented in an interesting fashion in this autobiography.

Operator's Wireless Telegraph and Telephone Handbook. A Complete Treatise on the Construction and Operation of the Wireless Telegraph and Telephone, Including the Rules of Naval Stations, Codes, Abbreviations, etc. By Victor H. Laughter. Frederick J. Drake and Co., Chicago (copyright, 1918). Cloth, 5 x 8 in., 191 pp., illus., 1 pl. $1.

A student's text, in which he is led from a study of simple elementary systems to the more complicated types of wireless telegraph and telephone instruments. Directions for the construction of instruments are given.

Plane Surveying. A Practical Treatise on the Art of Plane Surveying, Including Chaining, Leveling, Compass and Transit Measurements, Land and Construction Surveying, Topographic Surveying, and Mapping. By J. K. Finch. American Technical Society, Chicago, 1918. Flexible cloth, 5 x 7 in., 243 pp., 154 illus., 11 pl., 10 tables. $1.50.

This manual is especially intended for home study. It is planned to give the practical man a working knowledge of the subject, and to be used by trained surveyors as a convenient review.

A Practical Course in Wooden Boat and Ship Building. The Fundamental Principles and Practical Methods Described in Detail. Especially Written for Carpenters and other Woodworkers who Desire to Engage in Boat or Ship Building, and as a Text-Book for Schools. By Richard Van Gaasbeek. Frederick J. Drake and Co., Chicago (copyright, 1918). Cloth, 5 x 8 in., 204 pp., 119 illus. $1.50.

This text-book is the outgrowth of a course for shipbuilders given at Pratt Institute to assist house carpenters and other woodworkers in transferring from their usual occupations to the shipbuilding industries. The author has attempted to provide a brief, fundamental course in the general principles of construction.

Reinforced Concrete Construction. Part I. With Examples Worked Out in Detail for All Types of Beams, Floors and Columns. By M. T. Cantell, Mem.Am.Soc.M.E. Second edition. Spon & Chamberlain, New York, 1918. Cloth, 5 x 7 in., 160 pp., 75 illus., 1 pl.

The chief object in this work is to endeavor to meet the requirements of students, as well as others who have practical experience but only an elementary knowledge of mathematics and mechanics, for a simple practical treatment of the subject. Part I contains the principles, general information and examples of designing required by the majority of students and practical men. This

edition is revised to comply as far as possible with American and Canadian, as well as British, conditions and practice.

The Second Power Kink Book. A Collection of Short Articles from *Power* in Which Practical Men Describe Simple Expedients They Have Found Effective in Meeting Every-day Emergencies in Power-Plant Work. Compiled by the Editorial Staff of *Power*. McGraw-Hill Book Co., Inc. (sole selling agents), New York, 1918. One-half cloth, 6 x 9 in., 161 pp., 137 illus. $1.

The first Power Kink Book, published in 1917, has led to requests for a further collection of these notes on emergency power-plant practice, in response to which this volume is issued. The book, like its predecessor, is intended to suggest solutions for unusual problems and methods of meeting difficult situations.

Sheet Metal Workers' Manual. A Complete, Practical Instruction Book on the Sheet-Metal Industry, Machinery and Tools, and Related Subjects, Including the Oxy-Acetylene Welding and Cutting Process. By L. Broemel. With a Special Course in Elementary and Advanced Sheet Metal Work and Pattern Drafting for Technical and Trade School Instructors and Students; Also for Reference and Study by Sheet Metal Workers and Apprentices, by J. S. Daugherty. Frederick J. Drake and Co., Chicago (copyright, 1918). Flexible cloth, 5 x 7 in., 552 pp., 394 illus., 32 tables. $2.

The authors have tried to produce a comprehensive text-book on the machinery, tools and methods used in sheet-metal working, suited to the needs of manual training and trade schools. Outline courses in sheet-metal work and hand forging and welding which meet the requirements of emergency war training are included.

The Shipbuilders' Blue Book. This is the first and only practical handbook containing such information as you must have in your daily work. It covers everything on Rivets and Riveting, Spacing of Rivets, Riveting for Water and Oiltight Work, Buttlaps, Buttstraps, Brackets, Frames, Plating, etc., by a Practical Man. By Walter Kay Crawford; edited by E. R. Glass. Ocean Publishing Co., New York, 1918. Cloth, 4 x 6 in., 79 pp. $1.50.

A compact manual of information useful to apprentices and shipfitters; largely in tabular form.

ACCESSIONS TO THE LIBRARY

Aciers fers, fontes. Tome I. By Alexis Jacquet. *Paris, 1918.* Purchase.

Airplane Characteristics. By Frederick Bedell. *Ithaca, 1918.* Gift of author.

Alsace-Lorraine Protests, translated from original French records and published by Mr. D. Fricot. *Angels Camp, Cal. n. d.* Gift of Alfred D. Flinn.

American Institute of Mining Engineers. Transactions. Vol. 57, 58. *New York, 1918.* Purchase.

Association of Ontario Land Surveyors. Annual Report. No. 33, and Proceedings of 26th Annual Meeting. *Toronto, 1918.* Gift of Association.

Bangor Mineral District. (Tasmania. Geological Survey, Bulletin No. 27). *Tasmania, 1918.* Purchase.

Banking Evolution. An address delivered by Chas. H. Sabin, President of the Guaranty Trust Co., before the State Bank Section of the American Bankers' Association, Sept. 25, 1918. Gift of Guaranty Trust Co.

British Columbia, Department of Lands. Report of Water Rights Branch, 1917. *Victoria, 1918.* Gift of British Columbia Water Rights Branch.

Building and Ornamental Stones of Canada. Report. Vol. V. *Ottawa, 1917.* Purchase.

Bureau of Railway Economics. Summary of Railway Returns year ending Dec. 31, 1917. *Washington, 1918.* Gift of Bureau of Railway Economics.

Calcul des systèmes elastiques de la construction. By Ernest Flamard. *Paris, 1918.* Purchase.

California Railroad Commission. Decisions. Vol. XIV, 1917. *Sacramento, 1918.* Purchase.

Catskill Aqueduct Celebration. Historic and Museum Publications, 1917. Gift of Geo. F. Kunz.

Chicago Elevated Railroad Company. Safety Rules. *n. d.* Gift of Company.

Chilean Mining Code, January 1, 1889. By Charles E. M. Michels. *Santiago de Chile, 1914.* Gift of author.

The Co-Insurance Clause. An address delivered before the 129th meeting of the Insurance Society of New York on March 7, 1916. *New York, 1918.* Gift of Insurance Society of New York.

Combination, Not Competition of Railroads. By Blewett Lee. (Reprinted from Michigan Law Review, May, 1918.) Gift.

Diplomatic and Consular Service of the United States. Corrected to Aug. 31, 1918. *Washington, 1918.* Gift.

Duluth-Superior Harbor. Statistical Report of Marine Commerce of Duluth, Minn., and Superior, Wis. *1917.* Gift of Alfred D. Flinn.

L'Elecrochimie et l'Electrométallurgie. By Albert Levasseur. *Paris, 1917.* Purchase.

The Electrician. Annual tables of electricity undertakings of the United Kingdom, the Colonies and Foreign Countries. *London, 1918.* Purchase.

Electrical Blue Book. The Buyers' Encyclopedia of Electrical Material. Ed. 8th, 1918. *Chicago, 1918.* Gift of Alfred D. Flinn.

Engineering Association of New South Wales. Minutes of Proceedings, Vol. XXXII. *Sydney, 1918.* Purchase.

Engineering Profession Fifty Years Hence. By J. A. L. Waddell. (Reprinted from *Scientific Monthly*, Vol. VI, June 1918; Vol. VII, July-Aug. 1918.) *Lancaster, 1918.* Gift of author.

Fares and Freight Rates. What of the Aftermath of Government control of railroads? By H. W. Seaman. (Bulletin No. 46, City National Bank, *Clinton, Iowa*). *1918.* Gift of City National Bank.

Food Supply and the War, as shown by the Report of the New York State Food Supply Commission. *Albany, 1918.* Gift of New York State Food Commission.

Formations Géologiques Aurifères de l'Afrique du Sud. By René de Bonand. *Paris, 1917.* Purchase.

From the Falls to the Factory: a treatise on electric power transmission. British Aluminum Company. *London, n. d.*

Fuel Saving in Power Plants. (Bulletin No. 1, Advisory Engineering Committee to the Massachusetts Fuel Administrator). *Boston, 1918.*

Gravity and Temperature Tables for Mineral Oils from Determinations of the Bureau of Standards and Other Tables for General Testing and Refinery Practice. Compiled and edited by E. N. Hurlburt. *Rochester, 1918.* Gift of Taylor Instrument Companies.

Great Britain. Department of Scientific and Industrial Research. First Report of the Mine Rescue Apparatus Research Committee. *London, 1918.*

—— Report of the Committee of the Privy Council. 1917-18. *London, 1918.* Gift of Department of Scientific and Industrial Research.

Hartford Public Library. Annual Report of the Directors. 18th, 1918. *Hartford, 1918.* Gift of Public Library.

International Military Digest. Annual, 1917. *New York, 1918.* Purchase.

An Investigation into the Therapeutic Value of Compressed Yeast. By P. B. Hawk. (Reprinted from the *Journal of the American Medical Association.*) *New York, 1917.* Gift of The Fleischmann Company.

Jane's Fighting Ships, 1917. An encyclopedia of the navies of the world. *London, 1917.* Purchase.

Kingdom of Belgium. Ministry of Justice and Ministry of Foreign Affairs, War of 1914-1916. Reply to the German white book of the 10th May, 1915, Die völkerrechtswidrige Führung des belgischen volksriegs. *London, 1918.* Gift of Service Bureau of the Committee on Public Affairs.

Proctor Knott's Speech on Duluth, issued by the Public Affairs Committee of the Commercial Club of Duluth. Gift of Alfred D. Flinn.

La Distillation Fractionnée et la Rectification. By Charles Mariller. *Paris, 1917.* Purchase.

Laying the Rails for Future Business, with a synopsis of the Law for the Federal Control of Railroads. *New York, 1918.* Gift of Guaranty Trust Company.

Lessons in Community and National Life. Series A, for the upper classes of the high school. *Washington, 1918.* Gift of U. S. Bureau of Education.

Merchants' Association of New York. I. Opposing Government Ownership and Operation of Public Utilities; II. Advocating Exclusive Regulation of All Railroads by the Federal Government. Nov. 1916. Gift of Merchants' Association of New York.

Metropolitan Water Board. 12th Annual report on the results of the chemical and bacteriological examination of the London waters for the twelve months ended 31st March, 1918. By A. C. Houston. *London, 1918.* Purchase.

Minerals and Metals for War Purposes. Hearings before the Committee on Mines and Mining, United States Senate, 65th Congress, Second Session. *Washington, 1918.* Gift.

Mining Operations in the Province of Quebec, 1917. *Quebec, 1918.* Purchase.

National Advisory Committee for Aeronautics. Annual Report. 3d, 1917. *Washington, 1918.* Gift of A.S.M.E.

New Orleans, La. Sewerage and Water Board. Report, 36th semi-annual. *New Orleans, 1917.* Gift of Sewerage and Water Board.

New York State. Chamber of Commerce. Annual Report of the Corporation. 60th, 1917-18. *New York, 1918.* Gift of Chamber of Commerce.

New York State. Public Service Commission, Second District. Annual Report. 1917—II. *Albany, 1918.* Gift of New York State Public Service Commission.

New York Times Index. April-June 1918. Volume VII. *New York, 1918.* Purchase.

Ogden City, Utah. Monthly Financial Statement, May 1918, also containing summary of proceedings of the Board of Commissioners for the month of May 1918. Gift of City Recorder.

Oil, Paint and Drug Reporter. Green book for buyers. Fall edition, 1918. *New York, 1918.* Gift of Oil, Paint & Drug Reporter.

Pennsylvania. Department of Agriculture. Feeding Stuffs Report, 1917. (General bulletin No. 312). *Harrisburg, 1918.* Purchase.

Pocket List of Railroad Officials, No. 95, 1918. *New York, 1918.* Purchase.

Portland Cement Association. Magazine List, August, 1918. *Chicago, 1918.* Gift of Association.

Public Utilities Reports—Annotated, 1918 (—) B. C. *Rochester, 1918.* Purchase.

Recent Revolution in Organ Building. By G. L. Miller. Ed. 2. *New York, 1913* Gift of Samuel Wein.

Reconnoissance Soil Survey of North Eastern Wisconsin, with maps. (Bulletin No. XLVII to L, Soil Series 12-15.) *Madison, 1916.* Purchase.

TRADE CATALOGUES

Bigelow Company. New Haven, Conn.
Catalogue describing the Bigelow Hornsby water-tube boiler. 1917.

Burt Manufacturing Company. Akron, Ohio.
General catalogue on oil filters, exhaust heads and ventilators. 1917.
Blue print of Burt unit-type filter. 1914.

Defender Automatic Regulator Company. St. Louis, Mo.
Catalog No. 10. n. d.

E. I. du Pont de Nemours & Company. Wilmington, Del.
Blasters' Handbook. 1918.

General Electric Company. Schenectady, N. Y.
Bulletin No. 40017. Small Direct Current Generators, Type ML. August 1918.
——— No. 47702. Rheostat and Compensator Operating Mechanisms. August 1918.

General Electric Company, Ivanhoe Regent Works. Cleveland, Ohio.
Catalog No. 276. Ivanhoe metal reflectors and fittings for industrial illumination. 1918.

Harrison Safety Boiler Works. Philadelphia, Pa.
Catalog No. 550. Cochrane Steam and Oil Separators.
——— No. 710. Cochrane Heaters for Steam Power Plants.
Engineering Leaflet No. 18. Testing V-Notch Meters.
Cochrane Exhaust Steam Heating Encyclopedia. 1914.

Jeffrey Mfg. Co. Columbus Ohio.
Catalog No. 175. Jeffrey Standard Belt Conveyers.

Larner-Johnson Valve and Engineering Company. Philadelphia, Pa.
Bulletin No. 1. Johnson hydraulic valve. July, 1918.

New England Tank and Tower Company. Everett, Mass.
Wood tanks. (Catalogue F.)

Reynolds Electric Company. Chicago, Ill.
Bulletin No. 22. Reco color hoods. June 15, 1915.
——— No. 27. Reco flashers. July 1, 1915.
——— No. 33. Reco flashers. Dec. 1, 1915.
——— No. 202. Type "A" alternating-current motors.

Ross Heater and Manufacturing Company. Buffalo, N. Y.
Catalogue B. Ross crosshead-guided expansion joint.

Richardson Scale Company. Passaic, N. J.
Descriptive booklet describing Richardson automatic scales for pulverized coal.

Smith Serrell Company, Inc. New York City.
Bulletin No. 26. Francke flexible couplings. 1918.

Stephens-Adamson Mfg. Co. Aurora, Ill.
The Labor Saver. October 1918.

Tide Water Oil Company. New York, N. Y.
Veedol, lubrication of internal combustion engines. Ed. 4, 1918.

United Filters Corporation. Brooklyn, N. Y.
Sweetland's patent metallic filter cloth.

Wheeler Condenser and Engineering Company. Carteret, N. J.
Bulletin 112-A. Condensers, pumps, cooling towers, etc. 1918.

Worthington Pump and Machinery Corporation. New York, N. Y.
Vertical triplex power pumps, single and double acting. (D-702) May, 1918.

Yarnall Waring Company. Philadelphia, Pa.
Engineering devices for the power plant. Descriptive booklet.

PERSONALS

In these columns are inserted items concerning members of the Society and their professional activities. Members are always interested in the doings of their fellow-members, and the Society welcomes notes from members and concerning members for insertion in this section. All communications of personal notes should be addressed to the Secretary, and items should be received by December 15 in order to appear in the January issue.

CHANGES OF POSITION

Otto Da Costa-Schmidt, formerly affiliated with the Treadwell Engineering Company, Easton, Pa., has entered the employ of the Ohio Bronze Powder Company, Cleveland, Ohio.

Sidney G. Walker, until recently associated with the Manufacturers' Mutual Fire Insurance Company, Providence, R. I., has assumed the position of vice-president of the New York Reciprocal Underwriters, with headquarters at New York.

O. G. Jenner has resigned his position of superintendent with the Wilson and Bennett Manufacturing Company, Chicago, Ill., to assume a similar position with the Equipment Corporation of America, of the same city.

Adolph Starr has entered the employ of the Locomotive Superheater Company, New York, in the capacity of erecting engineer. Mr. Starr was, until recently, chief gage inspector, Winchester Repeating Arms Company, New Haven, Conn.

Harry E. Henrickson, formerly connected with the S. S. White Dental Manufacturing Company, has become associated with the Remington Arms and Ammunition Company, Bridgeport Works, as a process engineer.

William V. Lowe, formerly associated with the engineering department of John Bath Company, Fitchburg, Mass., has assumed the duties of foreman of the training school of the Putnam Machine Company, Fitchburg, Mass., which is one of the branches of the Manning, Maxwell and Moore Company. The training school, or vestibule school, has been established throughout the country to provide workmen for the shop to take the places of those who have gone to the front.

J. D. Goulette has accepted the position of construction engineer with the Gulf Production Company, Eastland, Tex. He was, until recently, affiliated with the Gulf Refining Company, Shreveport, La., in the capacity of construction engineer and plant superintendent.

George S. Blankenhorn, resigned from the American International Shipbuilding Corporation, on August 1, as engineer of steam machinery, and since then has been connected with the Wilson-Snyder Pumping Machinery Company, as engineer in their Philadelphia, Pa., district.

Louis J. Pelissier, formerly equipment engineer of the Norwich, Conn., Division of the Marlin Rockwell Corporation, is now mechanical superintendent of the Tacony, Philadelphia Division of the same company.

J. H. Romann, formerly connected with the Chicago, Ill., office of Joseph T. Ryerson and Son, is now in charge of the export division of the company in New York, which has recently been opened.

John G. Shirley, assistant works manager of the Gilbert and Barker Manufacturing Company, Springfield, Mass., has accepted an appointment as production manager of the S. K. F. Ball Bearing Company, Hartford, Conn.

Percy A. McKittrick, for 20 years with the Saco-Lowell Shops and the Lowell Machine Shop, has severed his connection with that company and is now assistant treasurer of the Parks-Cramer Company, of Fitchburg, Mass. The Parks-Cramer Company is a recent consolidation of two firms well known in mill circles, the G. M. Parks Company, of Fitchburg, Mass., and Stuart W. Cramer, of Charlotte, N. C.

Frederick A. Alden, formerly connected with Fay, Spofford and Thorndike, Boston, Mass., as mechanical engineer, has assumed the duties of division engineer, Sea Service Bureau, United States Shipping Board, Boston, Mass.

Lewis H. Miller has become affiliated with the Babcock and Wilcox Company, Barberton, O., in the capacity of designing engineer of the plant engineering department. He was formerly associated with the Tennessee Coal, Iron and Railroad Company, Birmingham, Ala., as mechanical engineer.

George H. John, Jr., until recently planning engineer with the Stokes and Smith Company, Philadelphia, Pa., has assumed the duties of instructor in mechanical engineering, Columbia University, New York.

John B. Purves, formerly associated with the Combined Locks Paper Company, Combined Locks, Wis., has resigned his position and has assumed the duties of mill manager with the Interlake Pulp and Paper Company, Appleton, Wis.

Stephen H. Painter has become special representative of the Ingersoll-Rand Company, in Chile and in Bolivia. He was formerly associated with the company in New York, as manager of the calyx drill department.

Philip M. Hathaway has resigned his position with the International Register Company, Chicago, Ill., to become chief engineer of the National Lead Company, Crooke Works, Brooklyn, N. Y.

JOHN W. MI[illegible], plant engineer at Bayles Shipyard, Inc., Port Jefferson, N. Y., is now employed in the ship construction department of the American International Shipbuilding Corporation, Hog Island, Pa.

STEPHEN THOMAS, formerly combustion engineer for the Goodyear Tire and Rubber Company at Akron, Ohio, has accepted a similar position with the E. I. du Pont de Nemours Company, Wilmington, Del.

ANNOUNCEMENTS

F. H. ROSENCRANTS has entered the engineering department of the Electric Bond and Share Company, New York.

A. H. PUGH has accepted the position of head of the loading and explosive section, Ordnance Department, Cincinnati, Ohio.

RUPERT K. STOCKWELL, formerly western manager, Robins Conveying Belt Company, Salt Lake City, Utah, has assumed the duties of general sales manager of the same company, with headquarters at New York.

CHARLES E. WADDELL has assumed the office of Chief of Conservation for North Carolina, under the United States Fuel Administration.

LIEUTENANT WILLIAM P. HAYES, United States Naval Reserve Force, is now in command of one of the United States vessels on the Asiatic Station.

LIEUTENANT FRANK P. BOYD, U. S. N. R., since the war chief engineer of the U. S. S. *Jupiter*, a 20,000-ton electrically propelled ship, has been stationed as engineer and repair officer, Submarine Base, New London, Conn., and has been promoted to Lieutenant Commander, U. S. N. R.

FRED V. HADLEY, consulting engineer for industrial furnaces, Boston, Mass., has closed his office to become associated with Tate-Jones and Company, of Pittsburgh, with headquarters at 50 Church St., New York.

FRANK MOSSBERG has assumed the duties of vice-president and general manager of the Hooker-Mossberg Corporation, which has recently been organized in the state of Massachusetts to take over a large contract for the manufacture of airplane parts for the Government. The factory is located at Attleboro, Mass.

FRANK C. GIGNOUX has assumed the duties of production expert, Bureau of Aircraft Production, U. S. A., Berkeley, Cal.

CHARLES W. WILLETTE has accepted a position with the California Barrel Company, of San Francisco and Portland, and is engaged in drawing plans for an immense plant comprising a sawmill and barrel factory combined which, when completed, will cover about 60 acres. Mr. Willette's headquarters are in Portland, Ore.

H. HOWARD HELLER has become associated with the Ford Instrument Company, New York, N. Y.

JULIUS ALSBERG has entered the Division of Fats and Oils of the U. S. Food Administration with headquarters at Washington, D. C.

JAMES C. HOBART, with the American Red Cross Ambulance Service in Italy, has been decorated by the Government for meritorious conduct in a recent offensive.

APPOINTMENTS

F. E. MATTHEWS, specializing in mechanical refrigeration, and engaged for several months past in research work of a physico-chemical nature in connection with the commercial development of a new system of refrigeration based on chemical reaction, has accepted an appointment for the duration of the war with the United States Department of Agriculture, Bureau of Markets, with headquarters in New York. He will have to do with the study of cold storage methods and costs to the end of assisting the industry in the establishment of an equitable and uniform basis for determining operating costs of chilling, freezing and carrying various cold storage products under refrigeration.

G. P. SONN has recently been appointed plant engineer of the National Conduit and Cable Company, Hastings, N. Y.

HENRY S. MORSE has been appointed chief engineer of the St. Joseph Lead Company at Herculaneum, Mo.

J. J. SWAN has been appointed Lieutenant-Colonel, U. S. Army, and assigned to the Personnel Branch of the Operations Division, General Staff, Washington, D. C.

A. F. BARNES, Dean of Engineering, New Mexico College of Agriculture and Mechanic Arts, has been appointed by the United States Fuel Administration, administrative engineer for New Mexico.

H. O. C. ISENBERG, formerly assistant factory manager of the Wright-Martin Aircraft Corporation, has been appointed factory manager of the corporation's New Brunswick, N. J., plant.

EMPLOYMENT BULLETIN

THE SECRETARY considers it a special obligation and pleasant duty to make the office of the Society the medium for assisting members to secure positions, by putting them in touch with special opportunities for which their training and experience qualify them, and for helping any one desiring engineering services. The Society acts only as a clearing house in these matters.

POSITIONS AVAILABLE

Stamps should be inclosed for transmittal of applications to advertisers; non-members must accompany applications with a letter of reference or introduction from a member; such reference letter will be filed with the Society records.

DIRECTOR OF WELFARE WORK and general plant coöperation with heads of departments and employees. Location, Middle West. L-0282.

DRAFTSMEN on industrial plant and power-station work. Traveling expenses and salary depending on man: $45 per week. Location, Wilmington, Delaware. L-0662.

MECHANICAL AND SAFETY ENGINEER having two or more years practical shop experience. Must be tactful and able to confer with high executives and Government officials. Excellent opportunity to make wide acquaintance in engineering profession. Salary $1800 to $2500. L-0767.

DRAFTSMAN, with experience in design of medium weight machinery. Responsible man. Steam-engine experience valuable. Pay according to experience and ability. Location, Buffalo. L-0768.

WORKS ENGINEER, technically trained, high class executive, to take charge of architectural and construction departments, complete power equipment, stock storage and transfer problems. Preference given to man with general manufacturing experience in addition to specializing on above problems. L-0770.

HIGH-GRADE MAN to take charge of heat-treating department, Indianapolis firm. Technically-trained man of energy, ambition and executive ability, to take hold of department and make it highly productive both in quality and quantity of work done. Some experience in carbonizing and cyaniding of steels. Fundamental grounding in heat treatment of steels and ability to trace causes through results. Should be capable executive and have genius sufficient to improve plant and equipment conditions. Position one of large opportunities. Salary $250 per month. Location, Indianapolis. L-0771.

INSTRUCTOR in practical mathematics for two or three evenings a week. Practical man preferred. L-0772.

DIRECTOR, toolmakers-apprentice school. Location, Utica, N. Y. L-0773.

MAN with aptitude for writing and engineering training and experience, training preferably in mechanical engineering to include familiarity with power-plant practice. Commercial and selling experience, and originality and interest in technical and commercial developments of advantage. Work can be so arranged that it can be done either largely at desk or combined with certain amount of traveling and interviewing of engineers and business men. Physical inability, interfering with getting about freely, would not necessarily disqualify. State training and experience and if possible send samples of own authorship. L-0774.

ASSISTANT GENERAL MANAGER, manufacturing of automobile parts in the way of transmissions, steering gears, differentials, clutches and controls for automobile trucks and tractors. At present employing 1600 men in factory with floor capacity of about 300,000 square ft. High-grade man with considerable experience in manufacturing and executive work. L-0782.

ENGINEERS AND DESIGNERS, high-grade men for permanent work. L-0784.

DESIGN AND LAYOUT MAN, not over 35, married man preferred. General knowledge of electrical construction with sufficient practical or technical training to lay out well-balanced design, together with knowledge of quantity production. Required for mechanical design of lighting, starting and ignition equipment for internal-combustion engines. Salary up to $175 per month. Location, Indiana. L-0786.

DRAFTSMAN for plant in Jones Point, N. Y. Salary $25 per week with transportation and meals. Prefer experience in chemical or sugar line. Application in hand writing. L-0787.

SALES ENGINEER, to assist with portion of engineering correspondence and problems, requiring man of technical education or training, with view to recommending and selecting proper sizes of ball bearings for various applications to fill requirements of clients. Location, Connecticut. L-0788.

MECHANICAL DRAFTSMEN, two or three for Government work. L-0797.

ENGINEER, competent to take charge of gas-engine plant, consisting of three Smith producers, two Allis-Chalmers engines, direct connected to two Bullock generators of 200-kw. each. Location, New York. L-0803.

TECHNICAL MEN in connection with experimental-engineering department, to determine by time-study method output of each operation; also study of speeds and feeds, to enable rate department to set piece rates. L-0805.

SAFETY ENGINEER, preferably with technical training, to carry on inspection service, education and committee work connected with large corporation. Location, Utica, N. Y. L-0806.

DRAFTSMAN on design-conveying machinery. Location, New York. Salary depends on man. L-0810.

MECHANICAL ENGINEER for engineering division in St. Louis Ordnance District, with considerable experience in machine design and shop practice. Capable of writing comprehensive letters concerning manufacture of ordnance material. Salary about $3000 a year. Desirable that man be familiar with manufacturing conditions of section. L-0813.

ASSISTANT INSTRUCTOR in Lowell Textile School, mechanical drawing, engineering department. Prefer man with some teaching experience. Could use one good draftsman. Salary $25 per week. L-0814.

SALES ENGINEER, age 28 to 35; keen, aggressive, tactful, pleasing personality. One who will not lose sight of engineering principles in desire for trade, willing to build from foundation up. Engineer with selling experience or salesman with engineering knowledge. Knowledge of ball-bearing field desirable. Location, Chicago. Salary $3000 to $4000. L-0815.

CHIEF INSPECTOR, age 35 to 40, electrical and mechanical; resourceful and systematic with organizing and executive ability. Thorough training with considerable practical experience in manufacturing small electrical devices. Knowledge insulating materials and very intricate processes incident to building wire-wound insulated apparatus. Good practical knowledge machine-shop practice, operation, testing and inspection. Location, Indiana. State salary. L-0816.

SHOP MANAGER AND DESIGNER on machine tools, especially engine lathes. State experience in detail during past ten years, capacity for producing results and salary expected. Location, Cincinnati. L-0818.

TWO INSTRUCTORS in mechanical drawing and descriptive geometry. Location, Hoboken, N. J. L-0819.

CHIEF ENGINEER, technical graduate, preferably mechanical; over 30 years of age, with good experience. Wanted for concern making pipe and pipe-bending machinery. Location, Harrisburg, Pa. L-0820.

FIELD INSTRUCTOR in mechanical-engineering extension division University of Wisconsin. Location probably at Milwaukee. L-0821.

YOUNG ENGINEER, at least five years' experience since graduation with operation and maintenance of mechanical equipment; an assistant master mechanic. Salary $250 per month. L-0822.

DESIGNER AND DRAFTSMAN, 30 to 40 years old. Single men preferred. Position permanent; designing ability in gas-engine electrical work of from ½ to 5 kw. capacity. Production is small gas engine electric-direct electric-connected unit. Salary $2400 and up. Headquarters at Dayton, Ohio. L-0823.

GAS ENGINEER, one capable of testing meters, calculating flow of gas, handling all mechanical details connected with gathering and distributing natural gas. Location, Oklahoma. L-0825.

ASSISTANT for material inspection needed. Man versed in actual inspection and tests of boiler tubes, boiler plate, ship plate and structural steel for ships. Essential that applicant be conscientious and absolutely trustworthy. Accuracy in mathematics required and references desired. Salary $175 per month, together with arrangement regarding traveling expenses. L-0827.

MECHANICAL DRAFTSMAN for essential work around furnaces and mines. State age, experience, reference and salary expected. L-0828.

ASSISTANT PURCHASING AGENT familiar with electrical equipment. Must be familiar with purchasing methods to obtain definite promises of delivery, and able to follow these up and see that promises are kept. Salary about $200 per month to start. Location, Middle West. L-0829.

FIRST-CLASS PRODUCTION MANAGER. Capable of supervising clerical record, thoroughly familiar with brass and aluminum foundry methods and machine shop and assembling practice. Department is in charge of handling all orders through factory and keeping machinery and other facilities properly employed, maintaining shipping dates and stock requirements with greatest possible degree of accuracy. Salary $4000 to $4500 per year. Location, Detroit. L-0831.

FACTORY-PLANT ENGINEERS. General manager and assistant general manager for manufacturing paper. Age 25 to 40. Salary $300 per month. Headquarters, Paterson, N. J. L-0832.

ASSISTANT TO ENGINEER in charge of construction work; Government proposition in Southern Jersey. Man familiar with C. E. fundamentals and office work in connection with varied construction. Salary $275. L-0833.

CHEMIST AND METALLURGIST. Foundry work. Salary depends on applicant's ability. Location Middle West. L-0836.

MAINTENANCE ENGINEER. Familiar with machine-shop practice, maintenance, and mechanical engineering. Shop work. Salary depends on applicant's ability. Location Middle West. L-0837.

MECHANICAL ENGINEER, experienced in design of high-grade steam engines and boilers, especially of the marine type. Thoroughly experienced man with good record required, and one able to handle draftsmen. Give age and experience in detail and salary desired. Location, Pa. L-0838.

CHIEF ENGINEER, familiar with design of structural and plate work, hoisting and conveying machinery of the heaviest type. Must have executive ability of highest order. Give age and experience in detail and salary desired. Location, Pa. L-0839.

WORKS MANAGER for plant located in middle west, manufacturing high-grade medium and heavy metal-working machinery. Must be at present similarly employed and have had extensive machine-tool experience, be a good organizer with years of experience in handling men; must be from plant with not less than 600 men under his direction. L-0845.

MEN AVAILABLE

Only members of the Society are listed in the published notices of this section. Copy for notices should be on hand by the 12th of the month, and the form of notice should be such that the initial words indicate the classification. Notices are not repeated in consecutive issues.

MECHANICAL ENGINEER. Age 31, 11 years' experience on maintenance and installation of mechanical and electrical equipment of machine shops, automobile factories, and cotton mills. At present plant engineer of large machine shop employing 3000. Salary $3000. L-283.

SUPERINTENDENT OR CHIEF ENGINEER of power plants or superintendent of plant and factory construction. Specially trained in handling large work in best engineering practice. Ten years' practical experience since graduation from technical school. American, age 33 years, ready to go anywhere. Now employed but can obtain release when necessary. Design, construction, operation, and maintenance of plants a specialty. L-284.

MECHANICAL ENGINEER, technical graduate and associate member, desires position as manager where executive ability is necessary with an extensive knowledge of modern scientific and production management. Held positions of superintendent and factory manager and with consulting industrial engineers. Will consider proposition only where high-grade man is required. Available about January 1. L-285.

MANAGER OR SUPERINTENDENT. Technical graduate; 20 years' experience in the manufacture of machine tools, gasoline engines, and electrical machinery in positions from machinist to manager. Also experienced in equipment of buildings and in use of modern methods in plant management and production engineering. At present superintendent. L-286.

PRODUCTION, EFFICIENCY ENGINEER, 15 years' technical and practical experience covering all branches of manufacturing. Have pleasing personality; six years as executive. At present with one of the largest automotive companies. Desire association with financial business man or promotor requiring man of ability to organize new business or give new life to an old one. Any correspondence must be confidential and proposition high-grade and essential. L-287.

MECHANICAL ENGINEER, age 30, eight years' broad experience. Last four years as chief draftsman on design, construction and maintenance in power plant of large public service company, and still so employed. Desires engineering position with large manufacturing or public utility company. L-288.

PRODUCTION OR PRODUCTION EQUIPMENT ENGINEER, or other responsible position, designing or manufacturing end or both. Salary about $4000. Would like to correspond with party needing self-starting man. Practical mechanic and designer. Experience covers originating, designing, building and operating numerous special and standard automatic and semi-automatic machines for producing wide variety of articles from wire, sheet metals, paper, wood, etc., for assembling, labor saving, processing, conveying, cost reducing, etc.; punches and dies, jigs, fixtures and tools and general engineering routine, cost accounting, bookkeeping, time study and production. Twenty-eight years old, married, with family. Will go anywhere. L-289.

EXECUTIVE, graduate naval architect and mechanical engineer. Member, ten years' broad practical experience in shipbuilding, steel-plate construction, oil engines and special machinery, filling positions of chief draftsman, engineer, works manager and general manager. Available January 1. Salary $5000; familiar with modern accounting, cost keeping, production and manufacturing methods and all phases of plant equipment, maintenance and operation. L-290.

MANAGER, GENERAL SUPERINTENDENT OR SUPERINTENDENT. Industrial engineer, member, American, age 42. Twenty-one years' broad experience covering design, manufacture, construction and operation, appraisal and investigation, cost analysis, purchasing and management, special machinery in manufacturing machine shops, covering engines, boilers, overfeed and underfeed stokers; kilns, dryers and metallurgical furnaces, pumps, condensers, evaporators and distillers; mining, conveying, transmission and process machinery; machine shop, power, water works, cotton-seed oil, cement, hydrated lime and chemical plant design; operation construction and direction during past ten years; at present on large Government plant construction. Seeks responsible permanent connection. Salary minimum $6000 per year to start. L-291.

MECHANICAL ENGINEER with eight years' experience in design and manufacturing. One year experimental and research engineering on rifles and machine guns and small interchangeable parts. Technical graduate. L-292.

SUPERINTENDENT, WORKS MANAGER, PRODUCTION SUPERINTENDENT, shell-forging plants, shipyards, machine or structural shops. Salary $4000 to $5000. Location preferably in the East. L-293.

SALES MANAGER OR SALES ENGINEER. American, 13 years' experience covering designing, construction, manufacturing and selling. Have initiative and ability to get results. At present employed as sales engineer; five years with large manufacturer; desires change about January 1, 1919. L-294.

EXECUTIVE, SALES ENGINEER, highly successful, desires change. Available January 1, 1919. Fifteen years' experience in Eastern territory dealing with executives, managers and consulting engineers almost entirely, and selling with the largest concerns in the country. Graduate mechanical engineer, good correspondent, well connected. Salary and commission preferred. Willing to make a moderate start with the right concern. L-295.

MECHANICAL ENGINEER, associate member, age 36, experienced in design, manufacture, sale and installation of rubber and wire machinery. Can show a successful record for 20 years, last five years as chief engineer of small plant manufacturing above lines. Desires position as chief engineer or chief draftsman of larger plant or as chief engineer of rubber or wire factory. Location East or Middle West. Available on 30 days' notice. Salary $4000. L-296.

WORKS ENGINEER. Graduate mechanical engineer. Thirty-three years old. Three years' shop experience, six years with leading steel-car manufacturing company; three years steel works. Active and energetic. Now employed. Will go anywhere. L-297.

INDUSTRIAL ENGINEER, three and a half years' experience installing scientific management methods. At present connected with prominent engineering concern doing this type of work. Desires position which involves little or no traveling. Age 27, married; available January 1. L-298.

POWER-PLANT ENGINEER, technical graduate, age 32, married; eight years' experience in steam-power plants, recently employed as superintendent of power. At present engaged in war work. Wish permanent position in power-plant operation, design of construction. L-299.

MECHANICAL ENGINEER, American, 23, four years apprentice as machinist in smelter, will graduate from Rensselaer in January. L-300.

CANDIDATES FOR MEMBERSHIP

TO BE VOTED ON AFTER DECEMBER 21

BELOW is a list of candidates who have filed applications since the date of the last issue of THE JOURNAL. These are classified according to the grades for which their ages qualify them, and not with regard to professional qualifications, i.e., the ages of those under the first heading place them under either Member, Associate or Associate-Member, those in the next class under Associate or Associate-Member, those in the third class under Associate-Member or Junior, and those in the fourth under Junior grade only. Applications for change of grading are also posted. The total number of applications listed below is 153.

The Membership Committee, and in turn the Council, urge the members to scrutinize this list with care and advise the Secretary promptly of any objections to the candidates posted. All correspondence in this regard is strictly confidential. Unless objection is made to any of the candidates by December 21, and provided satisfactory replies have been received from the required number of references, they will be balloted upon by the Council.

NOTE. The Council desires to impress upon applicants for membership that under the present national conditions the procedure of election of members may be slower than under normal conditions.

NEW APPLICATIONS

FOR CONSIDERATION AS MEMBER, ASSOCIATE OR ASSOCIATE MEMBER

Alabama

MACGUIRE, JAMES, Chief Inspector, Power Plant Equipment, Air Nitrates Corporation, Muscle Shoals

MIDDLEMISS, GEORGE H., Superintendent, Maintenance and Repairs, Alabama Power Company, Birmingham

PERRY, HARRY M., Southern District Manager, Ingersoll Rand Co., Birmingham

California

HELLERMAN, GEORGE N., Chief Engineer, San Diego Electric R. R., San Diego

KING, PETER M., Mechanical Engineer, General Petroleum Corporation, Vernon

MARDEL, CHARLES M., Chief Engineer, Oakland Antioch & Eastern R. R., Oakland

WILSON, WILLIAM W., Vice-President, Treasurer and Manager, Wilson & Willard Manufacturing Company, Los Angeles

Colorado

WOOLFENDEN, HENRY L., District Manager, Allis-Chalmers Manufacturing Company, Denver

Connecticut

BREITENSTEIN, ALBERT F., Designing Engineer and Chief Draftsman, The Geometric Tool Company, New Haven

BRISTOW, WILLIAM, Mechanical Engineer, Ordnance Department, U. S. A., Remington Arms, Bridgeport

BURNS, ROBERT H., Engineer, Remington Arms Company, Bridgeport

HALLOCK, HENRY E., Equipment Engineer, Marlin-Rockwell Corporation, New Haven

SMITH, PETER L., Superintendent, Power Department, Winchester Repeating Arms Company, New Haven

VAN SCHAACK, DAVID, Director, Aetna Life Insurance Company, Hartford

WOOD, BURTON S., Teacher of Manual Training, Driggs School, Waterbury

Delaware

SWAYZE, WILLIAM W., Mechanical Engineer, Wilmington

District of Columbia

HORWITZ, SAMUEL S., Captain of Engineers, U. S. A., Washington

Illinois

BUHMEYER, CLAUDE H., Assistant Production Manager, Free Sewing Machine Company, Rockford

CURRIER, CHARLES H., Vice-President, Drying Systems, Inc., Chicago

McBRIDE, HERBERT K., Structural & Mechanical Engineer, Wilson & Company, Chicago

PRITCHARD, RALPH W., Engineer Assistant to Manager, The Pullman Company, Pullman

SHAW, ENOS L., Civil Engineer, Chicago

SHUMATE, FRANK D., Mechanical Sales Engineer, Worthington Pump & Machinery Corporation, Chicago

WILSON, ALEXANDER H., Assistant Chief Draftman, Amalgamated Machinery Corporation, Chicago

Indiana

CRAWFORD, CHARLES S., Assistant General Manager and Chief Engineer, Premier Motor Corporation, Indianapolis

SIMS, ERNEST M., Secretary, Treasurer and Factory Manager, Metal Forming Corporation, Elkhart

Iowa

STODDART, FRANK P., Chief Mechanical Engineer, Murray Iron Works Company, Burlington

Maryland

BATHURST, ARTHUR F., Mechanical Superintendent, Crown Cork & Seal Company, Cartridge Manufacturing Division, Baltimore

HERITAGE, ARTHUR M., Engineer, U. S. Army, Edgewood

Massachusetts

AUDET, HERBERT R., Captain, U. S. Government Arsenal, Springfield Armory, Springfield

BRISTOL, BENNET B., Treasurer, The Foxboro Company, Foxboro

BUDLONG, GUY V., Power Engineer, American Steel & Wire Company, Worcester

HALL, WALTER B., Agent, Thorndike Company, Warren Cotton Mills, West Warren

HOOK, HENRY C., General Foreman, Norton Grinding Co., Worcester

KEOUGH, PETER F., General Mechanical Superintendent, Springdale Finishing Company, Canton

MANN, WILLIAM D., Chief Engineer, American Incandescent Heat Company, Roxton

MITCHELL, JOHN H., Plant Engineer, Hamilton Woolen Company, Southbridge

ROCHE, WESLEY C., 1st Lieutenant, Ordnance Department, Watertown Arsenal Production, Watertown

Michigan

HILL, WILLIAM C., Plants Engineer, Northwestern Leather Company, Sault Ste Marie

TAYLER, THERON C., Assistant Mechanical Engineer, Ford Motor Company, Detroit

TURNBULL, JOHN G., Mechanical and Electrical Engineer, Albert Kahn & Associates, Detroit

New Hampshire

FARMER, NOYES D., Supervisor of Costs, Atlantic Corporation, Portsmouth

HARMON, HARRY T., Master Mechanic, The Atlantic Corporation, Portsmouth

New Jersey

BELLER, IGNATIUS, Designing Engineer, Balbach Smelting & Refining Company, Newark

SPILLMAN, MAX, Works Engineer, Henry R. Worthington, Harrison

WHITNEY, OSCAR C., Engineer, Pintsch Compressing Company, Jersey City

New York

BAILEY, RAYMOND C., Expert Aid, Electrical and Mechanical, Public Works Department, New York Navy, New York

DICKINSON, JOSEPH H., Engineer and Manager, Logging Machinery Department, Lidgerwood Manufacturing Company, New York

HOFFMAN, WILLIAM H., Mechanical Engineer, Ford, Bacon & Davis, New York

LOGAN, WILLIAM, SR., Superintendent, James Stewart & Company, New York

McLEAN, EMBURY, Treasurer and Chief Engineer, The Engineer Company, New York

PFARRE, EDGAR G., Chief Engineer, George Tiemann & Company, New York

SEXTON, FRANK B., Manager of Sales, Van Blerck Motor Company, New York

SPRAGUE, LUCION C., Assistant Secretary and District Manager, Chicago Pneumatic Tool Corporation, New York

STORER, HARRY D., District Manager, New York City, Kerr Turbine Company, Wellsville

WAGNER, JULIUS H., Proprietor, Sheet Metal Contracting Business, Brooklyn

WEARIN, FRANK W., Engineer, Selson Engineering Company, New York

WILSON, JAMES A., Lieutenant, Naval Overseas Transportation Service, U. S. A., New York

Ohio

CAIN, JOHN N., Locomotive Engineer, Ashtabula

FISHBOUGH, HARRY E., Mechanical Engineer, The Hoppers Manufacturing Company, Springfield

MARSH, EDWARD L., Vice-President and Treasurer, The Bay View Foundry Company, Sandusky

SPROULL, JOHN C., Balloon Engineer, The B. F. Goodrich Company, Akron

Pennsylvania

BINZ, GUSTAV A., Sales Manager, Yarnall-Daring Company, Philadelphia

BRAEMER, WM. G. R., Consulting, Air Conditioning and Industrial Engineer, Philadelphia

KING, ALVIN W., Sales Manager, Nelson Valve Company, Philadelphia

RUSHTON, KENNETH, Chief Mechanical Engineer, The Baldwin Locomotive Works, Philadelphia

UZELMEIER, WILLIAM, Assistant Chief of Engineering Department, Harrison Safety Boiler Works, Philadelphia

WAGNER, CLYDE A., Construction Engineer, The Barrett Company, Philadelphia

WEBSTER, HOWARD J., Consulting Engineer, President, Uniflow Boiler Company, Philadelphia

Rhode Island

BIGELOW, FRED C. JR., Mechanical Superintendent, River Spinning Company, Philipsdale

STAHL, NICHOLAS, General Engineer, Narragansett Electric Lighting Company, Providence

Texas

PRATT, CLARENCE E., Consulting Engineer, Seymour

Wisconsin

CAHILL, CHARLES A., Administrative Engineer, Wisconsin Federal Fuel Administration, Milwaukee

Canada

FROST, EDGAR R., Mechanical Superintendent, Metals Chemical, Ltd., Welland, Ontario

McROBERT, WILLIAM M., Manager, Galt Foundry Company, Ltd., Galt, Ontario

ROBERTS, THOMAS L., Consulting Mechanical and Marine Engineer, Winnipeg

Cuba

CAMP, LEE G., Chief Engineer, Cuba Cane Sugar Corporation, Habana

Federated Malay States

SCOTT, JOHN MURRAY, Engineer, Nova Scotia Estate, Perak

FOR CONSIDERATION AS ASSOCIATE OR ASSOCIATE-MEMBER

California

O'NEILL, Paul A., Superintendent, Union Machine Company, San Francisco

Illinois

HOFSTETTER, Robert, Mechanical Engineer, Illinois Tool Works, Chicago

New York

BURNS, Raymond W., Estimator, Watervliet Arsenal, Watervliet

Ohio

KLEMIN, Alexander, 2nd Lieutenant, in charge Aeronautic Research Section, A. E. D. McCook Field, Dayton

RYDER, James C., Aeronautical Mechanical Engineer, Bureau of Aircraft & Production, Dayton

Pennsylvania

REIBER, Harry P., Mechanical Engineer, Oil Well Supply Company, Pittsburgh

Texas

SCHMAUDER, Walter G., Superintendent of Power, Texas Power & Light Company, Dallas

Wisconsin

SHUTE, Robert L., Works Engineer, The Albert Trostel & Sons Company, Milwaukee

FOR CONSIDERATION AS ASSOCIATE-MEMBER OR JUNIOR

Illinois

DIBBLE, Claude M., Erecting Engineer, Shell Division, Pullman Company, Pullman

WALTERS, Russell J., Tool Designer, Ordnance Department, Rock Island Arsenal, Rock Island

Maryland

KERR, George M., 1st Lieutenant, C. W. S., U. S. Army, Edgewood Arsenal, Edgewood

Massachusetts

HOWARD, Stanley R., 1st Lieutenant, Ordnance Department, U. S. A. Watertown Arsenal, Watertown

Michigan

CHATFIELD, Victor M., Chief Engineer, Bostaph Engineering Corporation, Detroit

New Jersey

BAKER, Edward, Superintendent Webb Wire Works, New Brunswick

GESELL, William H., General Manager, Hamersley Manufacturing Co., Garfield

OLSON, Oscar W., Leading Draftsman, Stationary Drafting Department, Babcock & Wilcox Company, Bayonne

New York

MILLER, Ralph, Erecting and Service Engineer, De La Vergne Machine Company, New York

PAGE, George A., Chief in Charge of Patent Department, also Auxiliary Engineer Mechanical Division, Bausch & Lomb Optical Company, Rochester

TITTERINGTON, Morris M., Chief Engineer, Aircraft Section, Sperry Gyroscope Company, Brooklyn

Ohio

DAY, Alfred C., Captain, Chemical Warfare Service, U. S. A., Chillicothe

McHUGH, Edwin C., Consulting Engineer, Cincinnati

VERKAMP, Walter F., Secretary and Engineer, The Ohio Electrolytic Oxygen Company, Cincinnati

Pennsylvania

CUSHMAN, Paul A., Assistant Professor of Mechanical Engineering, Penn State College, State College

PETTY, John, President and General Manager, Lebanon Boiler Works, Lebanon

Wisconsin

BERKELEY, Lawrence J., Vice-President and Chief Engineer, Hercules Manufacturing Company, Racine

France

GOSS, Leonard K., 1st Lieutenant, Ordnance, U. S. A., American Expeditionary Forces

VAN WYCK, Philip S., 2nd Lieutenant, c/o Co. A, 67th Engineers, American Expeditionary Forces

FOR CONSIDERATION AS JUNIOR

Connecticut

ATHERTON, Russell, Chief Machinist Mate, U. S. Naval Experimental Station, New London

DUPONT, Andrew T., Machinery Scientific Section, Lake Torpedo Boat Co., Bridgeport

RICE, Kenneth A., Ensign, U. S. N. R. F., Naval District Base, New London

Delaware

ANDERSON, Walter C., Engineer, The Continental Fibre Company, Newark

SMITH, Malcolm H., Designer, E. I. DuPont de Nemours & Company, Wilmington

District of Columbia

FARDELMANN, John H. Jr., Mechanical Draftsman, Engineering Bureau, War Department, Washington

MATHER, Thomas H., Ship Draftsman, Bureau of Construction & Repair, Washington

OLIPHANT, Abner C., Assistant Head, Gauge Branch, Inspection Division, Ordnance Department, U. S. A., Washington

STIRLING, Harry H., Lieutenant, U. S. Navy, Bureau of Steam Engineering, Washington

Illinois

CONZELMAN, J. Wilson, Assistant to District Steam Engineer, American Steel & Wire Company, Waukegan

TOBEY, Tom, Assistant Boiler House Foreman, Corn Products Refining Company, Argo

Maryland

PECK, Winfield F., Supervisor of Air Brakes, Baltimore & Ohio R. R., Baltimore

Massachusetts

ARONSON, Mark, Mechanical Section, Boston Navy Yard, Boston

SCHLICHTER, Louis R., Draftsman and Designer, Navy Yard, Boston Hull Division, Boston

WIESNER, Maurice W., Supervising Engineer of Test, Inspection Division, Ordnance Department, Boston

Michigan

PETERSON, Paul J., Assistant Chemist, Henry Ford & Son, Dearborn

New Jersey

ANTHONY, Sidney R., Machinists Mate, U. S. Navy, Hackensack

HOOT, Harold T., Mechanical Engineer, Oxweld Acetylene Company, Newark

New York

BASSETT, Gerald L., Chief Draftsman, Savage Arms Corporation, Utica

BERBERICK, John R., Draftsman, United Gas & Electric Engineering Corporation, New York

BURRILL, Harold G., Chief Engineer, Utica Gas & Electric Company, Utica

LO, Ying Chun, Calculator, American Locomotive Company, Schenectady

MING, Frederick W., Instructor of Mechanical Engineering, Polytechnic Institute of Brooklyn, Brooklyn

POSNACK, Emanuel R., Assistant to Production Engineer, Standard Shipbuilding Corporation, Shooters Island

Ohio

BROWN, Robert H., Engineer in charge of materials testing, Airplane Engineering Department, U. S. A., McCook Field, Dayton

Pennsylvania

LYNCH, Frank M., Hull Engineer, Bethlehem Shipbuilding Corporation, Bethlehem

WEISCOPF, Marcus W., Assistant Aeronautical Mechanical Engineer, Naval Aircraft Factory, Philadelphia

WOLF, Morris, Designer, H. Koppers Company, Pittsburgh

Virginia

RAMSEY, Alexander M., Mechanical Draftsman, Mathieson Alkali Works, Saltville

Wisconsin

NEKRASOFF, Alexis M., Draftsman in Maintenance Department, Allis-Chalmers, Milwaukee

Porto Rico

FIOL, Ignacio, Assistant Engineer, Fortuna Sugar Factory, Fortuna

CHANGE OF GRADING
PROMOTION FROM ASSOCIATE

Connecticut

MERKT, G. A., Chief Engineer, The American Tube & Stamping Company, Bridgeport

PROMOTION FROM ASSOCIATE-MEMBER

Connecticut

CARTER, Oscar S., Mechanical Engineer, Connecticut Light & Power Company, Waterbury

Illinois

DANIELS, George C., Mechanical Engineer, Central Illinois Light Company, Peoria

New York

MILLETT, Kenneth B., Assistant General Engineer, American Thread Company, New York

Pennsylvania

BACHMAN, B. B., The Autocar Company, Ardmore

PROMOTION FROM JUNIOR

California

GARRETT, John A., Mechanical Engineer, Fairbanks Morse & Company (Reinstatement), Los Angeles

Connecticut

ELIN, Michael B., Engineer, Colt's Patent Fire Arms Manufacturing Company, Meriden

District of Columbia

SCHLINK, Frederick J., Associate Physicist, Bureau of Standards, Washington

Illinois

GATELY, William A., 1st Lieutenant, Ordnance Department, U. S. A., Rock Island Arsenal, Rock Island

PARSONS, Harry N., Sales Engineer, U. S. Ball Bearing Manufacturing Company, Chicago

New York

ESTABROOK, Mansfield, Captain, Ordnance Department, U. S. A. Inspector of Ordnance, Remington Arms Union Metallic Cartridge Company, Ilion

JONES, Russell C., Vice-President, The Griscom-Russell Company, New York

KENT, Robert T., Supervising Engineer, Meyer, Morrison & Company, Inc., New York

Ohio

JEHLE, Ferdinand, Service Engineer, The Aluminum Castings Company, Cleveland

Rhode Island

FISHER, Howard C., Manager, Engineering Department, Frank A. Sayles, Pawtucket

Virginia

HENLEY, Earl K., Lieutenant, U. S. N. R. F., U. S. S. Jupiter, Norfolk

SUMMARY

New Applications	136
Applications for change of grading	
Promotion from Junior	11
Promotion from Associate-Member	5
Promotion from Associate	1
Total	153

SELECTED TITLES OF ENGINEERING ARTICLES

The section Selected Titles of Engineering Articles comprises an index to current articles on mechanical engineering and related subjects.

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Chief attention is paid to articles directly concerned with the branches of mechanical engineering. When it is thought they will be of interest or value to mechanical engineers, however, other articles are listed, in the realms of physics and chemistry; civil, mining and electrical engineering, technology, etc.; and in subjects in broadly related fields such as training and education, safety engineering, fire protection, employment of labor, welfare work, housing, cost keeping, patent law, public relations, etc. Cross-references are introduced and where the titles themselves are not sufficiently descriptive, explanatory sentences are appended. The main abbreviations used in the items are given at the bottom of page 1096.

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ACCOUNTING

Highways

Classification of Expenditures for Highway Cost Accounting. Good Roads, vol. 16, no. 19, Nov. 9, 1918, pp. 178-180. Outline of system proposed in recent publication of Office of Public Roads and Rural Engineering.

Handling Materials

Coke Loading Tipples in the Municipal Gas Works at Düsseldorf (Die Koksverladebrücke des Stadtischen Gaswerkes Düsseldorf). Journal für Gasbeleuchtung, year 61, no. 10, Mar. 9, 1918, p. 117, 1 fig.

AERONAUTICS

Aerostatics

Military Aerostatics, H. K. Black. Aerial Age, vol. 8, no. 4, Oct. 7, 1918, p. 169, 1 fig. Observation balloon in Navy. (Continuation of serial.)

Altitude Flight

The Flight of an Aeroplane at Different Altitudes, Louis de Bazillac. Translated from original French by B. Bruce-Walker Flight, vol. 10, no. 30, July 25, 1918, pp. 836-837, 4 figs. The logarithmic diagram-formulae for resistance and total lift for unit speed. (Concluded.)

Atlantic Flight

Atlantic Flight, M. A. S. Riach. Times Eng. Supp., no. 528, Oct. 1918, p. 216. Analysis of possibility of constructing an aeroplane capable of making journey in single flight.

British Aeroplanes

The Sopwith Camel Flight, vol. 10, no. 37, Sept. 12, 1918, pp. 1019-1022, 14 figs. Description of machine (F. 1. B. 6290) built by Sopwith Aviation Co. Translated from German paper. Also in Aviation, vol. 5, no. 6, Oct 15, 1918, pp. 361-362, 6 figs.)

Engineers, Aeronautical

The Education of Aeronautical Engineers Aeronautics, vol 15, no. 250, July 31, 1918, p. 96 Account of work being done in France

Engines

The 180-hp. Mercedes Aircraft Engine. Automotive Ind., vol. 39, no. 11, Sept 12, 1918, pp. 153-156, 9 figs. Fuel test results and table of data of development of 160-hp model, having same cylinder dimensions, compression increased and details redesigned.

The Design of Airplane Engines (VI), John Wallace. Aeronautics, vol. 15, nos. 253, 254, 256, 257, 258, 259, Aug. 21, 28, Sept. 11, 18, 25, Oct. 2, 1918, pp. 163-164, 4 figs. 200-202, 1 fig., 236-238, 5 figs., 267-269, 7 figs., 295-297, 9 figs., 317-320, 15 figs. Aug. 21: Torque reaction; side-thrust upon cylinder walls; Désaxé cylinder; Aug. 28; weight/power ratio; weight/cylinder capacity ratio; rotary motor; power/cylinder capacity ratio; weight/power ratio; mean effective pressure; Sept. 11: Volumetric efficiency; pumping losses; gas velocity; speed of revolution, effects of increased inertia forces; piston speed; speed of propeller shaft; cylinder dimensions; stroke to bore ratio; Sept. 18: Cylinder design; objections to cast cylinders; example of side-valve cylinder; overhead valve cylinder construction; valve ports; valve guides; Sept. 25: Construction and mounting of cylinders; water jackets; colonnette bolts; strength of cylinders; 160-hp. Benz cylinder; Mono Gnome cylinder; detachable cylinder heads; Oct. 2: Poppet valves; materials for valves; proportions of valves; operation of slide valves; valve springs; operation of overhead valves; Beardmore gear; camshafts; openings and timing valves.

The 300-hp. Maybach Engine. Flight, vol. 10, nos. 35, 37, 38, Aug. 29, Sept. 12, Sept. 19, 1918, pp. 962-965, 10 figs., 1031-1035, 12 figs., 1059-1063, 12 figs. Aug. 29: General features; details of cylinder, pistons, gudgeon pins, and floating small-end bushes. Issued by Tech. Dept., Aircraft Production, Ministry of Munitions; Sept. 12, Propeller hub; lubrication, crankcase ventilation; constructional details of oil pumps; Sept. 19, carburetors; resistance test; atomization test; petrol pump; delivery tests; starting gear. Issued by Tech. Dept. Aircraft Production Ministry of Munitions. Also published in Aeronautics, vol. 15, no. 255, Sept. 4, 1918, pp. 216-223, 15 figs.; Engineer, vol. 126, no. 3271, Sept. 6, 1918, pp. 194-196; 9 figs.; Aviation, vol. 5, nos. 6 and 7, Oct. 15, 1918, pp. 357-360, 10 figs., and Nov. 1, 1918, pp. 429-433, 13 figs.

French Aeroplanes

The French A. R. Biplane with 190-hp. Renault Motor. Flight, vol. 10, no. 38, Sept. 19, 1918, pp. 1053-1057, 12 figs. Description of machine (translated from German paper). Also in Aviation, vol. 5, no. 7, Nov. 1, 1918, pp. 423-424, 7 figs.

German Aeroplanes

German Airplane Albatros D. V. (Avion allemand Albatros D. V.) L'Aérophile, year 26, nos. 13, 14, July 1-15, 1918, p. 203, 3 figs. Scheme and dimensions.

New German Airplanes (Nouveaux avions allemands). L'Aérophile, year 26, nos. 13, 14, July 1-15, 1918, pp. 199-201, 6 figs. General characteristics of Pfalz D III, Fokker D VII, Halberstadt CII, and Riesenflugzeuge.

Report on the A. E. G. Armored Aeroplane, J. G. Weir. Aeronautics, vol. 15, no. 255, Sept. 4, 1918, pp. 212-214, 12 figs. Issued by Tech. Department, Aircraft Production, Ministry of Munitions. Also in Engineer, vol. 126, no. 3271, Sept. 6, 1918, pp. 206-207, 11 figs.; Aviation, vol. 5, no. 6, Oct. 15, 1918, pp. 367-368, 3 figs.; Flight, vol. 10, no. 35, Aug. 29, 1918, pp. 969-972, 15 figs.

Report on the Hannoveraner Biplane. Aeronautics, vol. 15, no. 256, Sept. 11, 1918, pp. 239-245, 21 figs. Particulars of enemy machine. By Technical Department, Aircraft Production, Ministry of Munitions.

Report on Two-Seater Rumpler Biplane, C 117 Aeronautics, vol. 15, no. 256, Sept. 11, 1918, pp. 245-249, 22 figs. Details of enemy machine using 260-hp. Mercedes engine. By Technical Department, Aircraft Production, Ministry of Munitions. Also in Flight, vol. 10, no 37, Sept. 12, 1918, pp. 1025-1030, 25 figs

Some Fokker "Milestones." Flight, vol. 10, no. 35, Aug. 29, 1918, pp. 966-967, 8 figs. Development of Fokker firm since outbreak of war.

The German Airplane, Pfalz D. III. (L'avion allemand Pfalz D. III.) L'Aérophile, year 26, nos. 13, 14, July 1-15, 1918, pp. 193-198, 6 figs. Details of planes, tail, fuselage, motor and armament.

The Pfalz Single Seater Fighter (II). Automotive Ind., vol. 39, nos. 11 and 12, Sept 12 and 19, 1918, pp. 462-463, 3 figs., and 503-505, 6 figs. Mounting of tail plane, tail skid, vertical fin and rudder and construction of these parts. Sept. 19: Seating arrangement—aileron, elevator, rudder controls; landing gear. (From Flight.) Also in Engineer, vol. 126, no. 3274, Sept. 27, 1918, pp. 270-272, 16 figs.

The Zeppelin Giant Airplane. Aviation, vol. 5, no. 6, Oct. 15, 1918, pp. 365-367, 6 figs. Wire-bracing; ailerons; vertical fins and rudders; internal arrangements; armament; undercarriage, controls; weight items. (Concluded.)

Model Aeroplanes

Model Aeroplane Building as a Step to Aeronautical Engineering. Aerial Age, vol. 8, no. 4, Oct. 7, 1918, p. 181, 10 figs. Construction of a 20-ft. glider. (Continuation of serial.)

Model Aeroplanes (XV), F. J. Camm. Aeronautics, vol. 15, no. 253, Aug. 21, 1918, p. 176, 1 fig. Rudiments of aerofoil theories. (To be continued.)

Performance, Aeroplane

Airplane Performance Determined by Engine Performance, G. B. Upton. Jl. Soc. Automotive Engrs., vol. 3, no. 4, Oct. 1918, pp. 275-279, 3 figs. Curves showing altitude against engine speed for various efficiencies and speed ratios, also curves showing engine and propeller power at different altitudes and ceiling height for conventional and theoretical constant power engine.

Propellers

Air Propeller Performance and Design by the Specific Speed Method, M. C. Stuart. Practical Engr., vol. 58, no. 1648, Sept. 26, 1918, pp. 148-150, 3 figs. Rotational speed and diameter of propeller being expressed in terms of power and forward velocity, a direct method of treatment obtained. (To be continued.)

Research

British Advisory Committee Report for 1917-1918. Aviation, vol. 5, no. 6, Oct. 15, 1918, pp. 368-370. Account of experimental work at National Physical Laboratory in aerodynamics and strength of construction.

The National Physical Laboratory Report, 1917-1918. Aeronautics, vol. 15, no. 255, Sept. 4, 1918, pp. 226-227. References to aeronautical work.

Third Annual Report of the National Advisory Committee on Aeronautics. Aerial Age, vol. 8, no. 4, Oct. 7, 1918, pp. 174-175. Board of war inventions in aeronautics; metric system for drawings and calculations; technical reports; general problems and activities. (Continuation of serial.) Also in Aeronautics, vol. 15, no. 256, Sept. 11, 1918, pp. 250-253.

Stresses in Structure

Stresses in Airplane Ribs, Irving H. Cowdrey. Aviation, vol. 5, no. 7, Nov. 1, 1918, pp. 425-428, 5 figs. Transverse testing under non-uniformly distributed load with special application to airplane wing ribs. Before Am. Soc. for Testing Materials.

The Stresses in a Fuselage in Torsion, H. A. Webb. Aeronautics, vol. 15, no. 250, July 31, 1918, pp. 105-106, 4 figs. Method of approximation based on assumption that wires are initially unstretched and torsion is carried entirely by wires, the struts and longerons merely holding them in position.

Trajectory, Aeroplane

Trajectory of Airplane Equipped with a Fuselage. (Trajectoire de l'aéroplane à nacelle), L. Farand, L'Aérophile, year 26, nos. 13 and 14, July 1-15, 1918, pp. 204-208, 12 figs. Mathematical computation of hodograph based on assumption that the angle of the planes with the trajectory remains constant and that the force of propulsion remains always horizontal.

See also Engineering Materials (Aeroplane Fabrics); Internal-Combustion Engineering; Standards and Standardization (Aircraft Materials); Wood (Aeroplane Woods).

AIR MACHINERY

Air Supply to Boiler Room

The Air Supply to Boiler Rooms, Richard W.

Allen. Engineer, vol. 126, no. 3271, Sept. 6, 1918, pp. 198-199, 10 figs. Considering chiefly air supply to closed stokeholds. Paper before Instn. of Naval Architects, March 1918.

Blowers

Blower for Water-Tube Boiler Plant at Bristol Electricity Works. Engineering, vol. 106, no. 2744, Aug. 2, 1918, pp. 126. 13 figs. Drawings of boiler and blower arrangements.

Compressed Air

The Use of Compressed Air (l'emploi de l'air comprimé), M. C. F. Bernard. L'Echo des Mines, no. 2594, Oct. 6, 1918, pp. 507-508. Disposal of water of condensation collecting in compression chamber and conduits.

Wind Power

Some Long Island Windmills, Edward P. Buffet. Am. Mach., vol. 49, no. 16, Oct. 17, 1918, pp. 725-729, 10 figs. Illustrated description of century-old grist mills.

Utilization of Wind Power (Om Udnyttelse af Vindkraften), H. C. Vogt. Ingeniren, year 27, no. 79, Oct. 2, 1918, pp. 521-522.

See also Internal-Combustion Engineering (Gas Engines).

BRICK, CLAY AND STONE

Abrasion Test

Abrasion Test for Mineral Aggregates, H. H. Scofield. Good Roads, vol. 16, no. 12, Sept. 21, 1918, pp. 108 and 110. Suggested modification of Deval test for stone, gravel and similar materials.

See also Testing and Measurements (Sand); Power Generation and Selection (Quarry).

BRIDGES

Concrete Bridges

Recommended practice for Concrete Bridge Construction. Cement & Eng. News, vol. 30, no. 8, Aug. 1918, pp. 30-34, 2 figs. General specifications, prepared by engineers of Portland Cement Assn., based on recommendations of committee on Bridges of Am. Concrete Inst. and on parts of Bul. no. 10 of Illinois State Highway Department, a Manual for County Superintendents of Highways, Resident Engineers, and Inspectors.

Recommended Practice in Design and Construction of Permanent Highway Bridges of Concrete and Steel, John W. Towle. Mun. & County Eng., vol. 55, no. 4, Oct. 1918, pp. 144-145. Features of three types: flat slabs or box culverts, girder with two or more heavy stringers; circular or elliptical bridge.

Standard Practice in Concrete Bridge Construction, H. Colin Campbell. Eng. & Cement World, vol. 13, no. 6, Sept. 15, 1918, pp. 11-16, 6 figs. Considerations to determine suitable type of highway bridge for a given location.

Old Bridges

Investigating Old Bridges for Heavier Loading, C. F. Loweth. Ry. Age, vol. 65, no. 17, Oct. 25, 1918, pp. 741-745, 1 fig. Abstract of paper at convention of Am. Ry. Bridge & Building Assn., Chicago, Oct. 1918.

Quebec Bridge

The New Quebec Bridge. Engineering, vol. 106, no. 2750, Sept. 13, 1918, pp. 237-281, 23 figs. A fully illustrated account.

Trunnion Bearing

Repairing a Bascule Bridge Trunnion Bearing. Ry. Age, vol. 65, no. 18, Nov. 1, 1918, pp. 771-772, 3 figs. To insert a new bushing it was necessary to lift an entire span, weighing about 800 tons.

BUILDING AND CONSTRUCTION

Dams

Dams for $20,000,000 Miami Conservancy. Contracting, vol. 7, no. 9, Nov. 1, 1918, pp. 276-277, 5 figs. Construction of earth embankments containing up to 4,000,000 yd. with excavated material transported on cars, dumped into sumps, and pumped to place.

Foundations

Reconstructing Foundations of Philadelphia City Hall (II). Contracting, vol. 7, no. 9, Nov. 1, 1918, pp. 271-272, 3 figs. Replacement of rubber footings by heavy concrete sectional construction built in sheeted pits 6 ft. long.

Integral Forms

Concrete Construction with Integral Forms. Contracting, vol. 7, no. 9, Nov. 1, 1918, pp. 273-274. Utilization of elements of permanent structure eliminating steel and wood temporary forms.

Masonry Building

Guatemala Earthquakes Destroyed All Masonry Buildings, Edward Stuart. Eng. News-Rec., vol. 81, no. 14, Oct. 3, 1918, pp. 623-626, 8 figs. Wood and concrete frames stood shocks well; wrecked sanitary services to be rebuilt under direction of Red Cross engineers.

Piers

Building B. & O. R. R., Pier No. 9, Baltimore. Contracting, vol. 7, no. 9, Nov. 1, 1918, pp. 274-275, 3 figs. Replacement of 160 x 850 ft. burned pier and freight house.

The Furness-Withy Company Reinforced Concrete Pier at Halifax, N. S., A. F. Dyer. Contract Rec., vol. 32, no. 35, Aug. 28, 1918, pp. 692-695, 5 figs. Work being done in construction of a pier 590 ft. long by 90 ft. wide, carrying a single-story shed 514 ft. by 70 ft.

Shops

New Shop of Standard Steel Car Company. Ry. Rev., vol. 63, no. 13, Sept. 28, 1918, pp. 465-467, 9 figs. Designed for rapid erection to meet war needs; cost of construction; details of plans.

Tanks

Advice on Oil-Storage Tanks. Petroleum Rev., vol. 39, no. 836, July 27, 1918, p. 60. Manufacture of reinforced concrete tanks; expansion joints. From U. S. Bureau of Mines Bul. (Concluded)

Tank Construction (XXI), Ernest G. Beck. Mech. World, vol. 64, no. 1651, Aug. 23, 1918, pp. 90-91, 5 figs. Formulae and diagrams; side walls of rectangular tanks.

Tower Erection

Some Practical Points in Pole and Tower Erection and Support, Charles R. Harte. Elec. Ry. Jl., vol. 52, no. 12, Sept. 21, 1918, pp. 490-494, 11 figs. Particular reference to erection in marshy ground and the procedure in raising steel towers of different types.

Wind Pressure, Chimneys

Wind Pressure on Tall Chimneys. Engineering, vol. 106, no. 2752, Sept. 27, 1918, pp. 334-336, 8 figs. Observations of Professor Omori on movement to which top of a chimney is subjected by wind pressure; chimney in question is 567 ft. high.

Compression Load

The Coefficient of Safety of Reinforced and Non-reinforced Concrete Bodies Subject to Centrally and Excentrically Applied Compression Loads (Über den Sicherheitsgrad von Bewehrten und unbewehrten Betonkörpern, die auf zentrischen und exzentrischen Druck beansprucht werden), C. Bach and D. Graf. Armierter Beton, year 11, no. 5, May 1918, pp. 84-90, 4 figs. (To be continued.)

See also Wood (House Finish).

CEMENT AND CONCRETE

Cold Weather

Placing Concrete in Cold Weather. Ry. Signal Engr., vol. 15, no. 216, Sept. 1918, pp. 329-330. Rules for preparing concrete mixtures and means to protect them when freshly placed during periods of cold weather. (Portland Cement Assn. of Chicago.)

See also Railroad Engineering, Steam (Ties).

Disintegration

See Harbor Works.

Floors

On the Distribution of the Energy Stored in Reinforced Concrete Beams and Column-Supported Flat-Slab Floors, Henry T. Eddy. Jl. Franklin Inst., vol. 186, no. 4, Oct. 1918, pp. 439-448. Analytical interpretation of results obtained in 333 tests carried out by United States Bureau of Standards described in tech. paper 2.

Harbor Works

Reinforced Concrete in Harbor Works, A. F. Dyer. Can. Engr., vol. 35, no. 13, Sept. 26, 1918, pp. 277-284 and 289, 11 figs. Causes of disintegration or disruption and means of preventing them; description of two structures. Before Eng. Inst. of Can.

Paving

Concrete for Level Slope Paving. Eng. & Cement World, vol. 13, no. 6, Sept. 15, 1918, pp. 21-22, 9 figs. Results obtained in 500,000 acres reclamation project in Little River Drainage District, Mo.

Piles

Supporting Power of Concrete Pedestal Piles, Henry W. Young. Eng. & Cement World, vol. 13, no. 6, Sept. 15, 1918, pp. 17-19, 3 figs. Methods of forming and results achieved in various soil conditions.

Sections

A Note on the Determination of Excentrically Loaded Concrete Sections (Beitrag zur Bestimmung exzentrisch belasteter Eisenbetonquerschnitte), H. Paeplou. Armierter Beton, year 11, no. 5, May 1918, pp. 90-96, 2 figs.

Determination of Cross Sections of Concrete under One-Sided Compression or Tension with or without Consideration of Tensile Strength of the Concrete (Bestimmung einseitig gedrückter oder gezogener Eisenbetonquerschnitte ohne und mit Berücksichtigung der Betonzugfestigkeit), E. Elwitz. Beton u. Eisen, year 17, nos. 7-8, May 4, 1918, pp. 84-86, 3 figs.

Setting Process

The Mechanism of the Setting Process in Plaster and Cement, Cecil H. Desch. Sci. Am. Supp., vol. 86, no. 2232, Oct. 12, 1918, pp. 234-235. Attempts to examine two hypothesis and evidence induced in their support, and to indicate the nature of observed discrepancies.

CHEMICAL TECHNOLOGY

Alcohol

Manufacture of Ethyl Alcohol from Wood Waste. Engineer, vol. 126, no. 3271, Sept. 6, 1918, pp. 204-205, 1 fig. Historical resumé; description of present process; economic considerations; uses of ethyl alcohol.

Ammonia

Enormous Quantities of Ammonia Soon Available. Gas Age, vol. 13, no. 7, Oct. 1, 1918, pp. 317-318. Prospect of yield from Government synthetic plants.

The Oxidation of Ammonia, J. R. Partington. Jl. Soc. Chem. Ind., vol. 37, no. 17, Sept. 16, 1918, pp. 337R-338R, 1 fig. Form of technical converter unit for oxidation by passing ammonia and air over a heated catalyst.

Ammonium Sulphate

The New Plant at the Värta Gas Works in Stockholm, Sweden, for the Production of Ammonium Sulphate and Spirit of Salmiac (Die Neuanlagen auf dem Värtagaswerk in Stockholm zur Herstellung von schwefelsaurem Ammoniak und Salmiakgeist), O. Thümmel. Journal für Gasbeleuchtung, year 61, nos. 18 and 19, May 4 and 11, 1918, pp. 205-210, 14 figs., and pp. 217-220, 2 figs.

Atomic Weights

Revisions of Atomic Weights in 1917 (Les révisions de poids atomiques en 1917), E. Moles. Journal de Chimie Physique, vol. 16, no. 3, Sept. 16, 1918, pp. 350-376. Methods followed and results obtained in each of ten reports; list of publications on subject published in that year.

Boiling Points

Considerations on the Causes for Abnormal Boiling Points. (Considérations sur les causes des points d'ébullition anormaux), A. Berthoud. Jl. de Chimie Physique, vol. 16, no. 3, Sept. 15, 1918, pp. 245-278. Analytical research of influence of molecular association in causing the existence of abnormal boiling points with remarks on Forcrand's experiments with H_2O, ammonia and fluorhydric acid.

Copper Carbonates

The Basic Carbonates of Copper, H. Barratt Dunnicliff and Sudarshan Lal. Jl. Chem. Soc., vols. 113 and 114, no. 671, Sept. 1918, pp. 718-722. Examination of a number of samples of commercial copper carbonate showing that the statement that it has same composition as malachite is erroneous; attempt to prepare a basic copper carbonate of approximately constant composition from pure materials.

Explosives

Methods for Routine Work in the Explosives Physical Laboratory of the Bureau of Mines, S. P. Howell and J. E. Tiffany. Department of the Interior, Bureau of Mines, tech. paper 186, 63 pp., 15 tables. Precautions to be observed in storing, handling, and testing explosives; physical examination; tests with ballistic pendulum; tests in gas-and-dust gallery; rate of detonation by Mettegang recorder; conversion tables used in explosive work; list of publications.

Gasoline

Petrol From Your Own Well Gas. Petroleum World, vol. 15, no. 216, Sept. 1918, pp. 371-378, 4 figs. Facts about recovery of gasoline from natural gas by compression and refrigeration; plan of typical direct-connected compressor plant, coils and tower.

Substitute for Lamp Gasoline (Lampenbenzinersatz), A. Krieger. Journal für Gasbeleuchtung, year 61, no. 19, May 11, 1918, pp. 220-221, 1 fig.

Glass

The Significance of Glass-Making Processes to the Petrologist, N. L. Bowen. Sci. Am. Supp., vol. 86, no. 2231, Oct. 5, 1918, p. 221, 1 fig. Processes of manufacturing optical glass and factors making for inhomogeneity in glass. From Jl. of Wash. Academy of Sci.

Hydrocarbons from Coal

The Reactions of Carbonization. Times Eng. Supp., no. 528, Oct. 1918, p. 205. Conclusions drawn from experimental work in preparation of hydrocarbons from coal.

Hypophosphates

On the Preparation of Hypophosphates, R. G. Van Name and Wilbert J. Hull. Am. Jl. of

Sci., vol. 46, no. 271, Oct. 1918, pp. 587-590, 1 fig. Apparatus for preparation by oxidation of yellow phosphorus.

Leather

Recent Developments in Leather Chemistry, H. R. Proctor. Jl. Roy. Soc. of Arts, vol. 66, no. 3440, Oct. 25, 1918, pp. 747-753. Preparing skins or hides for tannage and account of some treatments.

Naphthalene

Description of Direct Determination of Naphthalene in Tar Oil and Raw Naphthalene by the Picric Acid Method (Eine Methode der direkten Naphthalin-Bestimmung in Teer, Teeröl und Rohnaphthalin durch Überführen in Pikrat), Knublauch. Journal für Gasbeleuchtung, year 61, no. 12, Mar. 23, 1918, pp. 134-137.

Determination of Naphthalene in Tars and Tar Oils, Oscar Knublauch. Gas Jl., vol. 143, no. 2888, Sept. 17, 1918, pp. 530-531. Adaptation of author's method of estimating naphthalene by direct titration of picrate with standard alkali to analysis of tars and tar oils. (From Journal für Gas Beleuchtung, vol. 61, pp. 131, 145.)

Nitrogen Oxide

Contribution to the Study of the Velocity of Oxidation of Nitrogen Oxide (Contribution à l'étude de la vitesse d'oxydation du gas oxyde d'azote), E. Briner and E. Fridori. Journal de Chimie Physique, vol. 16, no. 3, Sept. 15, 1918, pp. 279-321, 6 figs. Experimental investigation based on refrigeration of gaseous mixture.

Peat

Sulphite Peat Coal, R. W. Strehlenert. Jl. Am. Peat Soc., vol. 11, no. 4, Oct. 1918, pp. 269-274. Experiments in preparation of coal from residues of paper sulphite process. From Pulp & Paper Mag. of Can.

Petroleum

Petroleum under the Microscope, James Scott. Petroleum World, vol. 15, no. 216, Sept. 1918, pp. 378-379, 3 figs. Forms of carbon and microstructure of soot. (Continuation of serial.)

Rubber

Apparatus for Drying or Heat Treatment of Rubber. India-Rubber Jl., vol. 56, no. 14, Oct. 5, 1918, pp. 5-6, 1 fig. Apparatus in which material or articles to be treated are adapted to be supported by rotary member which conveys articles through oven.

Gauging the Degree of Vulcanization. India-Rubber Jl., vol. 56, no. 14, Oct. 5, 1918, p. 6. Operation by discontinuing supply of vulcanizing medium when rubber has expanded to an extent corresponding with degree of vulcanization desired.

Substitutes in Germany. Eng. Rev., vol. 32, no. 3, Sept. 16, 1918, pp. 71-72. Graphite economics and substitutes; regenerated rubber and substitutes; fibrous materials. (Continuation of serial.)

Synthetic Rubber. Can. Machy., vol. 20, no. 14, Oct. 3, 1918, p. 400. Substitute prepared in Germany from long continued boiling of isoprene and dimethylbutadiene.

The Rubber Industry, J. Bretland. Sci. Am. Supp., vol. 86, no. 2229, Sept. 21, 1918, pp. 178-179. Brief account of recent scientific methods. From Jl. Roy. Soc. of Arts.

Silicic Acid Gels

Silicic Acid Gels, Harry N. Holmes. Jl. Phys. Chem., vol. 22, no. 7, Oct. 1918, pp. 510-519, 4 figs. Information for preparing special silicic acid gels and report of work on effect of high concentrations of acid mixed with sodium silicate and comparative effect of weak and strong acids on silicic acid.

Sulphuric Acid

Some Data on the Contact Process of Sulphuric Acid Manufacture of the Association of Chemical Factories of Mannheim (Beiträge zur Kenntniss des Kontaktschwefelsäureverfahrens des Vereins Chemischer Fabriken in Mannheim), Hugo Ditz and Franz Kanhäuser. Zeitschrift für angewandte Chemie, year 31, no. 63, Aug. 6, 1918, pp. 149-150.

Water Gas

Discussion of the Chemical Phenomena Underlying the Formation of Water Gas (Ueber die chemischen Grundlagen der Wassergasbildung). Zeitschrift für angewandte Chemie, year 31, no. 57, July 16, 1918, pp. 137-139.

COAL INDUSTRY

Coke

On the Formation of Coke (Sur la formation de coke), Georges Charpy and Marcel Godchot. Comptes Rendus des séances de l'Académie des Sciences, vol. 167, no. 9, Aug. 26, 1918, pp. 322-324. Report of experimental work in coking carbon mixtures of different qualities.

Lignites

The Briquetting of Lignites, R. A. Ross. Iron & Steel of Can., vol. 1, no. 9, Oct. 1918, pp. 357-358. Feasibility of meeting requirements in Saskatchewan and Manitoba by utilizing prepared lignites and sub-bituminous coal.

Panel System of Mining

Suggestions for Improved Methods of Mining Coal on Indian Lands in Oklahoma, J. J. Rutledge and D. Harrington. Department of the Interior, Bureau of Mines, tech. paper, 154, 36 pp., 12 figs. Applicability of different modifications of the panel system to mining coal; list of publications on coal mining.

Screens

A New Type of Screen, M. Raymond. Coal Age, vol. 14, no. 13, Sept. 26, 1918, pp. 589-590, 3 figs. Modified form of American system of rope transmission used for coal screening.

See also Electrical Engineering (Induction Motors).

CORROSION

Iron

The Corrosion of Iron and Steel and its Prevention, Abe Winters. Can. Foundryman, vol. 9, no. 8, Aug. 1918, pp. 185-186. Important factors in process of sherardizing; conditions for commercial work.

Electrolytic Prevention

The Cumberland Electrolytic System for the Prevention of Scale and Corrosion. Elecn., vol. 81, no. 2104, Sept. 13, 1918, p. 419, 1 fig. Description of a system used by British navy and merchant marine to prevent scale and corrosion in boilers and condensers.

ELECTRICAL ENGINEERING

Air Gaps

The Reluctance of an Air Gap Having Slots in Both Opposing Surfaces, F. W. Carter. Elecn., vol. 81, no. 2103, Sept. 6, 1918, pp. 400-401, 3 figs. Comment on article by S. P. Smith appearing in Elecn. Feb. 8, 1918.

Alternators

Armature Reaction and Wave Form of a Single Phase Generator (in Japanese), G. Shimizu. Denki Gakkwai Zasshi, no. 362, Sept. 10, 1918.

Synchronising of Alternators, E. Styff. Elecn., vol. 81, no. 2098, Aug. 2, 1918, pp. 290-291, 4 figs. Abstract of article in Electrotechnische Zeitschrift.

Cables

Causes of Corrosion of Underground Electric Cables (Kabelzerstörungen in der Erde), C. Michalke. Dingler's Polytechnisches Journal, vol. 333, no. 6, Mar. 23, 1918, pp. 43-45. A somewhat general discussion.

Measurement of Power Losses in Dielectrics of Three-Conductor High-Tension Cables, F. M. Farmer. Elecn., vol. 81, no. 2098, Aug. 2, 1918, pp. 288-289, 3 figs. Describing methods used at electrical testing laboratories for measuring dielectric power losses in 10-ft. samples of three-conductor cables subjected to three-phase potential; results given for two specimens of cable, one having low and other high power loss in dielectric.

Central Stations

Reconstruction of a Two-Phase Station. Elec. World, vol. 72, nos. 14 and 17, Oct. 5 and 26, 1918, pp. 644-646, 7 figs., and 788-790, 2 figs. How some problems made necessary by rapid load developments were handled by an Iowa company. Description of furnace equipment and efficiency instruments installed in plant. (First article.)

Conductivity

A New Method for the Determination of Conductivity, Edgar Newbery. Jl. Chem. Soc., vols. 113 and 114, no. 671, Sept. 1918, pp. 701-707, 2 figs. Apparatus in which direct current is used and disturbing effects of polarization at electrodes are eliminated; values obtained for specific conductivity of solutions in mhos, at 25 deg.

Conductors, Heating of

Experiments on Heating of Conductors, Henry C. Horstmann and Victor H. Tousley. Elec. World, vol. 72, no. 15, Oct. 12, 1918, pp. 690-693, 1 fig. Application of tables which show allowable sizes of wire to use with intermittent loads such as are created by skip hoists and crane motors; economy possible in choice of conductor. (Second article.)

D. C. Motors

Operation of Direct-Current Motors in Parallel or Series, Gordon Fox. Power, vol. 48, no. 19, Nov. 2, 1918, pp. 666-668, 6 figs. Considerations leading to use of two motors in parallel are discussed.

Discharges, Disruptive

See Sparks.

Frequency Changers

Load Division Between Synchronous Frequency Changers Operating in Parallel, Quentin Graham. Power, vol. 48, no. 17, Oct. 22, 1918, 3 figs. (Second article.)

Distributing Systems

Electrical Distribution System at Hog Island Shipyard, H. W. Young. Elec. Rev., vol. 73, no. 18, Nov. 2, 1918, pp. 683-685, 5 figs. Extensive distributing system for power and lighting at world's biggest shipyard; circuits largely underground; connected load of 30,000 kw. power and 6000 kw. lighting.

Inductive Interference

Interference by High Power Lines, H. C. Don Carlos. Telephony, vol. 75, no. 17, pp. 28-30. Features of inductive interference by power lines of practical value to rural telephone companies. Before Can. Independent Telephone Convention.

Induction Motors

The Running and Maintenance of Induction Motors at Collieries, L. Fokes. Colliery Guardian, vol. 96, no. 3014, Oct. 4, 1918, pp. 701-702, 4 figs. Selection of motors; electrical considerations; pressure distribution in a star-connected stator with neutral earth—neutral insulated delta—connected stator; stator windings; type of stator best suited for colliery work.

The Slip-Ring Induction Machine (La machine asynchrone à baques), Marius Latour. Revue Générale de L'Electricité, vol. 4, no. 9, Aug. 31, 1918, pp. 291-296, 19 figs. Study of devices proposed by various inventors to increase power factor or regulate speed.

Insulation

The Protection of Electrical Apparatus, P. M. Lincoln. Elec. Jl., vol. 15, no. 9, Sept. 1918, pp. 346-348. Review of methods by which integrity of electrical insulation may be secured and permanently assured.

Installation and Care of Large Electrical Apparatus for Steel Mills, O. Needham. Elec. Jl., vol. 15, No. 9, Sept. 1918, pp. 333-336, 2 figs. Suggestion in regard to insulation protection, handling, starting and operation of large motors.

Japanese Electrical Exhibition

Big Japanese Electrical Exhibition, A. E. Bryan. Elec. News, vol. 27, no. 20, Oct. 15, 1918, pp. 25-27. General description of exhibit held by Japanese Elec. Soc. to show possible markets and competition to be expected after the war

Magnetism

Normal State and Polarization in Ferro-Magnetic Materials (Normalzustand und Polarization in Ferromagnetikum), Edy Velander. Reprint from Archiv für Elektrotechnik, vol. 6, no. 12, June 22, 1918, pp. 409-437, 32 figs.

Note on a Property of Ferromagnetism (Sur une propriété du ferromagnétisme), Pierre Weiss. Revue Générale de l'Electricité, vol. 4, no. 8, Aug. 24, 1918, pp. 257-258, 2 figs. Magnetization curves of nickel at various temperatures near the Curie point. (From Comptes des Séances de L'Academie de Sciences, July 8.)

Magneto

Ignition Magneto Construction, H. R. Van Deventer. Jl. Soc. Automotive Engrs., vol. 3, no. 4, Oct. 1918, pp. 257-265, 28 figs. Review of features of magneto construction and adjustment.

On the Potential Generated in a High-Tension Magneto, E. Taylor Jones. Lond. Edinburgh & Dublin Phil. Mag., vol. 36, no. 212, Aug. 1918, pp. 145-169, 6 figs. Theoretical study of phenomena taking place after contacts are separated, and especially of manner in which secondary potential rises and in which its value depends upon the properties of the circuits.

Magnets

An Instrument for Testing Permanent Magnets. Automotive Ind., vol. 39, no. 12, Sept. 19, 1918, p. 505, 1 fig. Designed for testing total flux and coercive force.

Outdoor Apparatus

Housing of Outdoor Electrical Apparatus, Roger L. Evans. Quarterly of Nat. Fire Prevention Assn., vol. 12, no. 2, Oct. 1918, pp. 155-156, 1 fig. Objections to use of corrugated iron structures.

Outdoor Distribution Substation in War Times, R. E. Cunningham. Elec. World, vol. 72, no. 14, Oct. 5, 1918, pp. 642-643, 3 figs. Three-phase transformers with automatic pole-top oil switches in primary; innovation found suitable under certain conditions.

Paper, Inductive Capacity

Specific Inductive Capacity of Paper, H. C. P. Weber and T. C. MacKay. Elec. Rev., vol. 73, no. 14, Oct. 5, 1918, p. 525, 2 figs. Effect

of temperature and impregnation upon capacity. From Jl. Franklin Inst., Sept. 1918.

Polyphase Motors

Protection of Polyphase Motors with Primary Resistor Type Self-Starters. Jl. of Elec., vol. 41, no. 9, Nov. 1, 1918, pp. 407-408, 1 fig. Connections for typical resistor type self-starter with three-section resistor to give balanced starting conditions.

Rectifiers

Mercury Vapor Rectifier (Vom Quecksilberdampf-Gleichrichter). Schweizerische Bauzeitung, vol. 72, no. 13, Sept. 28, 1918, pp. 117-120, 13 figs.

Remote Control

The Remote Control of Motor Driven Pumps and Compressors, F. M. Nourse. Mun. & County Eng., vol. 55, no. 4, Oct. 1918, pp. 133-136, 14 figs. Operation of automatic motor starter.

Resistance

Direct Calculation of the Resistance of Any Number of Conductors Connected in Parallel (Calcul direct de la resistance d'un nombre quelconque de conducteurs associés en parallèle), E. Haudie. Revue Générale de l'Electricité, vol. 4, no. 10, Aug. 31, 1918, p. 297, 2 figs. Proposes improvement in methods shown in issues of Mar. 23 and June 29.

On the Rate of Change at 100 deg. cent. and at Ordinary Temperatures in the Electrical Resistance of Hardened Steel, E. D. Campbell. Iron & Steel Inst., Sept. 12-13, 1918, advance copy, paper 2, 6 pp., 2 figs. Results obtained with bars 6 millimeters square and 15 cm. long which were suspended and kept for an hour in an electrically heated furnace before being quenched in a large volume of water maintained below 10 deg. cent.

Resonance Transformer Circuits

The Power Factor in the Resonance Transformer Circuit, P. Baillie. Wireless World, vol. 6, no. 67, Oct. 1918, pp. 376-380, 3 figs. Curves showing surtension (L. Ω /R) against cos Φ for different values of K (number of semiperiods between two consecutive sparks), plotted from values computed from the formuæ derived in article.

Rotary Converters

The Design Construction and Use of Rotary Converters, C. Sylvester. Electricity, vol. 32, no. 1453, Sept. 13, 1918, pp. 479-480, 7 figs. Explanations of author's experiments illustrating principle of operation of converters. (To be continued.)

Sparks

Photographs of Electric Spark Discharges (Figures de la décharge électrique sur plâques photographiques), Usaboro Toshida. Revue Générale de l'Electricité, vol. 4, no. 8, Aug. 24, 1918, pp. 253-256, 10 figs. Interpretation of formation of Lichtenberg figures on photographic plates, from experiments under various conditions. (From Memoirs of the College of Science, Kyoto Imperial Univ., Mar. 1917.)

Storage Batteries

Thermostatic Generator Control Now Proves Success. Automotive Ind., vol. 39, no. 11, Sept. 12, 1918, p. 460, 3 figs. Saving battery life by compensation for atmospheric temperature.

Substations

The Automatic Substation Has Come to Stay, Walter C. Slade. Elec. Ry. Jl., vol. 52, no. 15, Oct. 12, 1918, pp. 651-654. Outlining present status of automatic substation.

See also Outdoor Apparatus.

Transformers

The Economical Loading of Transformer Banks. Elec. World, vol. 72, no. 16, Oct. 19, 1918, pp. 737-738, 2 figs. Giving curves which make it possible to keep most economical number of transformers in service.

Siemens-Halske Automatic Fire Extinguisher for Use in Transformer Installations (Extincteur d'incendie automatique pour cabines de transformateurs, système Siemens et Halske.) Génie Civil, vol. 73, no. 7, Aug. 17, 1918, pp. 135-136, 1 fig. Sends a large volume of carbon dioxide, gives warning and indicates place where fire started. (From Elektrotechnische Zeitschrift, May 23.)

Temperature Indicator for Transformer Winding, V. M. Montsinger, and A. T. Childs. Elecn., vol. 81, no. 2106, Sept. 27, 1918, pp. 450-451, 2 figs. Abstract of article in Genl. Elec. Rev.

Transmission Lines

Transmission-Line Construction of Duquesne Light Company, Thomas R. Hay. Elec. Rev., vol. 73, no. 17, Oct. 26, 1918, pp. 643-646, 5 figs. Difficulties met with in building a 66,000-volt line through a mountainous region.

Trouble Location

Tests for Locating Armature Trouble. Power Plant Eng., vol. 22, no. 21, Nov. 1, 1918, pp. 881-882, 3 figs. All common armature defects detected by one-man bar to bar and ground tests with voltmeter and bank of lamps.

Wiring

Insuring Against Disagreements over Wiring. Elec. World, vol. 72, no. 16, Oct. 19, 1918, pp. 735-737, 4 figs. Forms of contracts used by United Illuminating Co. of Bridgeport, Conn.

See also Factory Management (Electric Motors); Heating and Ventilation (Electric Heating); Power Plants (Power Factor); Safety Engineering (Fire Protection); Steel and Iron (Electric Steel).

ENGINEERING MATERIALS

Aeroplane Fabrics

International Aircraft Standards. Aeronautics, vol. 15, no. 253, Aug. 21, 1918, pp. 173-175, 1 fig. Specifications for unmercerized cotton aeroplane fabric (grade A); specifications for mercerized cotton aeroplane fabric (grade B); specifications for unmercerized cotton aeroplane fabric (grade B.).

Aluminum Bronze

Aluminum Bronze as an Engineering Material, Charles Vickers. Machy., vol. 25, no. 2, Oct. 1918, pp. 135-136. Difficulties in casting; use and characteristics; composition; high-tensile aluminum bronzes.

Aluminum Bronzes (Los bronces de aluminio), Jean Escard. Revista de Obras Publicas, year 66, no. 2244, Sept. 26, 1918, pp. 485-492. Their properties, manufacture and industrial utilization.

Asphalt

Standardization of Required Consistency for Asphalt, J. R. Draney. Can. Engr., vol. 35, no. 14, Oct. 3, 1918, pp. 309-310. Present variations and needed efficiency.

Bearing Metals

Conservation of Tin in Bronze Bearing Metals, G. H. Clamer. Foundry, vol. 46, no. 315, Nov. 1918, pp. 532-533. Abstract of paper at Inst. of Metals Div. of Am. Inst. of Min. Engrs., Milwaukee, Oct. 1918. Also in Am. Mach., vol. 49, no. 17, Oct. 24, 1918, pp. 773-775.

Some Notes on Babbitt and Babbitted Bearings, Jesse L. Jones. Metal Ind., vol. 16, no. 9, Sept. 1918, pp. 402-404, 5 figs. Brinell tests at progressively increasing temperatures for a lead-base and a tin-base babbitt; process and tool to give accurate and smooth surfaces to bearings. (Inst. of Metals Division of Am. Inst. of Min. Engrs., Milwaukee, October 1918.)

Boiler Plates

Causes of Failure on Boiler Plates, Walter Rosenhain and D. Hansen. Can. Machy., vol. 20, no. 14, Oct. 3, 1918, pp. 393-396, 14 figs. Effect of grain growth; alteration of crystalline structure by mechanical deformation; suggested remedies.

Copper

The Alloys of Copper and Zinc: An Investigation of Some of their Mechanical Properties, F. Johnson. Steamship, vol. 30, no. 352, Oct. 1918, pp. 82-83. Report of Brinnell hardness tests as cast and after annealing and tensile tests after annealing. Before Inst. of Metals.

The Effect of Cold Work on Copper, W. E. Alkins. Engineering, vol. 106, no. 2750, Sept. 13, 1918, pp. 283-285, 4 figs. Effect of progressive cold work upon tensile properties of pure copper. Paper before Inst. of Metals, Sept. 1918.

Gun Metal

The Influence of Impurities on the Mechanical Properties of Admiralty Gun-Metal, F. Johnston. Steamship, vol. 30, no. 352, Oct. 1918, pp. 83-84. Review of experimental results of other investigators and account of author's experiments. Before Inst. of Metals.

Hardness

The Resistance of Metals to Penetration Under Impact, C. A. Edwards. Engineering, vol. 106, no. 2750, Sept. 13, 1918, pp. 285-288, 9 figs. Including a note on hardness of solid elements as a periodic function of their atomic weights. Paper before Inst. of Metals.

Precast Concrete Lumber

Precast Concrete Lumber Proves Successful in Mine. Eng. News-Rec., vol. 81, no. 14, Oct. 3, 1918, pp. 627-629, 1 fig. Fire resistivity sought in replacing steel and wood or all-timber construction; costs about twice those of timber.

Sand

Sand and Sandstones, James Scott. Stone, vol. 39, no. 10, Oct. 1918, pp. 464-466, 3 figs. Study of minute structure and composition of sand.

Solders

Solders and Substitutes for Lead-Tin Solders, Charles W. Hill. Metal Ind., vol. 16, no. 9, Sept. 1918, pp. 412-415, 3 figs. Some notes on results of experiments conducted in Research Laboratory of Westinghouse Elec. & Mfg. Co., Pittsburgh, Pa.

Strength of Materials

The Strength of Materials, W. Cawthorne Unwin. Times Eng. Supp., no. 528, Oct. 1918, p. 219. Experimental progress in study of mechanical properties of materials, giving brief history of struggle during 18th and 19th centuries to establish the foundations of knowledge of strength of materials and touching on some recent advances in testing machines and methods. Thomas Hawksley lecture.

Tool Steel

Tool Steels. Can. Foundryman, vol. 9, no. 8, Aug. 1918, pp. 174-175. Processes followed to insure proper hardness.

See also Metallurgy; Steel and Iron.

FACTORY MANAGEMENT

Electric Motors

Care and Operation of Electric Motors in Factories, Joseph P. Collopy. Elec. Rev., vol. 73, no. 17, Oct. 26, 1918, pp. 648-662, 4 figs. Proper maintenance of special timely value; good motor location important, points on maintenance of direct-current, induction and synchronous motors.

Employment Manager

Selecting the Employment Manager, Philip Brasher. Am. Mach., vol. 49, no. 15, Oct. 10, 1918, pp. 677-678. Requirements of ideal employment manager as seen by author.

The Employment Manager—A New Factor in Industrial Relationship, Edward D. Jones. Am. Gas Eng. Jl., vol. 109, no. 16, Oct. 19, 1918, pp. 361-364. Psychological evolution and present value of this employment. Also in Jl. Engrs. Club of St. Louis, vol. 3, no. 5, Sept.-Oct., pp. 292-301.

Factory Management

The Basis of Scientific Management, M. H. Potter. Can. Machy., vol. 20, no. 14, Oct. 3, 1918, pp. 397-399. Question of personnel in problem of management.

Graphic Control of Production

Graphic Production Control, C. E. Knoeppel. Indus. Management, vol. 56, no. 4, Oct., 1918, pp. 284-288, 5 figs. Fifteen laws of control. (Second article.)

Speeding Production by Using Graphic Meters. Elec. World, vol. 72, no. 13, Sept. 28, 1918, pp. 588-589, 6 figs. How a paper products company has installed a system of circuits in order to permit the management to check from executive office any operation going on within the plant.

Shipbuilding Methods

Shipbuilding Methods of the "Eagle" Chaser Factory. Eng. News-Rec., vol. 81, no. 18, Oct. 31, 1918, pp. 788-795, 13 figs. Hull erection divided among seven stations; extensive pre-assembly; rivets heated by electric current; launching platform; automatic platform.

Time Studies

Time Studies for Rate Setting on Gisholt Boring Mills, Dwight V. Merrick. Indus. Management, vol. 56, no. 4, Oct. 1918, pp. 289-299. (Fourth article.)

Waste

Possibilities of Salvage and Utilization of Waste, David Currie. Surveyor, vol. 54, no. 1389, Aug. 30, 1918, pp. 99-100. Work being done in U. S.; German methods; possibilities of municipal salvage. (Inst. Cleansing Superintendents.)

See also Industrial Organization; Machine Shop (Drawings); Mines and Mining (Efficiency); Power Plants (Operation).

FORGING

Axle Forging

Shaping the Front Axle Forging on the Nash Motor Car, J. Ledin. Am. Mach., vol. 49, no. 15, Oct. 10, 1918, pp. 679-680, 5 figs. Describing design of special bulldozer die for simultaneously performing several distinct operations on automobile front-axle forging.

Shell Forging

Organizing for the Production of Forgings, J. H. Rodgers. Can. Machy., vol. 20, no. 14, Oct. 3, 1918, pp. 381-385, 7 figs. Significance of proper forging of shell in subsequent operations; new machine designed for gaging length of billets.

FOUNDRY

Casting

Casting Grey Iron Piston Rin. b. Machinery, Ellsworth Sheldon, Am Mach., vol. 49, no. 18, Oct 31, 1918, pp. 783-787, 10 figs. Description of the continuous casting of grey-iron piston rings by a machine in which advantage is taken of the action of centrifugal force upon the molten metal.

Electric Furnace

The Electric Furnace in the Steel Foundry, W. E. Moore. Can. Foundryman, vol. 11, no. 9, Oct 1918, pp 258-259. Resumé of progress attained during past few years. Before Am. Foundrymen's Assn.

Molding

A New Method of Molding Trench Mortar Shell, H. Cole Estep Foundry, vol. 46, no. 315, Nov. 1918, pp. 523-525, 6 figs. Two castings are made in each flask; jarring machines are used and production is 350 shells per day.

Modern Methods Facilitate Molding of Large Marine Engine Castings. Can. Foundryman, vol. 9, no. 8, Aug 1918, p. 178. Molding of triple-expansion engine cylinder casting.

Oil Fuel

Use of Oil Fuel in the Foundry in Urgent Exceptional Circumstances, A. E Plant. Steamship, vol. 30, no. 352. Oct. 1918, pp. 96-97. Account of installation and operation of foundry in connection with repair shops.

Sand

Bettering the Quality of Foundry Sand Mixtures, Henry B. Hanley. Can. Foundryman, vol. 11, no. 9, Oct. 1918, pp. 243-245, 5 figs. Results obtained in experimental investigation undertaken to determine mixtures of old and new sand best adapted to producing good castings. Before Am Foundrymen's Assn.

Much Depends on Securing Suitable Sand. Can. Foundryman, vol. 9, no. 8, Aug. 1918, pp. 176-177, 4 figs. Preparation of quartz and limestone sand for use in molds by Montreal company.

Steel Casting

Acid vs. Basic Steel for Castings, Edwin F. Cone. Iron & Steel of Can., vol. 1, no. 9, Oct. 1918, pp. 361-363. Uses of acid and basic castings; addition of ferro-alloys; question of oxygen; comparative physical properties; German and American steel castings.

Government Requirements for Steel Castings, E. R. Swanson. Foundry, vol. 46, no. 315, Nov. 1918, p. 538. Physical properties asked by Ordnance Department for three principal grades of steel castings are discussed.

Theory and Practice in Gating and Heading Steel Castings, Ralph H. West. Iron & Steel Inst. of Can., vol. 1, no. 8, Sept. 1918, pp. 338-347, 31 figs. Remarks on general work weighing from 1 to 500 lb., based on author's experience. Before Am. Foundrymen's Assn.

Making Ordnance Steel for the Army and Navy, John Howe Hall. Foundry, vol. 46, no. 315, Nov. 1918, pp. 535-537, Problems of steel castings manufacturers in meeting Government specifications; three essential elements of proper practice. Paper before Am. Foundrymen's Assn., Milwaukee, Oct. 1918. Also in Iron Age, vol. 102, no. 18, Oct. 31, 1918, pp. 1084-86.

See also Machinery, Special (Sand Blast Machinery).

FUELS AND FIRING

Air Preheating

Efficiency of Preheated Air. Power Plant Eng., vol. 22, no 21, Nov. 1, 1918, pp. 876-877, 3 figs. Advantages and systems of introducing preheated air to furnaces.

Ash

Fusibility of Ash from West Virginia Coals, Walter A. Selvig Power, vol 48, no 16, Oct. 15, 1918, pp. 566-567. Tables of softening temperatures of coal ash from West Virginia Coals.

Waste Due to Excess Ash in Coal. Coal Age, vol. 14, no 15, Oct. 10, 1918, pp 692-694, 4 figs. From report of J. G White Engrg. Corp. to Gano Dunn, Chairman of Engineering Committee of National Research Council.

Waste Due to Excessive Noncombustible in Coal, W. A. Shoudy. Power, vol. 48, no. 19, Nov. 2, 1918, pp. 682-683, 3 figs. From a communication to Chairman of Eng. Committee, National Research Council.

Coal

Calorific Value and Ash Yield of Coal Samples from the Same Seam, T. J. Drakeley. Colliery Guardian, vol 96, no. 3015, Oct. 11, 1918, pp. 753-794 Paper before Manchester Geological & Min. Soc., Oct 1918.

Coal Storage

Coal Storage Systems for Power Plants. Power Plant Eng., vol 22, no 18, Sept. 15, 1918, pp 750-753, 8 figs. Description of general methods of storing and reclaiming coal.

Checking Stored-Coal Temperatures Electrically, Thomas W. Poppe. Elec World, vol 72, no. 16, Oct. 19, 1918, pp. 740, 1 fig. Method of detecting incipient fires in piles of stored coal by means of electrical thermometer.

The Storage of Bituminous Coal, E. H. Stock. Power Notes, vol. 4, no 10, Oct. 1918, pp 1-3, 2 figs. Effect of storage in cost to consumer; ventilating a coal pile.

Composite Fuel

Artificial Fuel Compositions, Controlled by Industrial Fuel Corporation. Popular Engr., vol. 10, no. 1, Oct. 1918, pp. 24-25, 2 figs. Patented process to utilize accumulations of anthracite culm and slush.

Control of Heat

Automatic Heat Control for Coal Saving. Metal Worker, vol. 90, no. 16, Oct. 18, 1918, pp. 437-440. Report prepared by Committee of Heating and Ventilating Engineers by request of United States Fuel Administration. Also in Domestic Eng., Oct. 12, 1918, pp. 40-41.

Control Meters, Combustion

Combustion Control Meter. Power, vol. 48, no. 17, Oct. 22, 1918, pp. 599-600, 4 figs. Description of an arrangement of pyrometers developed by Combustion Control Co.

Diagrams of Consumption

Production and Consumption Diagrams in Central Stations, Steam and Others. (Diagrammes de production et diagrammes de consommation relatifs aux centrales électrogènes à vapeur et autres), A. Della Riccia. Revue Générale de' l'Electricite, vol. 4, no. 10, Aug. 31, 1918, pp. 299-310, 6 figs. Fuel consumption of boilers: empirical diagrams applicable to actual cases; conclusions relative to economical use of fuel. (Concluded.)

Firing Methods

Fuel Economy Made Simple, A. Bement. Power, vol. 48, no. 15, Oct. 8, 1918, pp. 524-526. Maintain a hot fire and control rate of combustion by means of draft. Appearance of fire the one comprehensive guide to fireman.

Saving Coal in Boiler Plants, Henry Kreisinger. Department of the Interior, Bureau of Mines, tech. paper 205, 24 pp., 3 figs. Instructions to firemen, engineers and owners of hand-fired plants including: methods of determining stack losses; significance of flue gas analysis; causes of large excess of air and remedy; losses from incomplete combustion; list of publications on the utilization of coal and lignite.

Fuel Conservation

Industrial Fuel Saving. Times Eng. Supp., no. 528, Oct. 1918, p. 204, 1 fig. Points out possibilities and methods.

On the Coal Economy in Steam Power Plant (in Japanese), H. Sekiguchi. Denki Gakkwai Zasshi, no. 362, Sept. 10, 1918.

Gas Firing

Installation for Burning Natural Gas under Boiler, J. J. Griffin. Natural Gas & Gasoline Jl., vol. 12, no. 8, Aug. 1918, pp. 285-286, 3 figs. Illustration and description of setting for low-pressure heating boilers.

Grates

Traveling Grate for Coke and Coke Breeze (Wanderroste für Koksgrus und Koks), Bruno Lepsien. Journal für Gasbeleuchtung, vear 61, no. 1, Jan. 5, 1918, pp. 3-8, 9 figs. Description of tests with the Pluto grate and the Nyeboe and Nissen Traveling grate for coke breeze, and the Belani and the Steinmuller grates for coke.

Half-Gas Furnaces

Half-Gas Furnaces with Undergrate Firing (Halbgasöfen mit Unterwindfeuerung), Dingler's Polytechnisches Journal, vol. 333, no. 3, Feb 9, 1918, pp. 22-23, 6 figs. Description of several German types of so-called half-gas furnaces, i.e., furnaces in which the fuel is partly gasified and partly brought to complete combustion.

Hand-Fired Furnaces

Fuel Economy in Hand Fired Boilers. Power Plant Eng., vol. 22, nos. 21 and 20, Nov. 1, and Oct. 15, 1918, pp. 878-880 and 837-839, 4 figs. Abstract of Circular no. 7, "Fuel Economy in the Operation of Hand Fired Boiler Plants," University of Illinois Engineering Experiment Station. (Second and Third article.)

Low Rate Combustion in Fuel Beds of Hand Fired Furnaces, H. Kreisinger, C. E. Augustine, and S. H. Katz. Department of the Interior, Bureau of Mines, tech. paper 139, 54 pp., 19 figs. Extension work reported in technical paper 137 which covered higher rates of combustion of 20 to 180 lb. of coal per sq. ft. of grate per hr., to rates below 20 lb. using the same apparatus and following largely equal methods.

Lignite

Burning Lignite with the Mechanical Stoker., Power House, vol. 11, no. 10, Oct. 1918, p. 306. Evaporation test made at the Government of Alberta power station with lignite slack coal.

Lignite Becomes of Importance as a Fuel Resource, S. M. Darling. Am. Gas Eng. Jl., vol. 109, no. 18, Nov. 2, 1918, pp. 415-418. Comparison of carbonized briquets for domestic service with anthracite coal; by-products from lignite. From tech. paper 178 of the United States Bureau of Mines.

Low-Grade Fuels

Low-Grade Fuels. Sci. Am. Supp., vol. 86, no. 2229, Sept. 21, 1918, pp. 191-192. Possible method of disposal. From London Times Eng. Supp.

Peat

Analysis of Canadian Peat. Jl. Am. Peat Soc., vol. 11, no. 4, Oct. 1918, pp. 253-268. From samples taken in deposits of Nova Scotia, Prince Edward Island, New Brunswick, Quebec, Ontario and Manitoba.

Inorganic Composition of a Peat and of the Plant from which it was Formed, C. F. Miller. Jl. Am. Peat Soc., vol. 11, no. 4, Oct. 1918, pp. 244-248. Brief description of both products; comparison of composition of peat and saw grass; comparison of losses of three soil forming materials in their transformation to soils.

The Peat Deposits in Minnesota, E. K. Soper. Jl. Am. Peat Soc., vol. 11, no. 4, Oct. 1918, pp. 227-243, 8 figs. Quantity, quality, and uses to which they are best adapted. Reprinted from Economic Geology, vol. 12, p. 526.

Petroleum

Petroleum as Combustible (El petroleo como combustible), J. R. Pérez. Revista de la Sociedad Cubana de Ingenieros, vol. 10, no. 9, Sept. 1918, pp. 523-531. Physical and chemical properties; refinement and uses; description of burners.

Unmined Petroleum Supply Limited, Allen Sinsheimer. Automotive Ind., vol. 39, no. 12, Sept. 19, 1918, pp. 491-493, 3 figs. Extent of supply made by United States National Museum following comprehensive survey of situation.

Powdered Coal

Powdered Coal Substituted for Fuel Oil at Seattle. Elec. Rev., vol. 73, no. 14, Oct. 5, 1918, pp. 529-531, 4 figs. Description of equipment for burning powdered coal at Puget Sound Traction Light & Power Co.'s central heating plant.

Pulverized Coal Tests Conducted at Milwaukee. Elec. Rev., vol. 73, no. 16 and 17, Oct. 19 and 26, 1918, pp. 615 and 658-659, 1 fig. Details of installation in Milwaukee. Efficiency of over 85 per cent obtained. Also in Elec. World, vol. 72, no. 16, Oct. 19, 1918, pp. 744-745; Ry. Rev., vol. 63, no. 17, Oct. 26, 1918, pp. 606-607, 2 figs; Ry Age, vol. 65, no. 15, Oct. 11, 1918, pp. 667-669, 2 figs; Power, vol. 48, no. 16, Oct. 15, 1918, pp. 556-559, 4 figs.

Smokestack Losses

Apparatus to Measure Chimney Loss and the Elements which Constitute it. (Apparell de mesure de la perte à la cheminée et des éléments constitutifs de cette perte).) Marcel Chopin. Comptes Rendus des Séances de l'Académie des Sciences, vol. 167, no. 9, Aug. 26, 1918, pp. 335-338, 2 figs. Suggests instrument registering temperature and amount of carbonic acid.

Waste Gases

Use of Waste Gases for Steam Generation, J. B. C. Kershaw. Coal Age, vol. 14, no. 13, Sept. 26, 1918, pp. 591-594. Study of progress and records of past few years.

Wood Burning

New Wood-Burning Station of Northwestern Electric Company. Elec. Rev., vol. 73, no. 15, Oct. 12, 1918, pp. 573-574, 2 figs. Details of construction and equipment.

See also Chemical Technology (Peat); Coal Industry; Foundry (Oil Fuel); Power Generation and Selection (Waste Heat); Mines and Mining (Oil Shales).

FURNACES

Electric Furnaces

The Development of Stellite, Elwood Haynes. Iron Age, vol. 102, no. 15, Oct. 10, 1918, pp. 886-888, 3 figs. Melting problems solved by Snyder Electric Furnaces which displaced gas-fired crucibles; three furnaces have capacity of over four tons in eleven hours.

Gas Ovens

Experiences with Horizontal Slot Ovens, Henry W. Douglas. Gas Age, vol. 13, no. 7,

Oct. 1, 1918, pp. 307-308. Installation of six oven benches containing three ovens each. Before Michigan Gas Assn.

See also Foundry (Electric Furnaces); Steel and Iron (Electric Steel).

HANDLING OF MATERIALS

Steel Plant

Canadian National Steel Plant. W. F. Sutherland. Can. Foundryman, vol. 9, no. 8, Aug. 1918, pp. 169-174, 13 figs. Handling of materials, arrangement of loading platform bins, installation of furnaces and other features.

HEATING AND VENTILATION

Electric Heating

Industrial Applications of Electricity. Dwight D. Miller. Elec. World, vol. 72, no. 15, Oct. 12, 1918, pp. 693-695, 2 figs. It is predicted that electric heating load will eventually surpass motor load; convenience of control of electrically generated heat results in improved product and increased production. (First article.)

Hot-Water Service

Standards of Central Station Hot Water Heating Service. Heat. & Vent. Mag., vol. 15, no. 10, Oct., 1918, pp. 31-36. Established by Public Service Commission of Indiana under date Aug. 3, 1918.

Public-School Ventilation

The Movement to Eliminate Mechanical Ventilation in New York City's Public Schools. Heat. & Vent. Mag., vol. 15, no. 10, Oct. 1918, pp. 47-49. Tests by Department of Health of classrooms in twelve rooms is basis for this action. A résumé of the tests.

Vacuum-Vapor System

Fuel Saving Heating Systems. Alfred G. King. Domestic Eng., vol. 84, no. 11, Sept. 14, 1918, pp. 390-392 and 423, 4 figs. How a vacuum-vapor heating system is installed and proves effective in fuel economy.

See also Mines and Mining (Ventilation).

HOISTING AND CONVEYING

Bonner Rail Wagon System

Freight Transportation Without Rehandling. Elec. Ry. Jl., vol. 52, no. 15, Oct. 12, 1918, pp. 658-659, 5 figs. Bonner rail wagon system aims to reduce cost and time of freight haulage by using containers on wheels which do not require warehouse facilities.

Conveyor, Coal

A Reciprocating Underground Coal Conveyor. J. F. K. Brown. Coal Age, vol. 14, no. 15, Oct. 10, 1918, pp. 682-684, 2 figs. A conveyor for use in coal beds where inclination is such that cars may be handled only with difficulty.

Cranes

Safety Code for the Operation of Electric Cranes. Power House, vol. 11, no. 10, Oct. 1918, p. 309. Formulated by Iron and Steel Elec. Engrs.

Grain-Unloading Plants

Portable Pneumatic Grain Unloading Plant. Engineer, vol. 126, no. 3266, Aug. 2, 1918, pp. 94, 95, 7 figs. Portability the interesting feature, the plant being set upon railway trucks; drawings and descriptions.

Mine-Car Dumping

Shipping Facilities at the World's Largest Coal Mine. R. W. Mayer. Coal Age, vol. 14, no. 13, Sept. 26, 1918, pp. 586-588. A mine producing 7000 tons of coal per day with mine cars dumped at rate of one every 12 sec.

Tipple

Valley Camp Coal Co.'s Tipple at Parnassus, Penn., George S. Jaxon. Coal Age, vol. 14, no. 13, Sept. 26, 1918, pp. 582-585, 11 figs. Designed to make four sizes of coal; a conveyor designed to facilitate cleaning the tracks under the tipple of spillage from the cars after the day's run.

Tractor-Trailer, Freight Handling by

Freight Handling by Tractors Found Economical. Eng. News-Rec., vol. 81, no. 16, Oct. 17, 1918, pp. 720-721, 2 figs. Tractor-trailer system replaces hand trucking and reduces costs at large L. C. L. freight station at Chicago.

See also Handling of Materials; Marine Engineering (Trimming Conveyor); Motor-Car Engineering (Crane Tractors); Transportation.

HYDRAULIC ENGINEERING

Artesian Wells

Artesian Wells for Water Supply, with Special Reference to the Artesian Wells of Wisconsin. W. G. Kirchoffer. Mun. & County Eng., vol. 55, no. 4, Oct. 1918, pp. 136-138. Velocity of flow in sandstone formations; mineral content found in ground and artesian waters.

Brazil

Water Power in Brazil. Times Eng. Supp., no. 528, Oct. 1918, p. 211. Prospects of utilization.

British Empire

Water Powers of the Empire. Can. Engr., vol. 35, no. 18, Oct. 31, 1918, pp. 383-386 and 391-392. Preliminary report of Water Power Committee appointed by Conjoint Board of Scientific Societies of Great Britain. (To be concluded.)

Dams

Calaveras Dam Slide. Report of Government Experts. D. C. Henry and C. H. Swigart. Eng. & Cement World, vol. 13, no. 7, Oct. 1, 1918, pp. 26-28, 2 figs.

Interconnected Plants

Economy of Water Effected by Intercommunication. R. H. Halpenny. Elec. World, vol. 72, no. 18, Nov. 2, 1918, pp. 828-831, 3 figs. Two hydroelectric companies, operating plants on the same stream, are interconnected through a 6000-kva. transformer; difference in load characteristics permits increasing total load with same flow of water.

Niagara Falls

Canada Rushing Huge Niagara Development as a War Conservation Measure. Eng. News-Rec., vol. 81, no. 18, Oct. 31, 1918, pp. 801-805, 9 figs. Report of construction work in digging a $8\frac{1}{2}$ mile canal around falls.

Penstock Pipes

Saving the Waste in Penstock Pipe Design. B. F. Jakobsen. Jl. of Elec., vol. 41, no. 9, Nov. 1, 1918, pp. 413-415, 2 figs. Points out manner of proportioning economically penstock pipes and transmission lines.

Turbines, Hydraulic

See Waterwheels.

Water Measurement

Measurement of Water by Means of Cipoletti Weir (Wassermessung mittels des Ueberfalls von Cipoletti). Dinglers' Polytechnisches Journal, vol. 333, no. 7, April 6, 1918, pp. 58-59. Abstract of a paper by Professor Luedecke in the German publication, Der Kulturtechniker, 1917, no. 4. Derivation of formulæ for determination of water discharge by the Cipoletti Weir. In the present article the logarithmic scale is applied and formulæ are derived.

Water Power

Fundamental Principles in the Development of Water Power. David R. Shearer. Power, vol. 48, no. 16, Oct. 15, 1918, pp. 563-565, 4 figs. Points to be considered in developing water power of a stream; explanation of fundamental calculations.

Water Supplies

The Development of Water Supplies for Rural Communities in Saskatchewan. E. L. Miles. Eng. & Contracting, vol. 50, no. 11, Sept. 11, 1918, pp. 254-255, 3 figs. Supply from springs; reservoirs; instructions for the construction of dams; dugout type of reservoir. (Engrg. Inst. of Canada.)

Waterwheels

Tests on a 715-Hp. High Speed Water Turbine. (Ueber Leistungsversuche an einer schnell aufenden Wasserturbine von 715 PS), W. Schmid. Schweizerische Bauzeitung, vol. 72, no. 14, Oct. 5, 1918, pp. 129-131, 4 figs.

Waterwheel Types and Settings. David R. Shearer. Power, vol. 48, no. 19, Nov. 2, 1918, pp. 670-672, 11 figs. Various forms of waterwheels and turbines with regard to direction of flow of water, position of shaft and casing of wheel.

Waterworks

New Water Works in the City of Trier (Das neue Grundwasserwerk der Stadt Trier im Moselthal bei Kenn), Wahl. Journal für Gasbeleuchtung, year 61, nos. 7, 8, 9 and 10, Feb. 16 and 29, Mar. 2 and 10, 1918, pp. 77-81, 8 figs., pp. 85-89, 3 figs., pp. 100-104, 8 figs., and pp. 111-117, 6 figs. Extensive description with illustrations.

The Economics of Public Utilities Extensions. J. W. Ledoux. Am. City, vol. 19, no. 4, Oct. 1918, pp. 293-295. Discussion of proper relation of estimated revenue to estimated cost of water-works extension or improvement.

See also Mines and Mining (Water in Mines); Power Plants (Hydroelectric); Safety Engineering (Water Mains.)

INDUSTRIAL ORGANIZATION

Accounting

Cost Accounting to Aid Production. C. Charter Harrison. Indus. Management, vol. 56, no. 4, Oct. 1918, pp. 273-282, 2 figs. Application of scientific management principles. (First article.)

Relation of Statistics and Accounting in Industrial Management. Milton B. Ignatius. Indus. Management, vol. 56, no. 4, Oct. 1918, pp. 312-315. Tells what matters should have statistical study and gives numerous practical points in regard to organizing work and selecting statistician.

Drafting Room

Simple Drafting Room Methods. G. F. Hamilton. Indus. Management, vol. 56, no. 4, Oct. 1918, pp. 301-304, 15 figs. How a machine building plant systemizes its drafting work.

Inspection

Inspection and Quality Control. F. E. Merriam. Indus. Management, vol. 56, no. 4, Oct. 1918, pp. 305-311, 5 figs. Practical application of underlying principles; outlines organization of an inspection department, points out divisions of work, treats of selection and training of inspectors, tells how to uphold standards, and gives suggestions on selection and application of inspection gages.

Reconstruction

Reconstruction Problems from an Engineering Standpoint. Jl. Engrs. Club of St. Louis, vol. 3, no. 5, Sept.-Oct. 1918, pp. 305-308. Suggestions to engineering organizations.

INTERNAL-COMBUSTION ENGINEERING

Constant-Pressure Engines

Fuel Admission Valve of Constant Pressure Internal Combustion Engines (Das Brennstoffventil der Gleichdruckmaschine). Dinglers polytechnisches Journal, vol. 333, no. 10, May 18, 1918, pp. 85-86, 3 figs.

(See also Oil Engines.)

Diesel Engines

Operation of Diesel Engines in China. Harold B. Wilson. Motorship, vol. 3, no. 11, Nov. 1918, pp. 9-10, 4 figs. Data concerning operation of five different Diesel makes under author's charge. (To be continued.)

The Diesel Engine; its Fuels and its Uses. Herbert Haas. Department of the Interior, Bureau of Mines, bul. 156, petroleum technology no. 44, 130 pp., 73 figs. Details of three general types, explosion, Diesel and Sabathé; methods permitting use of coal-tar and coal-tar oils; classification, composition and properties of fuels; formulae for computing fuel cost; examples of successful use of Diesel engines; selected bibliography. Also in Gas Eng., vol. 20, no. 11, Nov. 1918, pp. 513-519, 4 figs.

The True Status of Diesel Engines. J. C. Shaw. Marine Rev., vol. 48, no. 10, Oct. 1918, pp. 449-450. Remarks on rational design of an oil engine (Aug. issue) in reference to statements about ignition disturbances.

Gas Engines

1500-hp. Gas Blowing Engine. Engineer, vol. 126, no. 3271, Sept. 6, 1918, pp. 207, 4 figs. Principally drawings of engine.

Governors

The Design of Governors, with Special Reference to Small Diesel Engines. Arthur B. Lakey. Proc. Engrs. Soc. of Western Pa., vol. 34, no. 6, July 1918, pp. 461-481, 12 figs. and (discussion) pp. 482-488, 1 fig. Points out shortcuts in design and adjustment of certain types of centrifugal governors, and shows need of certain auxiliary apparatus to secure improved smoothness of running in the case of Diesel engines of small power, or with only small flywheels.

Governing

Investigation of Gas Engine Governing (Untersuchung einer Gasmaschinenreglung). A. Gramberg. Dinglers Polytechnisches Journal, vol. 333, no. 7, Apr. 6, 1918, pp. 53-55, 5 figs. Data of an extensive experimental investigation.

High-Speed Engines

High-Speed Internal Combustion Engines. Harry R. Ricardo. Mech. World, vol. 64, nos. 1645, 1649 and 1650, July 12, Aug. 9, and Aug. 16, 1918, p. 17, 7 figs., p. 69, 1 fig., and pp. 81-82, 6 figs. July 12: Comparative wear and tear of slow- and high-speed engines. Aug 9: Factors affecting volumetric efficiency and possibilities of increasing it, theories explaining detonation or "pinking." (Northeast Coast Instn. of Engrs. & Shipbuilders.)

Indicator Diagrams

The Theoretical Indicator Diagram. O. A. Malychevitch. Automotive Ind., vol. 39, no. 12, Sept. 19, 1918, pp. 499-502, 2 figs. Method of predetermining gas temperatures and pressures for various points in engine cycles from chemical composition of charge and physical properties of components.

Oil Engines

Faults in the Design of Some Surface Ignition Oil Engines, W. J. Woodcock. Motorship, vol. 3, no. 11, Nov. 1918, p. 16, 1 fig. An operator's idea of an improved motor.

New Type of Marine Oil Engine. Int. Mar. Eng., vol. 23, no 10, Oct. 1918, pp. 563-566, 6 figs. Two-cycle Weiss engine; simple injection system. Description of engine and discussion of scavenging.

Oil Engine Sprayers or Pulverizers. A. H. Goldingham and C. T. O'Brien. Motorship, vol. 3, no. 11, Nov. 1918, pp. 14-15, 5 figs. Details of various types of injection valves. (Concluded from Sept. issue.)

The Heavy Oil Engine, Charles E. Lucke. Int. Mar. Eng., vol. 23, no. 10, Oct. 1918, pp. 579-583. Discussion of factors to be considered in design; small demand as yet for heavy oil types; future possibilities. Paper before Engrs. Club of Philadelphia, Jan. 1918.

The Heavy Oil Engine, Chas. E. Lucke. Popular Engr., vol. 10, no. 4, Oct 1918, pp. 17-18 and 22. Presentation of ideas involved in development up to present time and consideration of possibility of change in near future. Before Engrs. Club of Phila.

Power Output

The Increase of Power Output, Emil Schimanek. Aerial Age, vol. 8, no. 4, Oct. 7, 1918, pp. 170-173 and 193, 20 figs. Increase of power output in internal combustion by (1) increasing thermal efficiency, (2) increasing number of working strokes in unit-time, or (3) increasing air charge in working cylinders. Translated from Zeitschrift des Vereines Deutscher Ingenieure.

Pulverizers

See Oil Engines.

Sleeve-Valve Engine

Tests of a Sleeve Valve Engine. Automotive Ind., vol. 39, no. 12, Sept. 19, 1918, pp. 494-498, 12 figs. Monograph diagram, horsepower and torque curves.

Sprayers

See Oil Engines.

See also Marine Engineering (Motor Ships.)

LABOR

Aliens

See Americanization.

Americanization

Making Americans on the Railroad. Samuel Rea. Am. Mach., vol. 49, no. 15, Oct. 10, 1918, pp. 673-676. Methods adopted and results achieved in persuading and fitting foreign-born employees of Penn. R. R. to become loyal and useful citizens.

Apprenticeship

Cooperative Management—The Apprentice, Arthur F. Johnson. Int. Mar. Eng., vol. 23, no. 10, Oct. 1918, pp. 567-568. Apprentice a vital essential in industry; should be given liberal education; freedom of shop important for his rounded education.

Bonus System

Fuel Bonuses in Central Stations (Prime à l'économie de charbon dans les stations centrales thermiques), L. Conge. Revue Générale de l'Electricité, vol. 4, no. 10, Aug. 31, 1918, pp. 319-320, 1 fig. How a bonus system may be established and employees made to coöperate in the economization of fuel.

Cooperation

The Babson Conference on Coöperation. Am. Mach., vol. 49, no. 17, Oct. 24, 1918, pp. 749-752. Account of conference, fifth annual, held at Wellesley Hills, Mass., Sept. 1918, on profit-sharing, labor turnover and efficiency, United States Employment Service, and experience in collective bargaining and in dealing with unions.

Employee Representation

Bethlehem Plan of Employee Representation. Iron Age, vol 102, no. 17, Oct. 24, 1918, pp. 1020-1022, 2 figs. Monthly committee meetings and annual conferences to consider wages, working conditions, housing and all other questions of mutual interest.

Housing

Lodging House for Thirty Men Costs $11,000 Elec. Ry. Jl., vol. 52, no. 14, Oct. 5, 1918, pp. 615-616, 5 figs. Details of a lodging house built by Connecticut Co. at Waterbury, Conn

Soldiers Discharged

The Employment of Discharged Soldiers Times Eng. Supp., no. 528, Oct. 1918, pp. 201-202. Methods by which engineering trades may help to solve problem.

Supervision

The Mechanical Department Supervision Problem, Frank McManamy. Ry. Age, vol 65, no. 17, Oct. 25, 1918, pp. 729-731. Dilution of quality of labor has increased need of more and better supervision. Abstract of paper before New York Railroad Club.

Training

How Best to Educate the Road Foreman, the Engineer and the Fireman, Frank J. Barry. Proc. Central Ry. Club, vol. 26, no. 4, Sept. 1918, pp. 442-448 and (discussion) pp. 448-466. Consideration of different methods and observations on matters having bearing on character of results education is likely to produce.

Training Minor Executives in a Large Shoe Factory, Roy Willmarth Kelly. Indus. Management, vol. 56, Oct. 1918, pp. 316-319, 2 figs.

Training School for Machine Operators. Iron Age, vol. 102, no. 17, Oct. 24, 1918, pp. 1011-1012, 2 figs. Special department at Timken plant gives better results than breaking in in regular departments.

Turnover

Keeping Track of Labor Turnover, E. H. Fish. Automotive Ind., vol. 39, no. 11, Sept. 12, 1918, pp. 445-446. Suggests careful compilation and analysis of turnover records in plants where semi-skilled men must be trained to meet labor needs.

Women

Introducing Woman Labor into the Shop, M. C. Hobart. Am. Mach., vol. 49, no. 17, Oct. 24, 1918, pp. 769-770. Experience of a Chicago firm in this new departure.

Manufacture by Women. Times Eng. Supp., no. 528, Oct. 1918, p. 217. Account of exhibitions of women's work formed by Ministry of Munitions through Technical Section of its Labor Supply, at Liverpool.

Putting Women Into the Machine Shop, F. L. Prentiss. Iron Age, vol. 102, no. 15, Oct. 10, 1918, pp. 892-896, 2 figs. Short probationary period successful in Cleveland plants; qualities in which women excel; reduced labor turnover.

Solving New Haven's Man-Power Problem, Charlton L. Edholm. Am. Mach., vol. 49, no. 16, Oct. 17, 1918, pp. 721-723, 2 figs. Account of effort to secure services of women of New Haven in munitions shops of Winchester Repeating Arms Co.

The Demand for and Supply of Women Workers. Automotive Ind., vol. 39, no. 12, Sept. 19, 1918, pp. 490-491. Contrast between percentages of American and English women now employed.

The Renumeration of Male and Female Labor. Eng. Rev., vol. 32, no. 3, Sept. 16, 1918, pp. 68-69. Discussion of relative efficiencies of male and female labor in the light of extensive experience in engineering shops.

Women in Central Station Work, J. W. Alexander. Jl. of Elec., vol. 41, no. 9, Nov. 1, 1918, pp. 392-393, 5 figs. Account of work being done by women as power plant operators and meter readers.

LEGAL

Building Law

Puzzling Variations in Important Building-Law Clauses, R. Fleming. Eng. News-Rec., vol. 81, no. 13, Sept. 26, 1918, pp. 579-581. Requirements as to stresses; specified wall thickness often wasteful; wind bracing neglected; interesting special features.

See also Electrical Engineering (Wiring); Safety Engineering (Dangerous Tools), (Grinding Tools.)

LIGHTING

Dispersion of Light

Dispersion of Light as a Means of Reducing the Surface Brightness of Artificial Illuminants (Die Streuung des Lichtes als Mittel zur Verringerung der Flächenhelle künstlicher Lichtquellen), N. A. Halbertsma. Dingler's polytechnisches Journal, vol. 333, no. 9, May 4, 1918, pp. 76-77, 2 figs.

Better Lighting of Glass Works and Potteries, F. H. Bernhard. Elec. Rev., vol. 73, no. 15, Oct. 12, 1918, pp. 567-572, 6 figs. Eighth of a series of articles on improvement in lighting in the industries.

Lighting of Rubber-Goods Factories, F. H. Bernhard. Elec. Rev., vol. 73, no. 17, Oct. 26, 1918, pp. 653-657, 5 figs. Ninth of a series on lighting in industries.

Factory Lighting

Terminal Shop and Classification Yard Lighting. Ry. Rev., vol. 63, no. 18, Nov. 2, 1918, pp. 625-627, 5 figs. General discussion of modern shop and yard lighting systems through the use of the flood system. Committee report before Convention of Assn. of Ry. Elec. Engrs., by J. E. Gardner.

House Lighting

The Lighting Ration in Practice. Illuminating Engr., vol. 11, no. 7, July 1918, pp. 177-181. Suggests how lighting rations under household fuel and lighting order may be expected to apply to two typical houses, having respectively six and twelve rooms.

Illuminants

Experimental Comparison of the Lighting Efficiency of Various Artificial Sources of Illumination (Zur Beurteilung der Beleuchtungswirkung künstlicher Lichtquellen), W. Bertelsmann. Journal für Gasbeleuchtung, year 61, no. 6, Feb. 9, 1918, pp. 61-64.

Lighting Economies

Possible Wartime Lighting Economies. Elec. News, vol. 27, no. 21, Nov. 1, 1918, pp. 23-26. Report of committee on war service of the Illuminating Eng. Soc.

Mantle Lights

A Physical Study of the Welsbach Mantle, H. E. Ives, E. F. Kingsbury, and E. Karrer. Jl. Franklin Inst., vol. 186, no. 4, Oct. 1918, pp. 401-438, 15 figs. Details of theory of ordinary mantle, and application of Rubens methods, as well as other new methods, to mantles composed of other oxides and oxide mixtures. (To be continued.)

Urges Use of Pilots with Mantle Lamps as Fuel Conservation Measure. Am. Gas Eng. Jl., vol. 109, no. 16, Oct. 19, 1918, pp. 367-371. Report of Illuminuating Eng. Soc. giving rules limiting use of artificial light to minimum necessary number of hours per day and promoting most efficient use of artificial light during those hours.

Photometers

Improvements in the Spherical Photometer, R. von Voss. Elecn., vol. 81, no. 2104, Sept. 13, 1918, pp. 418-419, 1 fig. Abstract of an article in the "Elektrotechnische Zeitschrift," no. 52, 1917.

Street Lighting

War-Time Street Lighting Economy. J. R. Cravath. Am. City, vol. 19, no. 4, Oct. 1918, pp. 303-304, 2 figs. Indicates where reductions can be made. From compilations of data and opinions of illuminating engineers throughout the country presented before Illum. Engrs. Soc.

See also Standards and Standardization (Lamp Voltages.)

LUBRICATION

Cutting Lubricants

Cutting Lubricants. Times Eng. Supp., no. 528, Oct. 1918, p. 218. Memorandum issued by Department of Scientific and Industrial Research, prepared by a committee of department in connection with a survey of field for research on lubricants and lubrication.

Explosion Engines

Lubrication of Explosion Engines. Petroleum World, vol. 15, no. 216, Sept. 1918, pp. 380-381. Action of oil and suggestions on selection of lubricant. (Concluded.)

Marine Engines

The Lubrication of Marine Engines. Shipbuilding & Shipping Rec., vol. 12, no. 12, Sept. 19, 1918, pp. 277-278. Principles to be followed regarding place of application of oil; considerations on frequency and pressure.

Viscosity of Oils

Viscosity and Constitution of Lubricating Oils. Sci. Am. Supp., vol. 86, no. 2232, Oct. 12, 1918, p. 240. Review of conclusions obtained by various experimenters.

MACHINE DESIGN

Cams

Cam Profiles (II). Wm. Ker Wilson. Mech. World, vol. 64, no. 1649, Aug. 9, 1918, pp. 66-67, 7 figs. Displacement curves of cam giving simple harmonic motion to roller and of cam giving uniform acceleration to roller.

MACHINE PARTS

Bearings

Life of Ball Bearings (Ueber Lebensdauer von Kugellagern), Henry Gärtner. Dingler's Polytechnisches Journal, vol. 333, no. 5, Mar. 9, 1918, pp. 35-38, 4 figs. Safe loads on ball bearings and the life of ball bearings under various conditions of loading and maintenance.

Roller Bearings for Machine Shop Equipment, Edward K. Hammond. Machy., vol. 25, no. 2, Oct. 1918, pp. 115-122, 14 figs. (Fourth article.)

The "Dragon" Ball Bearing. Can. Machy., vol. 20, no. 17, Oct. 24, 1918, pp. 475-476, 4 figs. Double row ball bearings, manufactured in standard single row widths, in each instance containing approximately double the number of balls of corresponding single row bearing, the two rows of balls being staggered in relation to each other.

Bolts

On the Strength of Bolts in Aeroplane Structures, John Case. Aeronautics, vol. 15, no. 253, Aug. 21, 1918, pp. 158-162, 8 figs. Analytical computation of distribution of load between several bolts bearing same load in (1) strap joint under direct load, (2) single lateral force divided between several bolts, (3) when there is bending. (Concluded.)

Stress Distribution in Bolts and Nuts, C. E. Stromeyer. Int. Mar. Eng., vol. 23, no. 10, Oct. 1918, pp. 589-591, 4 figs. Character and analysis of strains in butt straps; instrument for ascertaining difference in thread pitch. Paper before Inst. of Naval Architects, London, March 1918.

Flywheels

Disastrous Flywheel Explosion at Chicago. Power, vol. 28, no. 15, Oct. 8, 1918, pp. 516-519, 6 figs. Details of an accident to a 24 by 42-in. 500 hp. Corliss engine.

Keyways

Figuring Keyways on Shafts, John Havekost. Machy., vol. 25, no. 2, Oct. 1918, pp. 152, 1 fig. A collection of formulæ.

Sprockets

Sprocket Design, Theory and Practice, Wiley M. Free. Machy., vol. 25, no. 2, Oct. 1918, pp. 147-150, 4 figs. Factors controlling designing of sprockets for malleable chain drives, and action of chain on driving and driven sprockets under different conditions.

See also Standards and Standardization (Gearing.)

MACHINE SHOP

Balancing

Methods of Balancing Rotors, C. C. Brinton. Elec. Jl., vol. 15, no. 9, Sept. 1918, pp. 349-352, 9 figs. Static and dynamic balances; balancing machines.

Chain Cables

Memorandum Regarding the Manufacture of Cast-Steel Chain Cables. Steamship, vol. 30, no. 352, Oct. 1918, pp. 90-91. Report of Committee of Lloyd's Register; summary of previous attempts and present position; testing of cast-steel chains. Also in Practical Engr., vol. 58, no. 1643, Aug. 22, 1918, pp. 91-92. (To be continued.)

Chain Making

The Manufacture of a Diamond Transmission Chain, J. V. Hunter. Am. Mach., vol. 49, no. 15, Oct. 10, 1918, pp. 643-647, 13 figs. Description of some automatic and semi-automatic machines used in manufacture of transmission chain.

Drawings

A Study of Drafting Room Errors, R. Fleming. Eng. & Contracting, vol. 50, no. 17, Oct. 23, 1918, pp. 378. Most common and most expensive errors made in structural drafting.

Representation of Screw Threads and Dimensioning. Can. Machy., vol. 20, no. 9, Sept. 5, 1918, pp. 291-294, 27 figs. Rules for dimensioning drawings.

Gages

Developing a Gaging System for Small Arms and Heavy Ordnance, Erik Oberg. Machy., vol. 25, no. 2, Oct. 1918, pp. 93-107, 9 figs. First of a series describing principles involved and procedure followed in developing gaging systems for interchangeable manufacture. Based upon experience of Pratt & Whitney Co. in furnishing gaging equipment for small arms and heavy ordnance work.

Rules for Computing Gage Tolerances, D. Douglas Demarest. Indus. Management, vol. 56, no. 4, Oct. 1918, pp. 332-334, 3 figs. Three simple rules show how to compute overall length, mean length and mean depth of finish.

Gage Making

Gage Making in a Shell Plant, Franklin D. Jones. Machy., vol. 25, no. 1, Sept. 1918, pp. 1-6, 19 figs. Sixth of series of articles describing methods employed in a plant making United States 75-mm. shell.

Gear Cutting

Electric-Railway Motor Pinion Making. Am. Mach., vol. 49, no. 15, Oct. 10, 1918, pp. 648-650, 7 figs. Describing various steps in manufacture of gears and pinions for electric-railway motors.

Heat Treatment

Annealing Cold-Rolled Aluminum Sheet by Abbreviated Exposures at Various Temperatures, Robert J. Anderson. Page's Eng. Weekly, vol. 33, no. 734, Oct. 4, 1918, pp. 160-161. Report of experiments. Before Inst. of Metals.

Hosiery-Machine Making

Making Hosiery-Machine Parts, Robert Mawson. Am. Mach., vol. 49, no. 16, Oct. 17, 1918, pp. 709-710, 5 figs. Sequence of operations in milling certain members of hosiery machines as practised by Hemphill Mfg. Co., Pawtucket, R. I.

Irregular-Shaped Work

Generating Cams and Irregular-Shaped Work, Douglas P. Hamilton. Am. Mach., vol. 49, no. 17, Oct. 24, 1918, pp. 737-740, 12 figs. Outlining possibilities of producing in gear shaper and on a commercial basis cams and other irregular forms.

Moving-Picture-Machine Making

Making a Moving Picture Machine, M. E. Hoag. Am. Mach., vol. 49, nos. 16 and 17, Oct. 17 and 24, 1918, pp. 718-720, 16 figs., 759-761, 10 figs. The light shutter. (Second and third article.)

Screw Work

Production Problems of Aircraft Bolts, Screws and Nuts, W. H. Sheahan. Aviation, vol. 5, no. 6, Oct. 15, 1918, pp. 363-365, 4 figs. Gaging machines.

Tractor Manufacture

Manufacturing the Caterpillar Tractor, Frank A. Stanley. Am. Mach., vol. 49, nos. 17 and 18, Oct. 24 and 31, 1918, pp. 745-747, 5 figs., and 801-804, 9 figs. General features. (First and second article.)

Truck Making

Assembling the Liberty Truck, M. E. Hoag. Am. Mach., vol. 49, no. 18, Oct. 31, 1918, pp. 813-815, 11 figs. Description of methods used in a Western factory.

Welding

Cutting Test Pieces from Shells. Can. Foundryman, vol. 9, no. 8, Aug. 1918, p. 183, 1 fig. General details of machine operating by oxy-acetylene torch.

Fusion Welding Fallacies, S. W. Miller. Machy., vol. 25, no. 2, Oct. 1918, pp. 123-124, 2 figs. (Fourth article.)

New Work for the Welding Engineer, C. W. Brett. Aeronautics, vol. 15, no. 253, Aug. 21, 1918, pp. 170-171, 4 figs. Shows application of welding to an aluminum airplane engine crankcase and to a cast-iron cog wheel.

Practical Data Upon Electrical Spot Welding, G. A. Hughes and R. H. Pool. Elec. World, vol. 72, no. 16, Oct. 19, 1918, pp. 742-744, 2 figs. Power consumption, strength of welds and speed with which welds can be made determined for various kinds of plates.

Selection and Application of Electric Arc Welding Apparatus, A. M. Caudy. Elec. Jl., vol. 15, no. 9, Sept. 1918, pp. 337-346, 25 figs. Requisites for alternating-current arc welding and direct-current arc welding; constant current versus constant potential generators; protective equipment and accessories; welding principles; selection of electrodes; gas versus electric arc.

Some Notes on the Resistance Method of Electric Welding, G. W. Stubbings. Mech. World, vol. 64, no. 1654, Sept. 13, 1918, p. 124. Manner of applying electric supply to weld in case of direct current and also in case of alternating current.

The Oxy-Acetylene Process for Welding Boiler-Plate, H. A. Boyd. Mech. World, vol. 64, no. 1649, Aug. 9, 1918, pp. 69-70. Result of tests made of three pieces taken from new boiler-plate. (Cal. Safety News.)

The Practice of Oxy-Acetylene Welding, J. T. Morton. Aeronautics, vol. 15, no. 253, Aug. 21, 1918, pp. 165-169, 12 figs. Suggestions regarding selection of burners, determination of correct proportions of burning gases in flame and other details of process.

See also Engineering Materials (Tool Steel); Railroad Engineering, Steam (Shops); Safety Engineering (Punch Presses); Steel and Iron (Quenching); Machinery, Special (Sand-Blast Machinery).

MACHINE TOOLS

Second-Hand Tools

The Buying of Second-Hand Machine Tools, Donald A. Hampson. Can. Machy., vol. 22, no. 16, Oct. 17, 1918, pp. 466-467. Importance of determining age of machine and its serial number.

Sine-Bar Fixture

Sine-Bar Fixture. Machy., vol. 25, no. 2, Oct. 1918, pp. 145-146, 4 figs. Drawings of fixture and explanation.

See also Machine Shop (Moving-Picture-Machine Making), (Hosiery-Machine Making).

MACHINERY, SPECIAL

Sand-Blast Machinery

Automatic Shell Cleaning Cabinet Sand-Blast. Can. Foundryman, vol. 11, no. 9, Oct. 1918, p. 265, 4 figs. Machine designed to provide continuous operation for cleaning 155-mm. shells with direct high pressure.

How to Select Suitable Sand-Blast Equipment, H. D. Gates. Foundry, vol. 46, no. 315, Nov. 1918, pp. 539-545, 12 figs. Results and operation costs should carry greater weight than first price; description of various types. Paper before Am. Foundrymen's Assn., Milwaukee, Oct. 1918.

MARINE ENGINEERING

Boat Lowering

Boat Lowering Appliances, J. R. Hodge. Tran. Inst. Marine Engrs., vol. 30, paper 237, Aug. 1918, pp. 123-127, 4 figs. and (discussion), pp. 127-136. Discusses merits of gear for lowering and disengaging of boats from vessels in emergencies at sea.

Boilers

Sediment in Marine Boilers, W. R. Austin. Steamship, vol. 30, no. 352, Oct. 1918, pp. 94-95, 1 fig. Points out where risk of accident generally arises.

Cargo Gear

Some Insufficiently Considered Details of Ship Construction and Equipment, C. Waldie Cairns. Int. Mar. Eng., vol. 23, no. 10, Oct. 1918, pp. 570-575. Analysis of conditions of yard management; details of ship equipment criticized; stresses on cargo gear. Paper before northeast Coast Inst. of Engrs. & Shipbuilders, Newcastle-upon-Tyne.

Concrete Ships

Concrete Barges Built True to Design Dimensions. Eng. News-Rec., vol. 81, no. 16, Oct. 17, 1918, pp. 704-707, 6 figs. Special spacer fix wall thickness and rod location; account of yard started at Providence, R. I.

Method of Building Concrete Barges at Yard of Aberthaw Construction Co. Eng. & Contracting, vol. 50, no. 17, Oct. 23, 1918, pp. 383-384, 3 figs. Description of work in progress at Fields Point, R. I. Also in Int. Mar. Eng., vol. 23, no. 10, Oct. 1918, pp. 584-585, 3 figs.

Novel Method of Constructing Concrete Vessels, R. N. Stroyer. Shipbuilding & Shipping Rec., vol. 12, no. 14, Oct. 3, 1918, pp. 327-330, 5 figs. Description of writer's patented system which aims to reduce number of joints to minimum.

Standard Concrete Barge for Use on the New York State Barge Canal. Int. Mar. Eng., vol. 23, no. 10, Oct. 1918, pp. 586-588, 6 figs. Authorized design for service on state canal; unusual refinement of concrete used; plans and specifications.

The Building of Reinforced Concrete Ships. Engineering, vol. 106, no. 2744, Aug. 2, 1918, pp. 114-115, 4 figs. Illustrations taken at various stages of work showing reinforcing, etc.

Diving Machinery

Sisson Diving Machine. Steamship, vol. 30, no. 352, Oct. 1918, pp. 79-80, 2 figs. Oval shaped machine 9 ft. long, 7 ft. 6 in. in diameter, 9 tons weight, with pair of propellers on bottom for moving up and down and two on side for propelling forward or back.

Motorships

Motor Ship "Santa Margarita." Steamship, vol. 30, no. 352, Oct. 1918, pp. 91-92. Detail of ship equipped with Diesel Engines.

Propellers

Screw Propellers. Shipbuilding & Shipping Rec., vol. 12, no. 14, Oct. 3, 1918, pp. 331-332, 1 fig. Shape of blades and patent propellers; propeller immersion and efficiency. (Concluded.)

Rivetless Ships

See Welded Ships.

Salvage

Thirteen-Thousand-Ton Vessel Righted by Rolling and Lifting. Eng. News-Rec., vol. 81, no. 17, Oct. 24, 1918, pp. 764-767, 8 figs. Raising of "St. Paul" after settling on its side between New York piers.

Signaling

A Method of Avoiding Collision at Sea, J. Joly. Proc. Roy. Soc., vol. 94, no. A664, Aug. 1, 1918, pp. 547-560, 4 figs. Based on synchronized signals transmitted in different media, no other communication being necessary between the ships beyond signals.

Smoke System, Yarrow

The Yarrow Anti-Submarine Smoke System. Engineer, vol. 126, no. 3272, Sept. 13, 1918, pp. 218-219, 5 figs. Description of a smoke screen system of protection.

Standardized Ships

German Views on Standard Vessels, W. Kreul. Shipbuilding & Shipping Rec., vol. 12, no. 9, Aug. 29, 1918, pp. 212-213. Standardization as a means for accelerating building of ships; constructional parts and processes. Translated from Stahl und Eisen.

Standardized Concrete Ships in the United States. Shipbuilding & Shipping Rec., vol. 12, no. 9, Aug. 29, 1918, pp. 210-212. Alternative arrangement of concrete distributing plant.

Standardized Ships May be Permanent. Nautical Gaz., vol. 94, no. 17, Oct. 26, 1918, p. 224, 1 fig. Advantages and drawbacks of vessels of uniform type. From Engineering, London.

Stresses

Investigation of the Shearing Force and Bending Moment Acting on the Structure of a Ship, Including Dynamic Effects, A. M. Robb. Int. Mar. Eng., vol. 23, no. 10, Oct. 1918, pp. 592-593, 3 figs. Paper before Instn. of Naval Architects, London, March 1918.

Trimming Conveyor

Portable Automatic Trimming Conveyor. Colliery Guardian, vol. 96, no. 3012, Sept. 20, 1918, pp. 601-602, 6 figs. Description of an automatic conveyor used for trimming coal in bunkers on shipboard.

Valves, Kingston

Hand Regulated Valves. Mech. World, vol. 64, no. 1650, Aug. 16, 1918, pp. 78-79, 7 figs. Kingston valves of ships as examples of construction where element of safety is predominant above other considerations. (Concluded from Aug. 2.)

Welded Ships

The British Welded-Steel Motorship. Motorship, vol. 3, no. 11, Nov. 1918, pp. 22-23, 5 figs. Method of operation of novel type of oil engine installed in a merchant vessel.

See also Factory Management (Shipbuilding Methods); Safety Engineering (Fire Protection); Corrosion (Electrolytic Prevention).

MATHEMATICS

Bessel Functions

The Addition Theorem of the Bessel Functions of Zero and Unit Orders, John R. Airey. Lond., Edinburgh & Dublin Phil. Mag., vol. 36, no. 213, Sept. 1918, pp. 234-242. Form of addition theorem of $J_n(x)$ functions in which one of the terms is a root of a Bessel or Neumann function of zero or unit order.

A Diffraction Problem, and an Asymptotic Theorem in Bessel's Series, R. Hargreaves. Lond., Edinburgh & Dublin Phil. Mag., vol. 36, no. 212, Aug. 1918, pp. 191-199. Form to solve problem in two dimensions offered as more convenient than Sommerfeld's; also solution in definite integral transformed directly to series of Bessel's functions and trigonometrical functions of problem in three dimensions, which arises when plane of incident wave is not parallel to edge of barrier.

Collineation Groups

A Collineation Group Isomorphic with the Group of the Double Tangents of the Plane Quartic, C. C. Bramble. Am. Jl. of Mathematics, vol. 40, no. 4, Oct. 1918, pp. 351-365. Derivation by mapping methods of collineation group in which variables are irrational invariants of quartic curve; system for group and associated canonical forms of quartic.

Differential Equations

On the Asymptotic Solution of the Non-Homogeneous Linear Differential Equation of the *n*th order. A Particular Solution, W. Van N. Garretson. Am. Jl. of Mathematics, vol. 40, no. 4, Oct. 1918, pp. 341-350. Considers non-homogeneous equation where roots of characteristic equation are distinct, and follow, at the outset, the method employed by Dini in his researches on linear differential equations published in Annali di Matematica, ser. 3, vol. 2 (1898), pp. 297-324 and vol. 3 (1899), pp. 125-183.

Fourier Theorem

Fourier's Theorem and the Trigonometric series (Sur le théorème de Fourier et les développements en series trogonométriques), G. A. Andrault. Revue Générale de l'Electricité, vol. 4, no. 10, Sept. 7, 1918, pp. 331-340, 3 figs. Method of demonstrating synthetically and generalizing Fourier's theorem and study of the physical significance and independence of the coefficients.

History of Mathematics

Plans for a History of Mathematics in the Nineteenth Century, Florian Cajori. Sci. vol. 48, no. 1238, Sept. 20, 1918, pp. 279-284, 2 figs. Determination of volume of mathematical literature to be penetrated. Before Am. Mathematical Soc.

Plane Algebraic Curves

On the Plane Algebraic Curves having Common Multiple Points (Sur les courbes algébriques planes ayant des points multiples communs), R. de Montessas de Ballore. Camptes Rendus des Séances de l'Académie de Sciences, vol. 167, no. 8, Aug. 19, 1918, pp. 290-293. Analytical investigation of contact of two curves of order *n*.

Pohlke's Theorem

Proof of Pohlke's Theorem and its Generalization by Affinity, Arnold Emch. Am. Jl. of Mathematics, vol. 40, no. 4, Oct. 1918, pp. 366-374, 3 figs. Proof of generalization and establishment of related propositions, by making use of affine collineations in space, of theorem: Three straight line segments of arbitrary length in a plane, drawn from a point and making arbitrary angles with each other, form a parallel projection of three equal segments drawn from the origin on three rectangular coördinate axes; however, only one of the segments, or one of the angles, can vanish.

Theta Modular Groups

Theta Modular Groups Determined by Point Sets, Arthur B. Coble. Am. Jl. of Mathematics, vol. 40, no. 4, Oct. 1918, pp. 317-340. Establishes theorems concerning connection between point set and theta modular function in discontinuous groups defined by $\vartheta_{a,k}$

MECHANICS

Arches

Direct Design of Curvature of Arches, Frank Barber. Can. Engr., vol. 35, no. 18, Oct. 31, 1918, pp. 379-381, 3 figs. Analytical method of finding ordinates of curve for concrete and masonry arches, with example.

Columns

Columns Subjected to Compression and Bending (Stänger, utsatta för tryck och böjning), A. Palmgvist. Teknisk Tidskrift, Väg och vatten Byggnadskonst, vol. 48, no. 9, 1918, pp. 137-142, 5 figs.

Motion, Dissipation of

The Law of Dissipation of Motion, Ernst Jonson. Am. Jl. of Sci., vol. 46, no. 274, Oct. 1918, pp. 578-580, 2 figs. Derivation of law by resolving motion resulting from collision of two particles into two perpendicular components in such a way that each component of one motion is parallel to one of components of other motion, and that the two components which have same direction have also same size.

Relativity, Principle of

The Principle of Relativity in Mechanics (Het relativiteitsbeginsel in de mechanica), G. J. Van de Well. De Ingenieur, year 33, no. 38, Sept. 21, 1918, pp. 736-747, 1 fig.

Shafts, Critical Velocity

A New Critical Velocity Occurring when the Bending of a Shaft is Accompanied by Vibrations (Eine neue kritische Wellengeschwindigkeit bei mit Biegung verbundenen Schwingungen), Gümbel. Dingler's polytechnisches Journal, vol. 333, no. 9, May 4, 1918, pp. 71-75, 2 figs.

A New Critical Velocity of Rotating Shafts (Eeine neue kritische Wellengeschwindigkeit), A. Stodola. Dingler's polytechnisches Journal, vol. 333, nos. 1 and 3, Jan. 12 and Feb. 9, 1918, pp. 1-3, 1 fig., and pp. 17-19. (From Schweiz. Bauzeitung, Nov. 1917). An important article on the critical velocity of shafts containing interesting new views.

Critical Speeds of Shafts, G. Bonner. Mech. World, vol. 64, no. 1654, Sept. 13, 1918, pp. 128-129, 1 fig. Diagrammatic representation of torsion, thrust and centrifugal action stresses. Before N. E. Section Junior Instn. of Engrs. (To be continued.)

Torsional Stresses

Torsional Stresses, F. W. Salmon. Machy., vol. 25, no. 2, Oct. 1918, pp. 108. Table for finding torsional stresses for various sizes of shafts and of various sections.

See also Aeronautics (Stresses in Structure); Cement and Concrete (Sections); Internal Combustion Engineering (Governors).

METAL ORES

Chromium

Chromite, J. C. Williams. Min. & Eng. Rec., vol. 23, nos. 15 and 16, Aug. 31, 1918, pp. 160-162. Foreign deposits, ore in United States; uses; alloys; description; occurrence; concentration; and recognition of this mineral.

Iron

The Occurrence of Iron Ores in East Netherlands (Het voorkomen van ijzeretsen in Oost Nederland), W. H. D. de Iongh. De Ingenieur, year 33, no. 34, Aug. 24, 1918, pp. 644-648, 2 figs.

Talc

Talc: Its Occurrences and Uses, Percy A. Wagner. Min. Mag., vol. 19, no. 4, Oct. 1918, pp. 218-220. Occurrences in South Africa and information as to uses throughout the world. From South African Jl. of Ind.

Tungsten

The Genesis of Tungsten Ores, R. H. Rastall. Min. Jl., vol. 123, no. 4338, Oct. 12, 1918, pp. 597-598. Sheelite deposits; secondary tungsten deposits. From Geological Mag. (Continuation of serial.)

METAL-WORKING TOOLS

Boring Machines

Cylinder Boring Machine. Can. Machy., vol. 20, No. 17, Oct. 24, 1918, p. 485, 1 fig. Although specially designed for boring cylinders of Liberty motors, the machine can, by slight changes in design of gearing, etc., be made to accommodate most boring operations.

Gidding and Lewis No. 4, Boring, Milling and Drilling Machine. Am. Mach., vol. 49, no. 17, Oct. 24, 1918, pp. 777-778, 1 fig. Principal dimensions and general description.

Centering Machine

Machine for Accurately Centering Shells. Can. Machy., vol. 22, no. 16, Oct. 17, 1918, p. 455, 1 fig. System followed by Modern Tool Mfg. Co.

Chisels

The Cold Chisel, J. A. Lucas. Coal Age, vol. 14, no. 16, Oct. 17, 1918, pp. 730-734, 27 figs. Various types of cold chisels and their uses.

Lathes

Massive Shell Lathes for Neville Island. Iron Age, vol. 102, no. 18, Oct. 31, 1918, pp. 1071-1074, 5 figs. Machine for boring and turning shells 12 in. in diameter and larger and features developed especially for operations in view.

Simplified Lathe Adapted to Shell Work. Iron Age, vol. 102, no. 16, Oct. 17, 1918, pp. 945-948, 13 figs. Description of 16- and 25-in. simplified Gisholt lathes.

Locomotive Repair Tools

Repairing Locomotive Fittings, Frank A. Stanley. Am. Mach., vol. 49, no. 15, Oct. 10, 1918, pp. 663-665, 8 figs. Description of tools used in Californian railway repair shop.

METALLURGY

Brass

Thermal Expansion of Alpha and of Beta Brass between 0-600 Deg. Cent., P. D. Merica and L. W. Sehad. Jl. Franklin Inst., vol. 186, no. 4, Oct. 1918, p. 511. Comparison of thermal expansions of two constituents, alpha and beta, of which 60:40 brass is composed. (Abstract.)

Bronze, Phosphorus Content

Estimating Phosphorus in Bronzes, R. E. Rooney. Practical Engr., vol. 58, no. 1648, Sept. 26, 1918, p. 153. Table showing results obtained with different samples of commercial bronze by rapid and gravimetric methods of analysis.

Copper

Pure Carbon-Free Manganese and Manganese Copper, Arthur F. Braid. Bul. Am. Inst. Min. Engrs., no. 143, Nov. 1918, pp. 1697-1698. Deoxidizers and their uses in copper alloys.

Flue Gases

Precipitation from Flue Gases. Elec. Rev., vol. 73, no. 15, Oct. 12, 1918, p. 575, 2 figs. Description of installation at copper refinery where copper particles are recovered by the Cottrell process.

Grain Growth

Grain Growth in Metals, Zay Jeffries. Practical Engr., vol. 58, no. 1648, Sept. 26, 1918, pp. 151-153. Definition of germinative temperature; general laws of grain growth; typical examples. (Continuation of serial.)

Hardness of Metals

Hardness and Hardening, T. Turner. Metal Ind., vol. 16, no. 10, Oct. 1918, pp. 460-464, 1 fig. Address before British Inst. of Metals, Sept. 1918.

See also Engineering Materials (Copper), (Gun Metal).

MILITARY ENGINEERING

Ambulance Trains

An Ambulance Train for the American Army. Engineer, vol. 126, no. 3274, Oct. 27, 1918, pp. 260-262, 15 figs. Drawings and description of the British-built American ambulance train for American army.

Artillery

On the Propagation of Sound of a Cannon at a Great Distance (Sur la propagation du son du canon à grande distance), Maurice Collignon. Comptes Rendus des Séances de l'Académie des Sciences, vol. 167, no. 9, Aug. 26, 1918, pp. 333-335. Table of results of experimental work.

Variation of the Sight Position in Firing at Different Angles of Elevaton (Aenderung

der Visierstellung beim Schiessen unter vorschiedenen Geländewinkeln), K. Michalke. Dingler's polytechnisches Journal, vol. 333, no. 10, May 18, 1918, pp. 82-84, 5 figs.

Explosives

Digging Pole Holes with Dynamite, C. R. Van Drnff. Telephony, vol. 75, no. 18, Nov. 2, 1918, pp. 36-38, 4 figs. Method of blasting holes with dynamite to produce satisfactory results in different kinds of soil.

Sengite: The New South African Explosive, J. P. Udal. Min. Mag., vol. 19, no. 4, Oct. 1918, pp. 215-216. Gun-cotton base explosive, made by same process as tonite but substituting nitrate of soda for nitrate of barium. From South American Jl. of Ind.

Supply Base

Army Supply Base, South Brooklyn, N. Y. Contracting, vol. 7, no. 9, Nov. 1, 1918, p. 279. Placing of more than 11,000 yd. of floor and roof concrete.

See also Chemical Technology (Ammonia); Chemical Technology (Explosives); Safety Engineering (Explosives).

MINES AND MINING

Drills

Diamond-Drilling in Cornwall, J. A. MacVicar. Min. Mag., vol. 19, no. 4, Oct. 1918, pp. 184-187. Work done with Sullivan diamond-drill and author's opinion as to future possibilities.

Improved Sharpener Dies Make Better Drill Bits, Howard T. Walsh. Alaska & Northwest Min. Jl., vol. 12, no. 10, Oct. 1918, p. 91, 3 figs. Chart showing results obtained by one of largest copper mines in United States.

Efficiency

Increasing Coal Mine Efficiency, Charles E. Stuart. Coal Age, vol. 14, no. 16, Oct. 17, 1918, pp. 724-727, 5 figs. First of a series of articles on mine efficiency.

Engineers

The Work of the Mining Engineer, R. S. McCaffrey. Wisconsin Engr., vol. 22, no. 7, April 1918, pp. 285-286. Requirements of mining geology, mine engineering, and metallurgy.

Mine Gases

The Limits of Complete Inflammability of Mixtures of Mine Gases and of Industrial Gases with Air, Geo. A. Burrell and Alfred W. Ganger. Sci. Am. Supp., vol. 86, no. 2232, Oct. 12, 1918, p. 236, 2 figs. Results of experiments. From Tech. Paper 150, Bureau of Mines, Dept. of Interior.

Oil Shales

A Possible Fuel Oil Industry for Canada, James Ashworth. Can. Min. Jl., vol. 39, no. 19, Oct. 1, 1918, pp. 330-331. Discusses possibilities of encouraging production of oil and other by-products from coal and oil shales.

Ventilation

Canvas Tubing for Mine Ventilation, Lester D. Frink. S. A. Min. Jl., vol. 27, part 2, no. 1406, Sept. 7, 1918, p. 421. Explains manner in which canvas tubing is being used in the North Butte Co.'s mines at Butte, Mont. (To be continued.)

Water in Mines

The Unwatering of the Pensford Colliery, Charles Lewis. Iron & Coal Trades Rev., vol. 97, no. 2640, Oct. 4, 1918, pp. 371-374, 6 figs. Before South Wales Branch of Assn. of Min. Elec. Engrs., Sept., 1918.

See also Electrical Engineering (Induction Motors); Safety Engineering (Mine Rescue).

MOTOR-CAR ENGINEERING

Alcohol

The Utilization of Alcohol and Mixtures of Alcohol with Hydrocarbons, such as Benzole instead of Gasoline in Motor Cars, D. Tagneyeff (in Russian). Proc. of Russian Technical Soc., year 1917, nos. 4-7, Apr.-July, pp. 51-57, 1 fig. Data of work carried out by various German engineers.

Crane Tractor

An Electric Crane Tractor. Can. Machy., vol. 20, no. 14, Oct. 3, 1918, pp. 399-400, 1 fig. Machine with 15-ton trailing load capacity and provided with removable battery compartment.

Engines

Dorris Two-Ton Truck Model K-4. Automotive Ind., vol. 39, no. 12, Sept. 19, 1918, pp. 508-509, 4 figs. Detachable cylinder head doing away with valve cages.

Steam Motors

A New Coke Fuel Steam Motor. Engineer, vol. 126, no. 3266, Aug. 2, 1918, pp. 101-103, 11 figs. Details of coke fuel boiler and steam engine used in new steam automobile.

Tires

Tires for Tractor and Similar Vehicle Wheels. India-Rubber Jl., vol. 56, no. 14, Oct. 5, 1918, p. 6, 4 figs. Invention said to enable any existing tractor wheel of any diameter to be readily fitted with a number of studs or projections which will improve grip of wheel.

Tractors

The Wolverine Tractor. Auto, vol. 23, no. 40, Oct. 4, 1918, pp. 733-735, 7 figs. General features of 2-ton 30-50 hp. for three-furrow plowing.

Transmission

The Nuttall Traction Transmission. Automotive Ind., vol. 39, no. 12, Sept. 19, 1918, pp. 506-507, 4 figs. Designed to give two forward speeds and reverse and adaptable to either a longitudinally or a transversely mounted engine.

See also Hoisting and Conveying (Tractor-Trailer); Transportation; Electrical Engineering (Magneto), (Storage Batteries); Internal-Combustion Engineering; Roads and Pavements (Motorized Equipment).

MUNICIPAL

Poles

Joint Usage of Poles—A War Economy, T. N. Bradshaw. Elec. World, vol. 72, no. 18, Nov. 2, 1918, pp. 840-841, 1 fig. Statement of civic, economic and safety advantages resulting from adoption of practice; opinions regarding the form of construction which should be employed. Paper before International Assn. of Municipal Electricians, Atlanta, Sept. 1918, by A. L. Pierce.

Sanitary Survey

A Sanitary Survey of a City. Mun. Jl., vol. 45, no. 19, Nov. 9, 1918, pp. 359-361, 3 figs. Account of survey made by a State board of health. (To be concluded.)

Street Cleaning

A Report on Street Cleaning. Good Roads, vol. 16, no. 17, Oct. 26, 1918, pp. 160-161. Text of report submitted to Am. Soc. of Mun. Improvements by its committee on street cleaning.

Motor Apparatus in Buffalo Street Department, W. F. Schwartz. Mun. Jl., vol. 45, no. 17, Oct. 26, 1918, pp. 317-318, 1 fig. Sweepers and flushers. Before Am. Soc. Mun. Improvements.

Street Cleaning in San Francisco, Chas. W. Geiger. Mun Jl., vol. 45, no. 17, Oct. 26, 1918, pp. 315-317, 7 figs. Downtown streets swept by day and flushed by night; districting and increasing efficiency of force.

Surveying

Problems in City Surveying, W. W. Perrie. Can. Engr., vol. 35, no. 12, Sept. 19, 1918, pp. 257-260, 3 figs. and (discussion), pp. 260-261, 1 fig. Classification and description of resurveys. Before Assn. of Ontario Land Surveyors.

See also Lighting (Street Lighting); Sanitary Engineering.

MUNITIONS

Ammonia

Why We Are Asked to Conserve Ammonia, W. F. Sutherland. Power House, vol. 11, no. 10, Oct. 1918, pp. 290-291. Importance of ammonia in modern warfare.

Chucks

Chuck for Three-Inch Shrapnel Shells, Donald A. Baker. Machy., vol. 25, no. 2, Oct. 1918, pp. 111, 3 figs. Decribes and gives drawings of chuck.

Explosives

Military Explosives of Today (III.), J. Young. Jl. Roy. Soc. of Arts, vol. 66, no. 3439, Oct. 18, 1918, pp. 733-742, 4 figs. Requirements and classification of high explosives for shell filling; methods of detonation; tests for explosives; rate of detonation.

Fuses

Making the Mark III Detonating Fuse, Edward K. Hammond. Machy., vol. 25, no. 2, Oct. 1918, pp. 137-144, 13 figs. (Second article.)

Guns

The Development of Gun Manufacture, W. H. W. Skerrett. Am. Mach., vol. 49, no. 15, Oct. 10, 1918, pp. 655-661, 9 figs. Reviews construction and manufacture of guns from earliest times up to present high-pressure methods.

Shell Assembling Die

Shell Base-Cover Assembling Die and Press, P. H. White. Machy., vol. 25, no. 2, Oct. 1918, pp. 109, 5 figs. Describing a die and press developed by Root-Van Dervoort Engineering Co. of East Moline, Ill.

Shells

Cast-Iron Shells in Permanent Moulds, Edgar A. Custer. Foundry Trade Jl., vol. 20, no. 201, Sept. 1918, pp. 471-473, 2 figs. Essentials in their manufacture and data on a 1100-lb. casting.

High Explosive Shells and Shrapnel, J. M. Hall. Iron & Steel Inst. of Can., vol. 1, no. 8, Sept. 1918, pp. 333-338, 4 figs. Outline of general practice as used by one of largest producers. Before Steel Treating Research Soc.

Machining and Gaging 9.2-inch High-Explosive Howitzer Shells, M. H. Potter. Machy., vol. 25, no. 2, Oct. 1918, pp. 125-132, 17 figs. Machines and tools used, successive order of machining operations, and complete gaging equipment.

Making Semi-Steel Projectiles. Iron Age, vol. 102, no. 15, Oct. 10, 1918, pp. 879-883, 22 figs. Method of molding, including core making, and machining as practiced by American Radiator Co., at Buffalo.

The British 6-in. Howitzer, I. W. Chubb. Am. Mach., vol. 49, no. 16, Oct. 17, 1918, pp. 697-704, 24 figs. Breech mechanism. (Fourth article.)

Small Arms

Revolvers and Automatic Pistols (Les revolvers et les pistolets automatiques), L. Cabanes. Génie Civil, vol. 73, no. 6, Aug. 10, 1918, pp. 110-113, 12 figs. Mauser, 1912 model; parabellum; Manlicker, 1900. (Continuation of serial.)

Stokes Gun

The Stokes Bomb-Throwing Gun (II), Wilfred Stokes. Sci. Am. Supp., vol. 86, no. 2232, Oct. 12, 1918, pp. 228-230, 14 figs. Details of projectile and of propellant; range; time fuse; percussion fuse. (Concluded.) Also in Sci. Am. Supp., vol. 86, no. 2231, Oct. 5, 1918, pp. 212-213, 10 figs.

See also Metal-Working Tools (Lathes); Forging (Shell Forging); Testing and Measurements (Shell Steel).

PAINTS AND FINISHES

Oil, Infected

Paint Disease, James Scott. Ry. Engr., vol. 39, no. 465, Oct. 1918, pp. 198-199, 3 figs. Experimental confirmation of author's previous statement in regard to destructive effect of infected oil.

PHYSICS

Acoustics

Note on the Theory of the Double Resonator, Lord Rayleigh. Lond., Edinburgh & Dublin Phil. Mag., vol. 36, no. 213, Sept. 1918, pp. 231-234. Direct mathematical consideration of the general case of a double resonator where two reservoirs of different volumes communicate with each other and with the atmosphere by narrow passages. This case cannot be treated by formula given in author's Theory of Sound.

Adsorption of Gases

The Adsorption of Gases on Plane Surfaces of Glass, Mica and Platinum, Irving Langmuir. Jl. Am. Chem. Soc., vol. 40, no. 9, Sept. 1918, pp. 1361-1403. Experimental confirmation of author's theory of adsorption—that it is the result of time lag between condensation of gas molecule impinging on solid and its subsequent evaporation—against results obtained by other investigators who claim that adsorbed films are relatively thick.

Aggregation

A Geometrical Basis for Physical and Organic Phenomena, John Millis. Science, vol. 48, no. 1241, Oct. 11, 1918, pp. 353-360, 1 fig. Geometrical analysis of principle stated in previous paper by writer: In any aggregation of an indefinite number of equal spherical bodies an arrangement giving minimum total volume occupied and perfect symmetry is impossible.

Air

Physics of the Air, W. J. Humphreys. Jl. Franklin Inst., vol. 186, no. 4, Oct. 1918, pp. 481-510, 3 figs. Types and latitude variation of aurora polaris; gradient wind velocity tables for every 5 deg. of latitude from 25 to 60 deg. (Concluded.)

Arc, Circular

Some Two-Dimensional Potential Problems Connected with the Circular Arc, W. G. Bickley. Lond., Edinburgh & Dublin Phil. Mag., vol. 36, no. 213, Sept. 1918, pp. 273-279, 6 figs. Drawings of stream lines in case of disturbance due to infinitely long lamina in the form

of circular arc, examination of case of rotation of the arc, and brief discussion of motion of arc when free to move and acted upon by the consequent fluid pressures.

Arc, Electric, in Gases

Experimental Examination of the Arc in Gases under Pressure, W. Mathiesen. Elecn., vol. 81, no. 2106, Sept. 27, 1918, pp. 451-452, 2 figs. Abstract of article in Elektrotechnische Zeitschrift, no. 49, 1917.

Crystals

New Method of Analysis of Crystals by Means of X-Rays (Nouvelle méthode d'analyse des cristaux au moyen des rayons X). Revue Générale des Sciences, year 29, nos. 15-16, Aug. 15-30, 1918, pp. 449-450. Method consists of photographing diffraction image obtained by passing narrow pencil of monochromatic X rays through an ensemble of small crystals of substance.

Evaporation

The Evaporation of Small Spheres, Irving Langmuir. Phys. Rev., vol. 12, no. 5, Nov. 1918, pp. 368-370. Suggests theoretical explanation for phenomena observed in experiments on evaporation of small iodine spheres of about one millimeter diameter performed by Harry W. Morse and described in Proc. Amer. Acad. Arts & Sci., vol. 45, Apr. 1910.

Heat

Is the Principle of Equivalence a Consequence of Carnot's Principle? (Le principe de l'équivalence est-il une conséquence du principe deCarnot?), C. Raveau. Comptes Rendus des Séances de l'Académie des Sciences, vol. 167, no. 9, Aug. 26, 1918, pp. 329-331. On the nature of heat as directly deductible from the postulate of Carnot.

Optics

An Optical Method for Accurately Dividing a Circle into Degrees, R. S. Clay. Sci. Am. Supp., vol. 86, no. 2229, Sept. 21, 1918, pp. 188-189, 5 figs. Based on symmetrical images by two inclined mirrors. From Trans. Optical Soc., London.

The Scattering of Light by Air Molecules, R. W. Wood. Lond., Edinburgh & Dublin Phil. Mag., vol. 36, no. 213, Sept. 1918, pp. 272-273. Result of experiments indicating that ultra-violet light causes precipitation of something from air, causing a slight cloud.

State, Equation of

On the Influence of the Finite Volume of Molecules on the Equation of State, Megh Nad Shaha and Satyendra Nath Basu. Lond., Edinburgh & Dublin Phil. Mag., vol. 36, no. 212, Aug. 1918, pp. 199-202. Argument to show that b in van der Waal's equation of state, taking into account finiteness of molecules and influences of forces of cohesion, does not properly represent influence of finite molecular volumes.

Vibrations

Forced Vibrations Experimentally Illustrated, E. H. Barton and H. M. Browning. Lond., Edinburgh & Dublin Phil. Mag., vol. 36, no. 212, Aug. 1918, pp. 169-178, 2 figs. Types of experiments illustrating qualitatively and quantitatively the chief phenomena concerned with forced vibrations similar to the ones occurring in resonance tubes, fluorescence, Lodge's syntonic jars, Hertz's oscillator and resonator, and wireless telegraphy; detailed theory explaining them.

On Kirchhoff's Formulation of the Principle of Huygens, A. Anderson. Lond., Edinburgh & Dublin Phil. Mag., vol. 36, no. 213, Sept. 1918, pp. 261-270, 3 figs. Deviation in usual procedure to establish Kirchhoff's formula consisting in beginning with a single source and assuming that the vibrational velocity at a distance r from source of disturbance is $(M/r)\ \Phi\ (t - \frac{r}{a})$, where M is a constant and a the velocity of propagation.

PIPE

Joints

Cement Joints for Gas Mains. Eng. & Cement World, vol. 13, no. 4, Aug. 15, 1918, pp. 21-23, 3 figs. Suggestions regarding design of cement joints made from experimental tests conducted at Iowa State college, Ames, and Highland Park College, Des Moines. Abstract of article in Iowa Engr., Apr. 1918.

Sewer Pipe

How Glazed Cement Sewer Pipe Is Made. Cement & Eng News, vol. 30, no. 8, Aug. 1918, p. 22. Description of Process followed by a Cal. manufacturing concern.

Winter Breakages

Methods for Obviating Pipe Breakages in Winter (Beseitigung der Gefahr von Rohrbrüchen bei Frostwetter), Lorenz. Journal für Gasbeleuchtung, year 61, no. 20, May 18, 1918, pp. 236-237.

POWER GENERATION AND SELECTION

Agriculture

Note on the Applications of Electricity to Agriculture (sur les applications de l'électricité a l'agriculture). Revue Générale de l'Electricité, vol. 4, no. 10, Sept. 7, 1918, pp. 352-354. Conditions under which a central station for rural power consumption can be installed.

Costs

Mastering Power Production, Walter N. Polakov. Indus. Management, vol. 56, no. 4, Oct. 1918, pp. 321-329, 6 figs. Principle of essential cost and use of standard cost. (Ninth article.)

Docks

Utilization of Electricity in Docks and Harbors. Shipbuilding & Shipping Rec., vol. 12, no. 9, Aug. 29, 1918, pp. 205-206. Review of possibilities opened up by recommendations of Coal Conservation Committee recently issued by Ministry of Reconstruction.

Dredging

Using Electric Power to Dredge a Relocated River Channel, J. H. Walter. Eng. News-Rec., vol. 81, no. 16, Oct. 17, 1918, pp. 723-725. Washington Counties build suction dredge operated by 800-horsepower motor.

Isolated Plant

Interconnection Will Help Coal Situation. Power House, vol. 11, no. 10, Oct. 1918, pp. 294-296. Considerations on practicability of interconnecting isolated plants with central station.

Quarry

The New Modern Rock Crushing Plant of the Brownell Improvement Company. Cement Eng. News, vol. 36, no. 8, Aug. 1918, pp. 38-39, 1 fig. Quarry operations and details of power plant and electrical features.

Rolling Mills

Electrification of a Steam-Driven Three-High Merchant Mill at the Frodingham Iron and Steel Works. Elecn., vol. 81, no. 2098, Aug. 2, 1918, pp. 297-299, 4 figs. Account of some problems which were solved in making change from steam to electricity.

Statistics of Consumption

Power Consumption of National Industries, L. W. Schmidt. Power, vol. 48, no. 18, Oct. 29, 1918, pp. 628-630. An attempt by author to evolve a scheme according to which power requirements of leading national industries should be measured with a view to facilitating regional distribution and to prevent waste; a statistical table accompanies article.

Waste Heat

The Utilization of Waste Heat from Open-Hearth Furnaces for the Generation of Steam, Thomas B. Mackenzie. Iron & Steel Inst., advance copy, paper 12, Sept. 12-13, 1918, 24 pp., 4 figs. Report of tests conducted by author with acid-lined open-hearth furnace of 30 tons nominal capacity and Babcock and Wilcox water-tube boiler having 720 sq. ft. heating surface.

Water Power

Power Possibilities in California, F. H. Fowler. Jl. of Elec., vol. 41, no. 9, Nov. 1, 1918, pp. 393-395, 2 figs. Survey of streams indicating where maximum development has already been reached, drawbacks of certain localities and advantages of others.

The Energy Supply of North America, C. P. Steinmetz. Elec. News, vol. 27, no. 20, Oct. 15 1918, pp. 22-24 and 38. Urges conservation of coal and utilization of all possible water powers. Before Am. Inst. Elec. Engrs.

See also Air Machinery (Wind Power); Hydraulic Engineering (Inter-connected Plants).

POWER PLANTS

Argentine

Power Supply for the Central Argentine Electrification. Elec. Ry. Jl., vol. 52, no. 15, Oct. 12, 1918, pp. 646-650, 3 figs. Description of steam turbine electric power station supplying traction, lighting and power requirements in suburbs of Buenos Aires. Also in Elec. World, vol. 72, no. 15, Oct. 12, 1918, pp. 684-687, 3 figs.

Boiler-Room Management

See Operation.

Boiler Settings

Tight Boiler Settings an Aid to Economy, J. E. McCormack. Power House, vol. 11, no. 10, Oct. 1918, pp. 292-293. Instances under author's observation and suggestions to secure air-tightness.

Costs

Plant Arrangement and Costs of Construction. Elec. World, vol. 72, no. 17, Oct. 26, 1918, pp. 780-782, 4 figs. Features of latest station of Turners Falls Power & Electric Company, Chicopee Junction, Mass. (First article.)

Engine Economy

Increasing Engine Economy, M. A. Saller. Power Plant Eng., vol. 22, no. 21, Nov. 1, 1918, pp. 870-873, 7 figs. Effects on capacity and efficiency of running engine condensing. (Fourth article.)

Floods

The Power Station at Millers Ford. Elec. Rev., vol. 73, no. 16, Oct. 19, 1918, pp. 603-608, 7 figs. Description of features of new steam-electric power plant of Dayton Power Light Co. Precautions against floods.

Hydroelectric

Fourth Successive Hydro-Electric Plant Nears Completion at Rumford, Maine. Eng. News-Rec., vol. 81, no. 15, Oct. 10, 1918, pp. 654-657, 6 figs. Development, begun in 1892, has increased from 200 to 30,000 hp. Description with map and sketches of the new work.

Malamort Electric Power House (L'usine électrique de Malamort), A. Boudrau. Revue Générale de l'Electricité, year 29, nos. 15-16, Aug. 24, 1918, pp. 270-274, 6 figs. Account of development of hydroelectric power station.

New Hydroelectric Plant of Montana Power Company, W. A. Scott. Elec. Rev., vol. 73, no. 14, Oct. 5, 1918, pp. 535-537, 2 figs. (Second article.)

Instruments

See Operation.

Operation

Arrangements to Avoid Operating Difficulties. Elec. World, vol. 72, no. 16, Oct. 19, 1918, pp. 732-734, 8 figs. Description of a plant in Dayton, Ohio, in which special attention has been given to handling coal economically, obtaining clean intake water, providing flexible piping layout and furnishing adequate boiler-room instruments.

Boiler-Room Management Plan, T. N. Wynee. Elec. World, vol. 72, no. 12, Sept. 21, 1918, pp. 549-552, 5 figs. How fifty to one hundred thousand dollars is saved annually by Indianapolis Company in trained boiler-room men and in adequate boiler-room equipment. From paper before Indiana Electric Light Assn., Aug. 1918.

Power Plant Management; The Use of Instruments, Robert June. Power House, vol. 11, no. 10, Oct. 1918, pp. 281-283, 7 figs. Summary of best current practice.

The Millers Ford Station. Power Plant Eng., vol. 22, no. 20, Oct. 15, 1918, pp. 825-831, 10 figs. Unique method of handling condenser water, flood protection; electrical layout; description of steam-electric plant at Dayton, O.

Waterworks Operation. Mun. Jl., vol. 45, no. 17, Oct. 26, 1918, pp. 322-324. Using records for increasing efficiency; analyzing flue gases; soot blowers; steam jets; chain grate, overfeed and underfeed stokers.

Power Factor

Getting the Maximum Out of Equipment, Will Brown. Elec. World, vol. 72, no. 17, Oct. 26, 1918, pp. 791-793, 1 fig. The power producer and the user must coöperate in order to improve power factor, otherwise adequate power to meet essential needs may not be available in approaching winter; remedy readily applicable.

Power-Factor Correction, an Urgent Necessity, Will Brown. Elec. World, vol. 72, no. 18, Nov. 2, 1918, pp. 834-837, 1 fig. Overlapping of fall lighting and power loads together with fuel scarcity may curtail power unless power factor is improved; causes of low power factor, how to locate them and the proper remedies to apply.

Soot in Boiler Tubes

Keeping Boiler Tubes Free from Soot, W. Saller. Power House, vol. 11, no. 10, Oct. 1918, p. 297. Effect of soot accumulation on boiler efficiency.

Turbo-Electric

A New 25,000-kw. Power Plant for Dayton, Ohio. Power, vol. 48, no. 18, Oct. 29, 1918, pp. 620-624, 3 figs. Principal data and description of new turbo-electric plant.

Detailed Description of Recently Installed 45,000-kw. Turbine Generators, J. P. Rigsby. Elec. News, vol. 27, no. 20, Oct. 15, 1918, pp. 28-30. Westinghouse cross-compound, double-unit type, consisting of a high and low pressure turbine, each connected through a flexible coupling to its own generator, mounted on separate bedplates supported on foundations lying parallel to each other.

Water Softening

Use of Soda Ash in Water Softening, William Henry Hobbs. Ry. Rev., vol. 63, no. 18, Nov. 2, 1918, pp. 633-635. Emphasizes im-

portance of accuracy in adjusting treatment to individual needs.

See also Air Machinery (Air Supply to Boiler Room); Building and Construction (Wind Pressure), (Chimneys); Engineering Materials (Boiler Plates); Corrosion (Electrolytic Prevention).

POWER TRANSMISSION

Belting

Textile Belting for Driving and Conveying, A. Chadwick. India-Rubber Jl., vol. 56, no. 14, Oct. 5, 1918, pp. 1-5, 4 figs. Manufacture of sewn cotton ducks, balata, solid woven cotton, and solid woven hair belting. Before Lancashire Section of Textile Industry.

Magnetic Gearing

Magnetic Gearing Arrangement (fuelques dispositifs d'embrayage magnétique). Revue Générale de l'Electricité, vol. 4, no. 10, Sept. 7, 1918, pp. 354-356, 5 figs. Principle of operation and scheme of connections of an automatic differential type.

PRODUCER GAS AND GAS PRODUCERS

Wood Gasification

Some Data of Tests on Wood Gasification in Inclined Retorts in Sweden (Einige Mitteilungen über Versuche mit Holzvergasung in geneigten Retorten bei Värtagasverket in Stockholm, Schweden), Adolf Molin. Journal für Gasbeleuchtung, year 61, no. 5, Feb. 2, 1918, pp. 50-55, 5 figs.

PUMPS

Centrifugal

Progress in Water Works Pumping Machinery, L. D. Grisbaum. Fire & Water Eng., vol. 64, no. 12, Sept. 18, 1918, pp. 202-203. Development of centrifugal pumps and their various present uses.

Irrigation

Operating Features of a California Pumping Project. Elec. Rev., vol. 73, no. 14, Oct. 5, 1918, pp. 523-525, 4 figs. Terra Bella irrigation system operated entirely by motor-driven pumps supplied by central station.

See also Steam Engineering (Pumping Engines).

RAILROAD ENGINEERING, ELECTRIC

Electrification

Railway Electrification to Save Fuel, W. J. Davis. Jl. of Elec., vol. 41, no. 9, Nov. 1, 1918, pp. 411-412. Figures bringing out loss of fuel which results from present method of making each engine a power plant in itself.

Power House

Electrification of the Central Argentine Railway. Power, vol. 48, no. 16, Oct. 15, 1918, pp. 550-554, 5 figs. Details of power house and equipment.

Rolling Stock

Efficient and Systematic Maintenance Prolongs Life of Rolling Stock and Reduces Operating Costs. Elec. Ry. Jl., vol. 52, no. 14, Oct. 5, 1918, pp. 622-623, 5 figs. Account of methods of Evanston, Ill., Railway in cutting power costs and increasing fare collections.

Heavy Electric Traction on the Central Argentine. Elec. Ry. Jl., vol. 52, no. 14, Oct. 5, 1918, pp. 604-609, 7 figs. Details of rolling stock, power and brake control, collecting shoe and conducting rail.

Suburban Lines

Electric Railways in Argentina. Times Eng. Supp., no. 528, Oct. 1918, pp. 208-209, 3 figs. Details of transmission and distribution in Central Argentine suburban lines.

Track Switches, Automatic

Automatic Track Switches Release Men for Other Work, R. C. Cram. Elec. Ry. Jl., vol. 52, no. 16, Oct. 19, 1918, pp. 686-693, 18 figs. Study of development and present status of automatic and remote-control track switches with consideration of factors which have contributed to their evolution.

Universal Cars

The First Universal Car. Elec. Ry. Jl., vol. 52, no. 17, Oct. 26, 1918, pp. 729-730, 1 fig. Preliminary details of one-man, two-man pre-payment and post-payment car submitted by War Board to Housing Bureau.

See also Machine Shop (Gear Cutting).

RAILROAD ENGINEERING, STEAM

Alaska

Railroad Construction Progress in Alaska. Ry. Rev., vol. 63, nos. 14 and 15, Oct. 5 and 12, 1918, pp. 487-490, 7 figs and 537-539, 7 figs. Line between Seward and Anchorage completed; work on other sections well advanced.

Boilers

Constructing Locomotive Boilers and Fireboxes. Ry. Gaz., vol. 29, no. 12, Sept. 20, 1918, pp. 311-312, 2 figs. Operation of portable gap riveter.

Brazil

The Development of the Brazilian Railways. Ry. Age, vol. 65, no. 16, Oct. 18, 1918, pp. 701-704, 4 figs. Statistics of Brazilian railways; Brazil presented as important potential market for American railway supply manufacturers; statistics of imports of railway equipment.

Brakes

Importance of High-Speed Brakes in Railroad Operation (l'importance des freins rapides dans l'exploitation des chemins de fer), J. Cablier. Revue Générale de l'Electricité, vol. 4, no. 10, Sept. 7, 1918, pp. 351-352. Comparison of interest and amortization of involved expense with benefit derived in transportation service.

Cars

U. S. R. A. Standard Baggage Cars. Ry. Mech. Eng., vol. 92, no. 10, Oct. 1918, pp. 561-564, 6 figs. Description of 60-ft. and 70-ft. all steel baggage cars constructed for U. S. Railroad Administration.

Draft Gears

Draft Gears Should Be Maintained, L. T. Canfield. Ry. Mech. Eng., vol. 92, no. 10, Oct. 1918, pp. 565-567, 2 figs. Proper protection to car and to lading requires a system of periodical inspection and repairs.

Fireboxes

The Belpaire Firebox. Ry. Gaz., vol. 29, no. 12, Sept. 20, 1918, p. 308, 3 figs. Account of American experience with that type and subsequent design modifications required.

French Equipment

See Operation.

Heating, Train

The Coal Saving Problem and Train Heating. Ry. Gaz., vol. 29, no. 15, Oct. 11, 1918, pp. 383-384, 2 figs. Suggests apparatus for recovering waste heat. Before Instn. Locomotive Engrs.

Loading

Proper Methods of Loading Automobiles. Ry. Rev., vol. 63, no. 16, Oct. 19, 1918, pp. 565-569, 11 figs. Analysis of methods employed by shippers and a representative railroad.

Locomotive Crankpin

A Ball Bearing Crank Pin. Ry. Gaz., vol. 29, no. 15, Oct. 11, 1918, p. 385, 2 figs. Application of ball-bearing to crank pin of a 2-10-2 type. From Ry. Mech. Engr.

Locomotive Firing

The Economical Use of Coal in Railway Locomotives. University of Ill. Bul., vol. 16, no. 2, Sept. 9, 1918, 71 pp., 17 figs. Statement of facts concerning choice, distribution, storage, and use of coal, and suggestions intended to supplement efforts of railway men to save coal.

Locomotive Valve Gear

A New Locomotive Valve Gear. Ry. Gaz., vol. 29, no. 14, Oct. 4, 1918, p. 359, 1 fig. Motion of valve same as obtained with Stephenson gear, but eccentric motion work removed from between frames and applied to outside using double crank arm as substitute for eccentrics and straps.

Locomotives

First Standard 0-8-0 Switcher. Ry. Mech. Eng., vol. 92, no. 10, Oct. 1918, pp. 543-545, 5 figs. Description and principal data of standard switcher built for U. S. Railroad Administration. Also in Ry. Rev., vol. 63, no. 14, Oct. 5, 1918, pp. 513-515, 4 figs.

4-6-0 Passenger and Double Bogie Tender, London & South-Western Railway. Ry. Engr., vol. 39, no. 465, Oct. 1918, pp. 184-186, 2 figs. Dimensions of cylinders, wheels, valve gear, boiler, heating surface, and weights. Also in Ry. Gaz., vol. 29, no. 14, Oct. 4, 1918, p. 361, 1 fig.

4-6-2 Type Locomotive, Philadelphia & Reading Railway. Ry. Gaz., vol. 29, no. 15, Oct. 11, 1918, p. 387, 1 fig. Features and dimensions.

Heavy Mallet Compound for Virginian Railway. Ry. Rev., vols. 63 and 65, nos. 14 and 16, Oct. 5 and 18, 1918, pp. 497-498 and 688-691, 3 figs. General description with principal data.

Modern Locomotive Engine Design and Construction (XLII). Ry. Engr., vol. 39, no. 465, Oct. 1918, pp. 187-191, 4 figs. Effect of superheating on both steam and fuel consumption at various rates of expansion.

Pacific Type Locomotives for the Central of New Jersey. Ry. Age, vol. 65, no. 18, Nov. 1, 1918, pp. 769-770, 1 fig. Description and principal data.

U. S. R. A. Standard Six-Wheel Switching Locomotive. Ry. Age, vol. 65, no. 15, Oct. 11, 1918, pp. 655-657, 3 figs. Principal data, drawings and tonnage chart, with general description of smallest government engines.

Long Fork Railroad

The B. & O. Completes the Long Fork Railway, A. C. Clark. Ry. Age, vol. 65, no. 15, Oct. 11, 1918, pp. 663-665, 5 figs. Description of new line which is important step in development of coal resources of Kentucky.

Operation

Difficulties in Handling French Equipment, J. N. McVey. Ry. Rev., vol. 63, no. 16, Oct. 19, 1918, pp. 581-584. Trials encountered by Amer. Ry. Engrs. in handling foreign equipment.

Permanent Way

Stresses in Permanent Way. Ry. Engr., vol. 39, no. 465, Oct. 1918, pp. 191-194, 8 figs. Report of extensive tests made on two lines in United States, on various sections. (Continuation of serial.)

Rails

A Metallographic Investigation of Transverse-Fissure Rails with Special Reference to High-Phosphorus Streaks, G. F. Comstock. Bul. Am. Inst. Min. Engrs., no. 143, Nov. 1918, pp. 1699-1714, 17 figs. Experimental research of two proposed theories regarding formation of fissures: (1) that they are the result of fatigue of steel, and (2) that they are originated from a defect on steel.

Common Defects in Rail. Ry. Rev., vol. 63, no. 14, Oct. 5, 1918, pp. 498-501. From paper by C. W. Gennet before convention of Roadmasters & Maintenance of Way Assn., Chicago, Sept. 1918.

Relative Life of Manganese and Open-Hearth Rail on Curves, H. W. Roberts. Elec. Ry. Jl., vol. 52, no. 16, Oct. 19, 1918, pp. 697. Results of tests are given showing manganese rail to wear about seven times as long as open hearth.

Why Busy Rails Do Not Rust, Oliver P. Watts. Iron & Steel of Can., vol. 1, no. 9, Oct. 1918, pp. 359-361. Review of experimental investigations by various authors. Before Am. Elec. Chem. Soc.

Rates

Railway Rates, R. A. Lehfeldt. Jl. S. A. Instn. of Engrs., vol. 17, no. 2, Sept. 1918, pp. 19-26. Methods of economics as applied to engineering; comparison of American and South African units for passenger traffic.

Resistance

The Mechanics of Curved Resistance. Ry. Rev., vol. 63, no. 15, Oct. 12, 1918, pp. 527-531, 2 figs. A study, covering older theories with data of recent experiments. From paper by J. G. Sullivan contributed to Bulletin 207 of Am. Ry. Eng. Association. Also in Ry. Age, vol. 65, no. 15, Oct. 11, 1918, pp. 665-666.

Shops

Machining Locomotive Driving Boxes, Frank A. Stanley. Ry. Mech. Eng., vol. 92, no. 10, Oct. 1918, pp. 573-575, 11 figs. Outline of work as performed at the Sacramento shops of Southern Pacific.

New Devices in Soo Wheel Shop. Ry. Mech. Eng., vol. 92, no. 10, Oct. 1918, pp. 577-579, 5 figs. Shifting platforms at press and automatic discharging axle carrier add to efficiency of plant.

The Manufacture of Laminated Springs. Ry. Gaz., vol. 29, no. 15, Oct. 11, 1918, pp. 388-390, 4 figs. General layout of locomotive smithy and steam hammer shops.

Signaling

New Electric Interlocking at Clyde, Ill. Ry. Signal Engr., vol. 11, no. 10, Oct. 1918, pp. 306-307, 5 figs. Plant on Chicago, Burlington & Quincy for handling increased main line and yard movement due to heavier traffic.

Tenders

New Tender for Canadian Pacific Locomotives. Ry. Rev., vol. 63, no. 15, Oct. 12, 1918, pp. 525-526, 2 figs. Dimensioned drawing and general description.

Ties

Present Aspect of the Tie Situation. Ry. Rev., vol. 63, no. 14, Oct. 5, 1918, pp. 494-495. Principles governing buying and specification of cross ties and difficulties of correct price fixing. From remarks by John Foley at Annual Roadmasters' convention, Chicago, Sept. 1918.

Reinforced Concrete Ties on Southern Pacific. Ry. Rev., vol. 63, no. 16, Oct. 19, 1918, pp. 557-558, 4 figs. Practical solution of

problem faced in present-day shortage of wooden ties.

See also Metal Working Tools (Locomotive Repair Tools).

REFRACTORIES

Silica Bricks

The Manufacture of Silica Brick, H. Le Chatelier and B. Bogitch. Can. Min. Jl., vol. 39, no. 18, Sept. 15, 1918, pp. 314-317. Causes of failure of furnace roofs; why silica brick retains rigidity at high temperature; manufacturing operations. Paper before Am. Inst. of Min. Engineers, Milwaukee.

Tests

The Standardization of Tests for Refractory Materials, Cosmo Johns. Iron & Steel Inst., advance copy, paper 11, Sept. 12-13, 1918, 32 pp., 3 figs. Analysis of fire clays, raw ganisters, quartose, rocks, and manufactured products; analysis of dolomite and magnesite identification of the various forms of silica in silica bricks; porosity, water absorption and specific gravity tests; shrinkage of clays on drying and firing; tensile strength of dried clays; refractoriness and crushing strength. Prepared provisionally by a committee of refractories section of Ceramic Society.

REFRIGERATION

Refrigerating Plant, A. E. F.

Refrigerating Plant, Intermediate Depot for American Army in France, Robert K. Tomlin, Jr. Power, vol. 48, no. 17, Oct. 22, 1918, pp. 596-598, 4 figs. Description of plant to care for 5000 tons of meat.

Throttling of Ammonia

Throttling of Ammonia, Charles H. Herter. Power, vol. 48, no. 15, Oct. 15, 1918, pp. 530-531. Discusses question of whether it is better to regulate several expansion valves singly, or main liquid valve at receiver.

RESEARCH

British Committee

Scientific and Industrial Research. Third Annual Report. Iron & Coal Trades Rev., vol. 97, no. 2636, Sept. 6, 1918, pp 257. Report of Committee of Privy Council for Scientific and Industrial Research.

British National Physical Laboratory

Research the Mainstay of a Nation's Industries, Richard T. Glazebrook. Can. Machy., vol. 22, no. 16, Oct. 17, 1918, pp. 449-454, 5 figs. Work accomplished by Nat. Research Lab. of England.

The British National Physical Laboratory. Sci., vol. 48, no. 1238, Sept. 20, 1918, pp. 284-287. Brief report of work done during past year in electricity, heat, meteorology, aerodynamics and special research and investigations.

Cotton Manufacturers' Committee

Committee on Industrial Research. Textile World Jl., vol. 54, no. 19, Nov. 9, 1918, pp. 117-119. Report of committee of Nat. Assn. of Cotton Mfrs. on possibilities of research along lines connected with cotton manufacturing industry and best methods to carry it out.

See also Aeronautics (Research).

ROADS AND PAVEMENTS

Asphalt

Maintaining Old Asphalt Pavements in Buffalo, C. E. P. Babcock and J. A. Vandewater. Can. Engr., vol. 35, no. 15, Oct. 10, 1918, pp. 325 and 331-332, 2 figs. Average costs of repairs per yard at different ages to date of condemnation. Before Am. Soc. Mun. Improvements.

Cracks

The Prevention of Longitudinal Cracks in Hard-Surfaced Pavements, Wm. C. Perkins. Good Roads, vol 16, no. 17, Oct. 26, 1918, pp. 158 and 161. Description of patented method of constructing foundations for brick, concrete and other surfacing. Before Am. Soc. Mun. Improvements.

Drainage

Drainage The Most Important Consideration Entering into Road Construction, J. H. MacDonald. Can Engr., vol. 35, no. 15, Oct. 10, 1918, pp. 327-329 and (discussion) pp. 329-331. Salient features of this question from local investigations. Before Fifth Annual Congress Can. Good Roads Assn.

The Maintenance of Drainage, R. A. Meeker. Good Roads, vol. 16, no. 12, Sept. 21, 1918, pp. 107-108, 2 figs. Its importance in care of roadway.

Fillers

The Choice of Fillers for Block Pavements. John S. Crandell. Mun. & County Eng., vol. 55, no. 4, Oct. 1918, pp. 127-130, 5 figs. Types of fillers; functions of a filler; granite block pavement.

Macadam

American Road Building in French War Zone Organized, Robert K. Tomlin. Highway Mag., vol. 9, no. 6, July 1918, pp. 1-3 and 6, 1 fig. Development of methods of constructing water-bound macadam from inspection by United States highway engineers of British and French Systems.

Maintenance Work

How Well-Maintained Roads are Secured, D. H. Winslow and Charles R. Thomas. Am. City, vol. 19, no. 4, Oct. 1918, pp. 266-270, 4 figs. Study of comparative benefits of local and central government in developing good roads, with special reference to North Carolina system of road maintenance.

Organization for Road Maintenance, L. H. Neilsen. Good Roads, vol. 16, no. 17, Oct. 26, 1916, pp. 157-158. Discussion of administration and operation of maintenance work in Michigan, with special reference to patrol system in township. Before Mich. State Good Roads Assn.

Motorized Equipment

The Motor Truck and Trailer in Road and Street Building, Repair and Maintenance. Cement Eng. News, vol. 30, no. 8, Aug. 1918, pp. 24-28. Data taken from records in office of a county engineer.

Repairs

War Time Road Repairs. Am. City, vol. 19, no. 4, Oct. 1918, pp. 259-261, 2 figs. Necessity of repairing roads and manner of keeping an earth road in satisfactory condition.

Rural Roads

Road Construction in Alberta, J. D. Robertson. Can. Engr., vol. 35, no. 13, Sept. 26, 1918, pp. 285-286. Experience in province with rural roads of sand, gravel, etc. Before Eng. Inst. of Can.

Slag

Roads During and After the War, E. Purnell Hooley. Can. Engr., vol. 35, no. 12, Sept. 19, 1918, pp. 265-266. Use of furnace slag as surface course. Before Instn. Mun. & County Engrs.

See also Cement and Concrete (Paving); Accounting (Highways).

SAFETY ENGINEERING

Accidents

Accident Prevention and Safety, a list of new books and articles received in the library of the National Workmen's Compensation Service Bureau, New York, September, 1918, 9 pp.

Foundation for the Assumption that 18 per cent of Industrial Accidents are Due to Defects in Lighting Installation, R. E. Simpson. Am. Gas Eng. Jl., vol. 109, no. 16, Oct. 19, 1918, pp. 364-366. Based on Travelers Insurance Co. records.

Works Accidents, Their Causes and Remedies. Can. Foundryman, vol. 9, no. 8, Aug. 1918, p. 175. Brief account of investigation conducted on behalf of the Health of Munition Workers' Committee.

Construction Work

Precautions for Reducing Accidents on Construction Work, W. J. Lynch. Can. Engr., vol. 35, no. 18, Oct. 31, 1918, p. 398. Before Construction Section of Nat. Safety Congress.

Dangerous Tools

Dangerous Tools and Appliances, Chesla C. Sherlock. Am. Mach., vol. 49, no. 16, Oct. 17, 1918, pp. 705-707. Review of some court findings on liability of employers.

Explosives

Handling and Storing Explosives, Arthur La Motte. Eng. & Min. Jl., vol. 106, no. 11, Sept. 14, 1918, pp. 488-493. (Nat. Safety Council.)

Fire Protection

Fire Protection of Turbo-Alternators (Protection contre les incendies de turbo-alternateurs), L. Conge. Revue Générale de l'Electricité, vol. 4, no. 10, Aug. 31, 1918, p. 322, 3 figs. Details of method permitting fire extinction by steam jet under pressure.

How Some Important Ship Fires were Fought, with Notes on Tools for Marine Fire-Fighting, Edward J. Worth. Quarterly of Nat. Fire Prevention Assn., vol. 12, no. 2, Oct. 1918, pp. 143-149. Before International Assn. of Fire Engrs.

Maintenance of Sprinkler Equipments during Cold Weather in Western Canada, John Young. Quarterly of Nat. Fire Protection Assn., vol. 12, no. 2, Oct. 1918, pp. 157-159. Practice in layout of water mains and of heating gravity tanks.

Oil Interrupters and Fire Protection (les interrupteurs à huile et la protection contre l'incendie), P. Torche. Revue Générale de l'Electricité, vol. 4, nos. 9 and 10, Aug. 31 and Sept. 7, 1918, pp. 311-319, 4 figs. and pp. 343-348, 2 figs. Aug. 31: Résumé of tests on interrupters undertaken by the Association Suisse des Electriciens for the purpose of establishing rules for construction use and installation of these apparatus. Sept. 7: Causes of explosion and analysis of American piston type, which, in author's opinion, is the only one safe against internal pressure.

Shipyard Fire Protection. Quarterly of Nat. Fire Protection Assn., vol. 12, no. 2, Oct. 1918, pp. 126-128. Notes on the organization of the Plant Protection Section of the Am. Fleet Corporation.

The Fire Risk on Vessels, Samuel D. McComb. Quarterly of Nat. Fire Protection Assn., vol. 12, no. 2, Oct. 1918, pp. 133-142, 2 figs. Study of hazards of marine transportation. From the Weekly Underwriter.

Grinding Wheels

Bursting Grinding Wheels, Chesla C. Sherlock. Am. Mach., vol. 49, no. 17, Oct. 24, 1918, pp. 767-769. Decisions of courts under various circumstances.

Health Conditions

Health of English Workmen in Munition Factories (la santé des travailleurs anglais dans les usines de munitions.) Revue Générale de l'Electricité, year 29, nos. 15-16, Aug. 15-30, 1918, pp. 451-452. Brief account of report of special committee appointed by British Government to study health conditions in industries.

Mine Rescue

Mine Rescue Apparatus. Engineer, vol. 126, no. 3272, Sept. 13, 1918, pp. 219-220, 4 figs. Report of a committee appointed to investigate types of breathing apparatus used in coal mines.

Punch Presses

Safe Punch Press Operation, W. W. Roach. Iron Age, vol. 102, no. 18, Oct. 31, 1918, pp. 1076-1077. Elimination of cuts and lacerations; mechanical guards; lighting and arrangement of machinery; safe practices. Paper before National Safety Council, St. Louis, Sept. 1918.

Spontaneous Heating

Spontaneous Heating of Grain and other Foodstuffs (Ueber die Selbsterhitzung von Getreiden und anderen Nährstoffen), J. F. Hoffman. Dinglers polytechnisches Journal, vol. 333, no. 8, Apr. 20, 1918, pp. 63-67, 1 fig.

Water Mains

Leakage from High-Pressure Mains and its Variation with the Pressure. Can. Engr., vol. 35, no. 13, Sept. 26, 1918, pp. 286-287, 1 fig. Report of service in fire system of Borough of Manhattan. From Jl. Am. Waterworks Assn.

Protection of Water Mains, Fire Hydrants and Valves in Winnipeg, Thomas H. Hooper. Quarterly of Nat. Fire Protection Assn., vol. 12, no. 2, Oct. 1918, pp. 159-160.

See also Hoisting and Conveying (Cranes); Mines and Mining (Mine Gases).

SANITARY ENGINEERING

Disinfection

Disinfection by Heat. Times Eng. Supp., no. 528, Oct. 1918, p. 207. Type of disinfectors; suggestions on conditions to be observed.

Drainage

Main Drainage and its Relation to River and Harbor Front Improvement, Morris Knowles and J. M. Rice. Can. Engr., vol. 35, no. 14, Oct. 3, 1918, pp. 297-302 and 318. Résumé of methods adopted in many of world's leading cities with detailed notes regarding design of Essex border intercepter. Before Am. Soc. of Mun. Improvements.

Plumbing

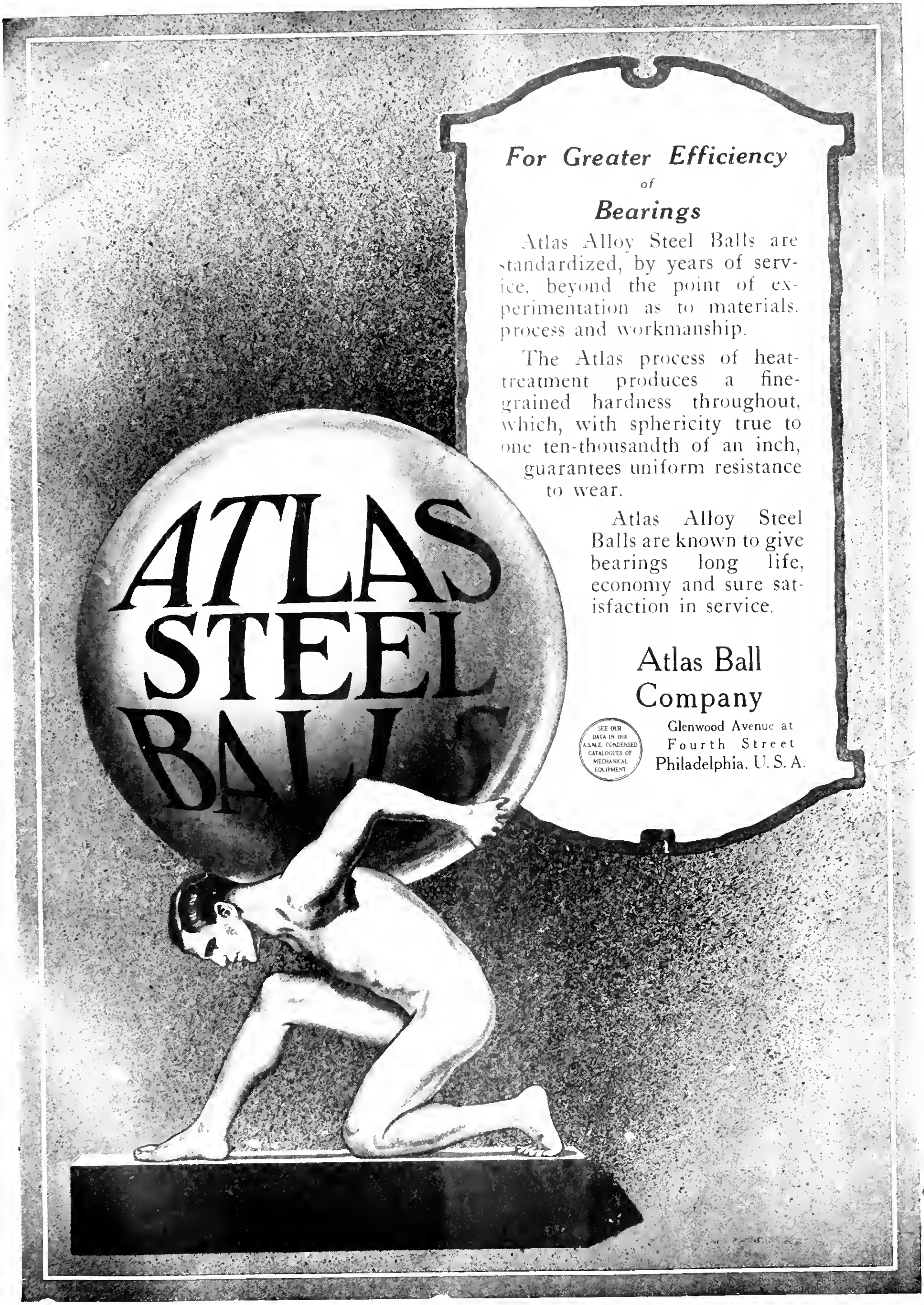
The Why and Wherefore of Sanitary Engineering, Arthur Bateman. Domestic Eng., vol. 35, no. 1, Oct. 5, 1918, pp. 5-7 and 32, 4 figs. Series on technical and scientific plumbing and sanitation.

Refuse Disposal

Refuse Incinerating Plants and their Operation, H. J. Harder. Mun. Jl., vol. 45, no. 17, Oct. 26, 1918, pp. 318-320. Tables giving name of city, capacity and other details of plant, and total cost per day.

Sanitation of Grounds

The Sanitation of Rural Workmen's Areas. Am. City, vol. 19, no. 4, Oct. 1918, pp. 275-278, 2 figs. Shows how to insure suitable living conditions for war-time industrial workers. From report of United States Public Health Service.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Sewage

Catch Basin Cleaning. Can. Engr., vol. 35, no. 13, Sept. 26, 1918, pp. 287-288. Annual report of superintendent of Bureau of Sewers, Chicago.

First Unit of Improved Means of Sewage Disposal for Philadelphia Well Started, W. L. Stevenson. Eng. News-Rec., vol. 81, no. 14, Oct. 3, 1918, pp. 629-633, 3 figs. Design features include intercepting sewer partly under pressure, ventilated grit chamber with sand removing and washing plant, and depressed Venturi meter.

Main Sewage Treatment Plant of Rochester, F. A. Fisher and N. A. Brown. Mun. Jl., vol. 45, no. 17, Oct. 26, 1918, pp. 326-329. Description and operating data of detritus tanks, Riensch-Wurl screens, Imhoff tanks, sludge beds and power plant. Before Am. Soc. Mun. Improvements.

Miles Acid Treatment of Sewage. Mun. Jl., vol. 45, no. 17, Oct. 26, 1918, pp. 321-322. Conclusion of report upon experiment with this process.

Operating Sewage Plants. Mun. Jl., vol. 45, no. 17, Oct. 26, 1918, pp. 327-328. Abstract of instructions issued by Texas State Board of Health; tanks, sludge beds, filters, activated sludge; operation records.

Sewage Purification by Activated Sludge Process, W. R. Copeland. Can. Engr., vol. 35, no. 14, Oct. 3, 1918, pp. 302 and 315-316. Comparative degrees of purification obtained with different quantities of air.

Sewer Design and Construction. Mun. & County Eng., vol. 55, no. 4, Oct. 1918, pp. 130-132, 1 fig. Sewage collection and disposal proposed at Los Angeles harbor; conditions calling for separate or combined sewers.

The Private Sewerage Question, D. H. Wyatt. Can. Engr., vol. 35, no. 14, Oct. 3, 1918, pp. 310-311. Results produced by leaky building drains and building sewers.

Uses and Accomplishments of Chlorine Compounds in Water and Sewage Purification, C. A. Jennings. Am. City, vol. 19, no. 4, Oct. 1918, pp. 296-304, 3 figs. Remarks on comparative value of liquid chlorine and hypochlorite for disinfection of water and sewage.

Water Purification and Sewage Treatment. Mun. & County Eng., vol. 55, no. 4, Oct. 1918, pp. 138-143, 8 figs. Prevention of Imhoff tank foaming at Schenectady; design and construction features of the slow sand water filtration plant at Auburn; chlorination and filtration.

Water Pollution

Salinification of Rivers and Elimination of Waste Liquids from Soda Works (Die Versalzung der Flüsse und die Beseitignng der Kaliabwässer). Journal fur Gasbeleuchtung, year 61, no. 19, May 11, 1918, pp. 221-224.

Pollution of Boundary Waters, F. A. Dallyn. Can. Engr., vol. 35, no. 15, Oct. 10, 1918, pp. 323-325. Examination of final report of International Joint Commission. Before Am. Soc. Mun. Improvements.

STANDARDS AND STANDARDIZATION

Aircraft Materials

British Engineering Standards Association. Aeronautics, vol. 15, no. 255, Sept. 4, 1918, pp. 224-226. Report regarding standardization of aircraft materials and parts.

Gearing

Standardization of Gearing, B. F. Waterman. Mech. World, vol. 64, no. 1645, July 12, 1918, pp. 14-15. Outline of details which author thinks may be standardized in each type. (Am. Gear. Mfrs. Assn. Convention.)

Lamp Voltages

The Standardization of Lamp Voltages, Leon Gaster. Illuminating Engr., vol. 11, no. 7, July 1918, p. 170. Announcement of Tungsten Lamp. Assn. proposing simplification in that respect.

See also Marine Engineering (Standardized Ships.)

STEAM ENGINEERING

Boiler Furnace Walls

New Data on Boiler Walls, J. C. Taylor. Nat. Engr., vol. 22, no. 9, Sept. 1918, pp. 408-409. Dominant factors in erection and operation of boiler furnace walls.

Boilers

Boiler Room Efficiency, A. H. Blackburn. Publicity Mag., vol. 17, no. 5, Sept. 1918, pp. 7 and 12-13. Suggestions for intensive fuel economy. Paper before Smoke Prevention Assn.

Development of Steam Boiler Baffles, Albert A. Straub. Power, vol. 48, no. 19, Nov. 5, 1918, pp. 656-659, 9 figs. Examples of baffles developed to obtain maximum economy and capacity consistent with the primary features for which the baffle was designed.

Feeding and Circulating the Water in Steam Boilers, John Watson. Page's Eng. Weekly, vol. 33, no. 735, Oct. 11, 1918, pp. 172-174. Survey of devices developed in recent years. Before Inst. Marine Engrs.

Removing Tubes, Headers and Baffles in Water-Tube Boilers. Power, vol. 48, no. 17, Oct. 22, 1918, pp. 584-590, 12 figs. Detailed directions with illustrations telling how to take out tubes of water-tube boilers, how to put them in, how to go about removing and replacing cast-iron and wrought-iron tube headers and what must be done to put in new brick for the baffling in the tubes.

Condensers

Keeping Condenser Performance up to the Mark, Hartley Le H. Smith. Elec. Ry. Jl., vol. 52, no. 16, Oct. 19, 1918, pp. 694-697, 4 figs. How station engineer can determine economy he should obtain and how he can correct causes of low vacuum.

Economizers

Economizers from the Viewpoint of a Designing and Operating Engineer, Louis R. Lee. Power, vol. 48, no. 18, Oct. 29, 1918, pp. 637-638, 1 fig.

Wear and Tear of Fuel Economizers, Edward Ingham. Colliery Guardian, vol. 96, no. 3014, Oct. 4, 1918, pp. 707. External corrosion; internal corrosion; water hammer; overheating; flue gas explosions; importance of frequent examinations.

Exhaust Steam

Using Exhaust Steam, S. E. Balcome. Power Plant Eng., vol. 22, no. 20, Oct. 15, 1918, pp. 832-835, 3 figs. Value of exhaust steam; limitations of its use; effects of engine efficiency; heat available with various types of engines.

Pumping Engines

Pumping Engines for the Cairo Main Drainage. Engineering, vol. 106, no. 2749, Sept. 6, 1918, pp. 251-252, 9 figs. Drawings of details and general description of quadruple expansion engines.

Turbines

Steam Turbine Development and Tendencies. Elec. Rev., vol. 73, no. 16, Oct. 10, 1918, pp. 612-614, 3 figs. Rapid development of turbine in past giving place to gradual developments affecting economy, reliability, safety and increased capacity.

Steam Turbines for Natural Steam Power Plant at Larderello, Italy. Engineering, vol. 106, no. 2752, Sept. 27, 1918, pp. 339, 14 figs. General description with drawings and illustrations.

See also Motor-Car Engineering (Steam Motors); Power Plants (Turbo-electric).

STEEL AND IRON

Acid-Resisting Irons

Acid Resisting Irons. Can. Foundryman, vol. 9, no. 8, Aug. 1918, p. 178. Properties and uses of silicon alloys; typical analysis of duriron and tantiron. (See also Tantiron.)

Cast Iron

A Method for the Prevention of Growth in Grey Cast Iron, J. E. Hurst. Iron & Steel Inst., advance copy, paper 10, Sept. 12-13, 1918, 5 pp., 3 figs. Investigation of possibility of removing graphite without subsequent production of cavities in metal by superficial decarbonization, oxidation of graphite being followed by liquidation of phosphate eutectic with remaining cavities. Also in Iron & Coal Trades Rev., vol. 97, no. 2638, Sept. 20, 1918, p. 323. Paper before Iron & Steel Inst., Sept. 1918.

Avoiding Shrinkage Troubles in Cast Iron. Can. Foundryman, vol. 11, no. 9, Oct. 1918, p. 264. Suggestions of some foundrymen regarding use of riser on top of casting to provide sufficient metal to prevent shrinking.

Influence of Some Special Constituents on Cast Iron, A. Campion. Foundry Trade Jl., vol. 20, no. 201, Sept. 1918, pp. 467-470. Nickel, chromium, molybdenum, tungsten, boron, and vanadium.

Duriron

See Acid Resisting Irons.

Electric Steel

Electric Pig Iron from Steel Scrap, Robert Turnbull. Iron Age, vol. 102, no. 17, Oct. 24, 1918, pp. 1026-1027. Paper before Am. Electrochemical Soc., Atlantic City, Oct. 1918.

Electric Steel Making, Arthur V. Farr. Am. Mach., vol. 49, no. 17, Oct. 24, 1918, pp. 753-755, 4 figs. Describing process of making steel electrically and giving analysis of charge at various stages of process and at end of melt. Paper before Am. Drop Forge Assn., Buffalo, N. Y., June 1918.

The Electric Furnace in the Steel Cast Industry, W. E. Moore. Elec. Jl., vol. 15, no. 9, Sept. 1918, pp. 331-332. Comparative value of crucible melting, open hearth melting, side-blow converter and electric furnace in producing steel.

Hot-Deformation

Influence of Hot-Deformation on the Quantities of Steel, Georges Charpy. Iron & Steel Inst., Sept. 12-13, 1918, advance copy, paper 4, 19 pp., 10 figs. Tensile tests, shock bend tests and notch tests on blooms resulting from three gun metal equal ingots, made in acid furnace and reduced from common original section of 355 x 355 mm., the first to 225 x 225 mm, the second to 165 x 165 mm, and the third to 125 x 125 mm.

Ingots

The Cooling of Steel in Ingot and Other Forms, J. E. Fletcher. Iron & Steel Inst., advance copy, paper 5, Sept. 12-13, 1918, 40 pp., 20 figs. Experimental investigation of laws governing freezing and cooling of steel in metal and sand molds involving the determination of variable speed of cooling, measurements of temperature gredients and contraction, and observations on influence of cooling on crystalline structure. Also in Engineering, vol. 106, no. 2752, Sept. 27, 1918, pp. 342-344, 6 figs.; Iron & Coal Trades Rev., vol. 97, no. 2638, Sept. 20, 1918, pp. 315-318, 9 figs. Abstract of paper before Iron & Steel Inst., Sept. 1918.

Iron Metallurgy

Some Experiments on the Reaction between Pure Carbon Monoxide and Pure Electrolytic Iron below the A 1 Inversion, H. C. H. Carpenter and C. Coldron Smith. Iron & Steel Inst., Sept. 12-13, 1918, advance conv, paper 3, 53 pp., 39 figs. Investigation under two different sets of conditions: (1) those in which gaseous products were removed continuously by passing a stream of carbon monoxide over the iron, and (2) tobe in which they were allowed to accumudate in apparatus.

Malleable Iron

Phosphorus in Malleable Cast Iron, J. H. Teng. Iron & Steel Inst., advance copy, paper 16, Sept. 12-13, 1918, 19 pp., 13 figs. Experiments at University of Birmingham on two series of test-bars: (1) by adding phosphoric iron to a very pure American washed white iron, (2) by adding the same to iron supplied by Birmingham malleable iron founders.

The Addition of Steel to Cast Iron, J. E. Hurst. Sci. Am. Supp., vol. 86, no. 2232, Oct. 12, 1918, p. 235. Experiments illustrating absorption of carbon by steel during melting in cupola; results obtained on melting steel borings and crop ends from smithy in a cupola together with 10 per cent ferro silicon. Also in Engineer, vol. 126, no. 3266, Aug. 2, 1918, p. 93.

Open-Hearth Furnace

The Principles of Open-Hearth Furnace Design, Chas. H. F. Bagley. Iron & Steel Inst., Sept. 12-13, 1918, advance copy, paper 1, 19 pp., 5 figs. Discussion from scientific and practical points of view in the light of author's 15 years' experience in England, Germany and United States. Also in Iron & Coal Trades Rev., vol. 97, no. 2637, Sept. 13, 1918, 5 figs.

Pyrometry

Pyrometry Applied to the Hardening of High Speed Steels, J. O. Arnold. Trans. Faraday Soc., vol. 13, part 3, June 1918, pp. 271-275. Results obtained at Sheffield University using an average temperature of 1300 deg. cent.

Quenching

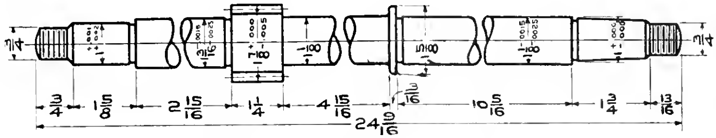
Note on the Warping of Steel through Repeated Quenching, J. H. Whiteley. Iron & Steel Inst., advance copy, paper 17, Sept. 12-13, 1918, 4 pp., 7 figs. Photographs showing change of shape of a cylindrical piece, weighing several pounds, which has been used for four years for warming small tank after being heated to blood-red heat. Also in Engineering, vol. 106, no. 2752, Sept. 27, 1918, pp. 340-341, 7 figs.

Spectra

A Comparative Study of the Flame and Furnace Spectra of Iron, G. A. Hemsalech. Lond. Edinburgh & Dublin Phil. Mag., vol. 36, no. 213, Sept. 1918, pp. 209-230, 7 figs. Experimental research leading autnor to conclude that iron spectra given by an electric-tube resistance furnace at atmospheric pressure and up to 2400 deg. cent. are caused by action of heat on a chemical compound of the metal and not on the free metal itself, that flame and furnace spectra are identical up to 2400 deg. cent., that the character of spectrum is independent of the nature of iron compound, and other similar results.

Steel

Composition and Properties of Steels, Howard Ensaw. Am. Mach., vol. 49, no. 15, Oct. 10, 1918, pp. 669-672, 1 fig. Composition of steels used for manufacture of various parts of intricate special machinery, especially airplane engines, requiring materials possessing



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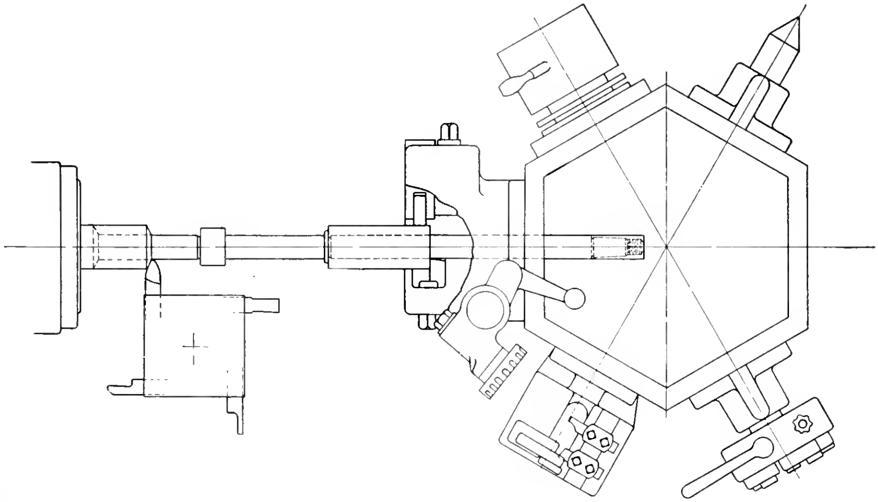

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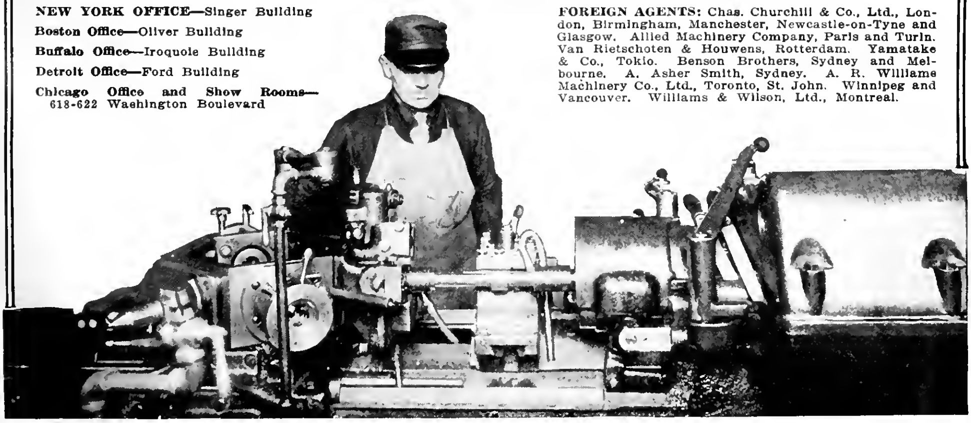

unusually high tensile strength and shock resisting qualities.

Iron, Carbon, and Phosphorus, J. E. Stead. Iron & Steel Inst. of Can., vol. 1, no. 8, Sept. 1918, pp. 323-333, 23 figs. Effect of introducing carbon, by cementation, into homogeneous solid solutions of iron and phosphorus; temperature ranges in which free phosphide of iron passes in and out of solid solution in iron. Before Iron & Steel Inst.

Non-Metallic Inclusions: Their Constitution and Occurrence in Steel, Andrew McCance. Iron & Steel of Can., vol. 1, no. 9, Oct. 1918, pp. 374-388, 35 figs. Experimental study of part played by inclusions in developing weaknesses and producing defects in steel products. (To be concluded.)

Note on Certain Colored Interference Bonds and the Colors of Tempered Steel, A. Mallock. Proc. Roy Soc., vol. 91, no. A664, Aug. 1, 1918, pp. 561-566, 2 figs. Scientific explanation of interference phenomena observed with two sheets of gauze when their distance is gradually altered.

The Influence of some Elements on the Tenacity of Basic Steel, with a new Formula for Calculating the Maximum Load from the Composition, Andrew McWilliam. Iron & Steel Inst., advance copy, paper 13, Sept. 12-13, 1918, 13 pp., 3 figs. Formula for sections that would give results near to those obtained on 1-in. round bars normalized, table showing effect of carbon between 0.1 and 0.75, and results of application of formula to certain series of steel.

Tantiron

Tantiron; Am. Acid Resisting Ferro-Silicon Alloy. Can. Machy., vol. 20, no. 17, Oct. 24, 1918, pp. 477-480, 8 figs. Properties, limitations, corrosion, molding and specialties. (See also Acid Resisting Irons.)

Testing

The Applicability of Electrical Resistance Measurements for the Investigation of Iron and Steel (Om användbarheten av elektriska motstandstmätningar för undersökning av järn och stal), B. D. Enlund. Jern-Kontorets Annaler, Nos. 3-4, 1918, pp. 165-221, 46 figs.

The Magnetic Analysis as a Means of Studying the Structure of Iron Alloys, Kôtaro Honda. Iron & Steel Inst., advance copy, paper 9, Sept. 12-13, 1918, 43 pp., 46 figs. Method based on following experimental facts: (1) the intensity of magnetization of simple homogeneous ferro-magnetic substances decreases at first slowly and subsequently more and more rapidly as temperature increases, and it vanishes at the critical temperature; (2) the critical temperature of a ferro-magnetic element or compound is a characteristic of substance independent of external conditions; (3) the magnetic susceptibility of a substance is abruptly changed when it undergoes an allotropic transformation.

Tuyeres

A Few Notes on Bosh Tuyeres, J. Hollings. Iron & Steel Inst., advance copy, paper 8, Sept. 12-13, 1918, 9 pp., 2 figs. Account of circumstances which led to adoption by author of bosh tuyeres, in 48-ft. furnace at Brymbo.

See also Railroad Engineering, Steam (Rails); Corrosion (Iron).

TERMINALS

Chicago

The Pennsylvania's New Goods Depot at Chicago. Ry. Gaz., vol. 29, no. 12, Sept. 20, 1918, pp. 304-307, 4 figs. Layout of tracks, general plans of floors and cross-sections.

Large Cities

Urges Study of Unit Operation of Railroad Terminals in Large Cities. Eng. News-Rec., vol. 81, no. 14, Oct. 3, 1918, pp. 615-619. Yards and Terminals Committee, Railway Engineering Assn., presents a special report recommending investigation by representative committees of possibilities of coördinating existing facilities.

St. Paul

Engineering at the St. Paul Passenger Terminal. Ry. Rev., vol. 63, no. 17, Oct. 26, 1918, pp. 595-597, 1 fig. New station; elevated tracks eliminating street crossings at grade; coach yard and locomotive terminal.

Toronto

Toronto Union Station an Imposing Structure. Can. Engr., vol. 35, no. 15, Oct. 10, 1918, pp. 319-321, 6 figs. Brief description of chief sub-contracts.

See also Lighting (Factory Lighting).

TESTING AND MEASUREMENT

Cells, Normal

Report on the Weston Normal Cells Exchanged with the Bureau of Standards and the National Physical Laboratory, Jûichi Obata. Department of Communications, Tokyo, Japan, Researches of the Electrotechnical Laboratory, no. 70, May 1918, 11 pp., 1 fig. Method of preparation of cell; three series of comparisons; variation in electromotive force of cell after transportation.

Dynamometers

A 900-Hp. Dynamometer Installation. Automotive Ind., vol. 39, no. 11, Sept. 12, 1918, pp. 449-451, 5 figs. Features relating to water cooling, exhaust disposal and dynamometer tests of mammoth engines in test house of Duesenberg Motors Corp. Also in Aviation, vol. 5, no. 6, Oct. 15, 1918, p. 371, 4 figs.

Gases, Temperature

Measuring the Temperature of Gases in Boiler Settings. H. Kreisinger and J. F. Barkley. Department of the Interior, Bureau of Mines, bul. 145, 72 pp., 31 figs. Discussion of various sources of error; manipulation of the potentiometer; list of publications on the utilization of coal and lignite.

Hardness

A New Method of Obtaining Brinell Hardness, J. G. Ayers. Automotive Ind., vol. 39, no. 11, Sept. 12, 1918, p. 457, 2 figs. Impact substituted for steady pressure to reduce time required for applying test.

Report on Hardness Testing: Relation between Ball Hardness and Scleroscope Hardness, A. F. Shore. Iron & Steel Inst., advance copy, paper 15, Sept. 12-13, 1918, 19 pp., 11 figs. Report of tests performed on a variety of metals both ferrous and non-ferrous, with different states of heat-treatment.

Hygrometry

Hygrometry in terms of the Weight of a Film of Gelatine, C. Barns. Science, vol. 48, no. 1241, Oct. 11, 1918, pp. 374-376, 2 figs. Adaptation of form of horizontal torsion balance used by author in measuring absolute viscosity of steel to indications of absorption of atmospheric vapors.

Insulation Resistance

Note on Measuring a Metallic or Insulation Resistance by the Voltmeter Method (Note sur la mesure d'une résistance (métallique ou d'isolement) par la méthode du voltmètre), Puget. Revue Générale de l'Electricité, vol. 4, no. 10, Sept. 7, 1918, p. 298, 2 figs. Indicates two methods to simplify for workingmen calculations involved in application of usual formula $X = R\,\frac{E - v}{u}$, where R is voltmeter resistance, E deviation connecting battery to voltmeter and u deviation with resistance in circuit.

Lead Testing

Lead Testing Machine. Can. Machy., vol. 20, no. 17, Oct. 24, 1918, pp. 484-485, 2 figs. Device consists of cast-iron bed machined all over with two parallel dovetail bearings on top.

Manometers

The Krell Manometer, A. A. Merrill. Aviation, vol. 5, no. 7, Nov. 1, 1918, pp. 421-422, 2 figs. Modification of air-laboratory U-type, in which one branch of U is a glass tube set at a small angle and other branch is a large tank.

Metric System

The International Bureau of Weights and Measures. Sci. Am. Supp., vol. 86, no. 2229, Sept. 21, 1918, pp. 186-187. Motives for creation and special features of metric system. From La Nature.

Pyrometers

The Types and Industrial Uses of Pyrometers. Can. Foundryman, vol. 9, no. 8, Aug. 1918, pp. 179-182, 3 figs. Classification into "contact" and "distant" classes; variation in indications; suitability of different types; location; details of electric circuit; radiation pyrometers.

Sand

Progress Report of Committee on Mechanical Analysis of Sands. Can. Engr., vol. 35, no. 18, Oct. 31, 1918, pp. 387-390. Specifications for standard sieves; methods of making mechanical analysis. From Report of Committee by Am. Water Works Assn.

Shell Steel

Physical Tests of Rolled Shell Steel, James J. Mahon. Iron Age, vol. 102, no. 18, Oct. 31, 1918, pp. 1082-1083, 2 figs. Explanation of frequent results at variance with chemical analysis; excessive precipitation of ferrite corrected by heat treatment.

Testing Machine, Tension and Compression

A Novel Tension and Compression Testing Instrument, Frank C. Perkins. Can. Machy., vol. 20, no. 14, Oct. 3, 1918, pp. 391-392, 6 figs. Device, applicable to wide range of specimen sizes, consists of two adjustable frames, each carrying two screws bearing on gage marks on specimen.

Thread Measurement

Projection Lantern for Thread Measurement, H. L. Van Keuren and E. C. Griess. Am. Mach., vol. 49, no. 18, Oct. 31, 1918, pp. 805-811, 10 figs. Describing an apparatus developed by the Bureau of Standards.

Voltameters

The Richards Form Silver Voltameters, Jûichi Obata. Department of Communications, Tokyo, Japan, Researches of the Electrotechnical Laboratory, no. 71, July 1918, 29 pp., 1 fig. Experimental investigation of the anode compilations in the silver voltameter and determination of voltage of Weston normal cell with Richards form silver voltameter.

See also Brick, Clay and Stone (Abrasion Test); Chemical Technology (Explosives); Hydraulic Engineering (Water Measurements); Lighting (Photometers); Metallurgy (Hardness of Metals); Refractories (Tests); Steel and Iron (Pyrometry); Steel and Iron (Testing).

THERMODYNAMICS

Heat-Transmission Tables

New Heat Transmission Tables, William R. Jones, Heat. & Vent. Mag., vol. 15, no. 10, Oct. 1918, pp. 36-41. Compilation in tabular form of factors given by leading authorities covering latest types of construction.

TIMBER

See Wood.

TRANSPORTATION

Farm Transport

Cheap Transport for Farmers and Rural Industries, Frank Dutton. South African Jl. of Industry, vol. 1, no. 12, Aug. 1918, pp. 1089-1105, 8 figs. Discussion of problem and description of possible solution by means of portable rail tracks for tractors.

Yard Transfer

Operating Methods of Transfer Railroads. Ry. Rev., vol. 63, no. 14, Oct. 5, 1918, pp. 490-493. Analysis of existing conditions and suggestions for improvement to meet demands of increased traffic. From paper by E. H. Lee contributed to preliminary report of Committee on Yards and Terminals, Am. Ry. Eng. Assn., Sept. 1918.

WOOD

Aeroplane Woods

Defects in Airplane Woods, Samuel J. Record. Sci. Am., vol. 119, no. 11, Sept. 14, 1918, p. 212, 5 figs. Method of judging quality of timber.

House Finish

The Uses of Wood (VI), Hu. Maxwell. Am. Forestry, vol. 24, no. 298, Oct. 1918, pp. 593-602, 16 figs. Its employment as house finish.

Kilns

Observation on Kiln Practice, N. S. Potter. Cement & Eng. News, vol. 30, no. 8, Aug. 1918, pp. 35-36. Suggestions as to the points to investigate in connection with raw material, kiln, coal, air, burner, draft and discharged gases, in order to secure efficient operation.

See also Engineering Materials (Precast Concrete Lumber); Fuel and Firing (Wood Burning).

WOOD-WORKING MACHINERY

Tie-Dressing Machine

Machine Dress Railroad Ties Before Treatment. Eng. News-Rec., vol. 81, no. 15, Oct. 10, 1918, 2 figs. Santa Fé stationary and portable plants that saw, adze, bore and brand ties in one continuous operation.

NOTE. The abbreviations used in indexing are as follows: Academy (Acad.); And (&); American (Am.); Associated (Assoc.); Association (Assn.); Bulletin (Bul.); Bureau (Bur.); Canadian (Can.); Chemical or Chemistry (Chem.); Electrical or Electric (Elec.); Electrician (Elecn); Engineer[s] (Engr.[s]); Engineering (Eng.); Gazette (Gaz.); General (Gen.); Geological (Geol.); Heating (Heat.); Industrial (Indus.); Institute (Inst.); Institution (Instn.); International (Int.); Journal (Jl.); London (Lond); Machinery (Machy.); Machinist (Mach.); Magazine (Mag.); Marine (Mar.); Materials (Matls.); Mechanical (Mech.); Mining (Min.); Municipal (Mun.); National (Nat.); New England (N. E.); New York (N. Y.); Record (Rec.); Refrigerating or Refrigeration (Refrig.); Review (Rev.); Railway (Ry.); Scientific or Science (Sci.); Society (Soc.); United States (U. S.); Ventilating (Vent.); Western (West.); State names (Ill., Minn., etc.); Proceedings (Proc.); Transactions (Trans.); Supplement (Supp.).